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Popular Article

Role of Plant Extracts on Growth and Development of Mulberry and Non-Mulberry Silkworms

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Abstract

Sericulture, to put it simply, is the utilization of an insect's method of producing silken cocoons. It is the activity of raising silkworms on a commercial scale for the production of silk. In sericulture, the quality and productivity of cocoon production to produce quality silk are of great concern. The primary criterion for good cocoon crop production is said to be the quality of the host plant leaves fed the silkworms. The growth and development of silkworms is significantly influenced by nutrition obtained from the leaves. Apart from this, different biotic and abiotic elements have an impact on the nutritional composition of host plant leaves. The growth and development of silkworms can be increased by improving the nutritional status of the leaves. To achieve this, a variety of strategies have been tested. Host plant leaf fortification with additional nutrient components is one method that can be used to enhance nutritional value and increase the production of silk with higher grades. In this context, using botanicals or plant extracts from *Ziziphus jujuba* L., *Rosa rubiginosa*, ferns, spirulina, *Ipomoea quamoclit*, *Pongamia glabra*, etc., are studied. Many plants have been shown to effect silkworm behaviour by boosting biomass or food consumption, growth and development of silkworm which increases cocoon output. Even though there are a ton of reports on these topics, the application tactics recommended are neither sufficient nor commensurate with the current production level. Therefore, a concerted effort has been undertaken in the current review to assemble all the data on the use of botanicals for the integrated improvement in economic features of the silkworms which may aid in the development of future plans.

Keywords: cocoon production, leaf fortification, nutritional status, botanicals, growth and development

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Introduction

Raising silkworms for the purpose of producing raw silk is known as sericulture. Despite the fact that there are multiple commercial species of silkworm, *Bombyx mori* L. and *Antherea mylitta* in South India; *Samia ricini* Donovan and *Antherea assamensis* Helfer in Northeast India are the most utilized species. Due to its dazzling brilliance, smoothness, elegance, toughness, and elastic characteristics, silk is recognized as the queen of textiles and a sovereign material (Venugopal 1991). Hence, the silkworm is seen as a necessary economic insect (Wang *et al*., 2011). Because of their fragility and sensitivity to environmental changes, silkworms cannot endure drastic changes in temperature and humidity. The effects of temperature and humidity show a significant relationship with silkworm physiology based on overall parameters and formative ranges influencing development, profitability, and silk (Bhatia and Youshuf, 2014).

Silkworms are phytophagous and depend solely on host plant leaves, from which it derives all of the nutrients it needs to grow and develop, including water (moisture content). The primary factor influencing the development of high-quality crop cocoons has been identified as the quality of leaves offered to the worms for eating. Superior leaves increase the likelihood of getting a good harvest of cocoons (Ravikumar, 1988). Diseases caused by pathogens in mulberry and silkworms limit the quality and quantity of silk production, which has an impact on the country's economy **(**Aruga and Tarada, 1985). Thus, the commercial worth of the cocoon can be raised by fortifying mulberry leaves with additional nutrients and feeding silkworms (Muniandy *et al.*, 1995). One method for boosting the output and quality of cocoons and silk is the enrichment of mulberry leaves with nutrients, such as pre and probiotics, antibiotics, vitamins, and amino acids (Radjabi *et al.*, 2007; Radjabi *et al*., 2009). The amount of nutrition needed when eating has a direct impact on genetic features such as pupation, reproductive qualities, pupal weight, and amount of silk production (Thangapandiyan and Dharanipriya, 2019).

Effect of plant extracts on mulberry silkworm

The total silk production in India during 2021-22 was 34,903 MT, an increase of 3.4% over the previous year (33,770 MT). The share of mulberry production is the largest among the other type of silks produced in the country which is almost about 71%. Several initiatives have been attempted to increase the quantity and quality of silk in order to preserve this output, including boosting the leaves with nutrients, spraying with antibiotics, vitamins, hormones, and hormone analogues, plant

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products, or employing plant extracts. The richest supplies of organic molecules on earth are found in plants, and phytochemicals have been shown to affect the survival and functionality of several insects (Rajasekaragouda *et al.*, 1997). By supplementing the silkworm *B. mori*, several plant extracts have been evaluated to examine how they affect the silkworm's body weight, silk gland weight, and silk thread length (Fig. 1).

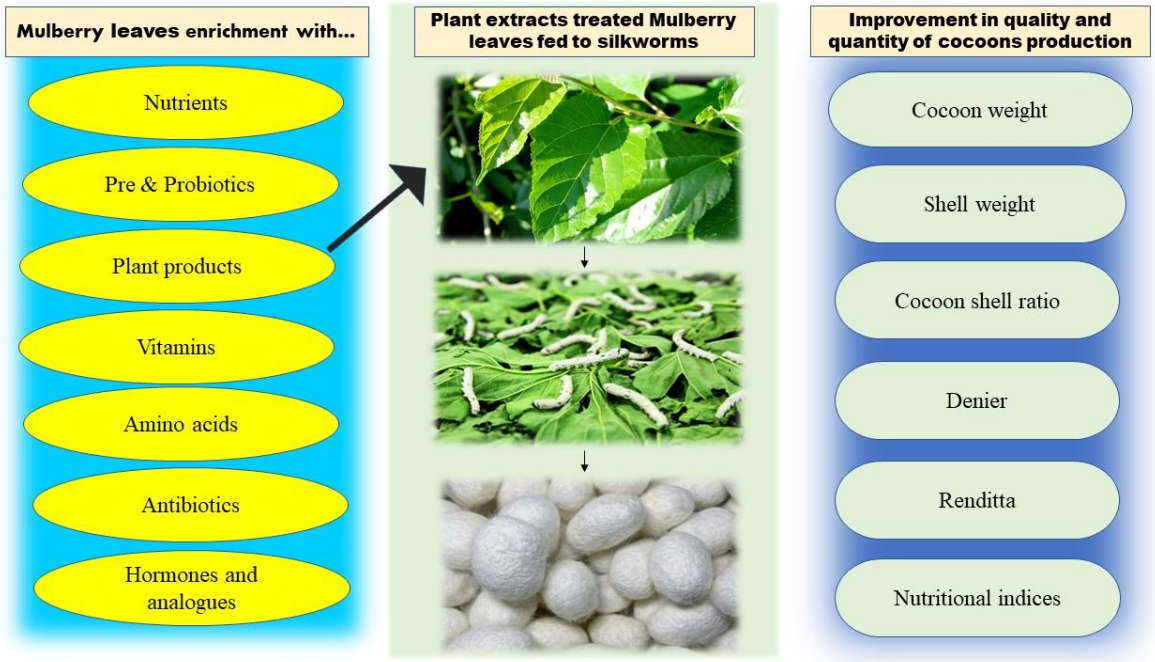

Figure 1. Effect of plant extracts on silkworms' growth and development

Efficacy of ferns on *B. mori* L.

In a lab setting with a mean temperature of 29.2°C and relative humidity of 70.5%, the growth-enhancing effects of the ferns *Nephrolepis auriculata* (L.), *Christella parasitica* (L.), *Dicranopteris linearis* (Borm.F) and *Pityrogramma calomelanes* (L.) on *Bombyx mori* L. L X NB4D2 were examined by Jeyapaul *et al.* (2005). They observed that after treatment with fern extracts, mulberry leaf consumption and efficiency measurements were much higher. The economic features were shown to be improved by fern concentrations of 0.1%. All ferns, with the exception of *Christella parasitica,* improved the efficiency of converting ingested food at a 0.4% concentration.

Efficacy of mulberry leaves fortified with *Ziziphus jujuba* L. on *B. mori*

Avhad and Hiware (2016) performed an experiment to examine the effects on the biological parameters (larval weight, mortality, cocoon weight, shell weight, pupal weight, shell ratio, filament

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length, filament weight, denier, and the number of filament breakages) of fifth instar larvae of *B. mori* L. PM X CSR2 hybrid race fed on mulberry leaves enriched with plant extracts of *Ziziphus jujuba* L. with concentrations (1: 2, 1:4 and 1:8). The outcome was quite intriguing and favorable for every aspect of the study subject, *B. mori* L. The study revealed that it had a significant impact on improving the quality and quantity of silk, which benefits farmers' ability to increase their income.

Efficacy of *Ipomoea quamoclit* plant extractson *B. mori*

Tests were conducted by Barge and Pardeshi (2022) to determine the effect of *Ipomoea quamoclit* plant extract on the growth and cocoon characteristics of *B. mori* L. silkworm larvae in their III, IV, and V instars. Various *Ipomoea quamoclit* plant extract concentrations in ethyl acetate (0.5, 1.0, 1.5, 2.0, and 2.5%) were given to silkworms in their third, fourth, and fifth instars together with mulberry. It was found that the weight of the larvae and the characteristics of the cocoon were affected by different plant extract concentrations. The exposure period and dose had a strong impact on the weight of the larvae and the characteristics of the cocoon. They also found that higher larval growth and increased cocoon weight were the results of the plant extract at a 2.0% concentration. The addition of this plant extract over the control also resulted in a rise in the typical pupa weight, weight of the shell, ratio of the shells, and silk filament length, sericin, and fibroin content.

Efficacy of phytoecdysteroid extracted from *Achyranthes aspera* on *B. mori*

Since the phytoecdysteroid stimulates physiological and developmental processes to speed up the larval stage so that cocoons can spin simultaneously and labour can be saved, studies of its administration to silkworm larvae have been conducted by Upadhyay and Pandey (2013). The *Achyranthes aspera* plant extract with phytoecdysteroid activity was used them in this experiment. The tests used single, double, and triple treatments with phytoecdysteroid concentrations of 40, 50, 60, and 70%. They found that the duration, length, weight, and survival of *B. mori* larvae were all strongly influenced by a variation in the number of treatments (P1>0.05). The number of days a larva spent developing fell from 22.90 days (the control) to a minimum of 21.52 days in the case of 60%, double treatment of larvae. They reported that the number of treatments, up to 60%, and double treatment of the larvae all contribute to an increase in larval length. The greatest recorded larval length was 6.98 cm in the case of 60% of double-treated larvae, while the minimum was 4.90 cm in the case of 70% of triple-treated larvae. Larval weight increased as phytoecdysteroid therapy intensified (from single to double treatment at concentrations of 40, 50, and 60%), reaching its

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highest level (0.14.36 gm) in the latter case. The maximum larval survival observed was 95.25-1.55 percent when larvae were doubly treated with 60% phytoecdysteroid concentration.

Efficacy of *Aloe vera* oil on the fecundity and hatchability on *B. mori*

In the sericulture sector, the use of *A. vera* oil on *B. mori* has been demonstrated to be significant. In order to treat *B. mori*larvae in their third, fourth, and fifth instars, the studies were carried out by Singh *et al*. (2014) using different concentrations of *A. vera* oil, namely 0.25, 0.50, 0.75, and 1.0 ml as single, double, and triple treatments. A triple treatment with 0.75 ml of *A. Vera* oil resulted in the highest levels of fecundity (409.663.31 eggs) and hatchability (96.751.22%). In the event of triple treatment with 1.0 ml of *A. Vera* oil, the lowest fecundity (270.001.86 eggs) and hatchability (75.001.60%) were observed. They have suggested that if *A. Vera* oil is applied carefully, it may promote the production of high-quality cocoons on a commercial scale.

Efficacy of dietary supplementation of *Sida acuta* plant extract on *B. mori*

To improve the performance of growth and cocoon characteristics of silkworms, *B. mori* the *Sida acuta* plant extract was tested against III, IV, and Vth instar larvae of silkworms by Barge and Pardeshi (2022). Several concentrations of *Sida acuta* plant extracts in methanol (0.5, 1.0, 1.5, 2.0, and 2.5%) were given to silkworms in their third, fourth, and fifth instars together with mulberry. They found that the weight of the larvae and the characteristics of the cocoon were affected by different plant extract concentrations. The exposure period and dose had an impact on how strong the influence was. They reported that higher larval growth and increased cocoon weight were the results of the plant extract at a 2.0% concentration. The average larval weights and the final instar larva of *B. mori* relative growth rate both rose. With this addition of plant extract over the control, the average pupa weight, shell weight, shell ratio, and silk filament length were also increased. They concluded that plant extract from *Sida acuta* has a growth-promoting function in silkworms, which helps to improve the silk's performance in *B. mori*.

Efficacy ofdietary supplementation of *Stevia rebauidana* extract on *B. mori*

The research was carried out by Shahin (2019) to determine the effect of stevia leaf extract on the biological, economic, and physiological traits of *B. mori* L., as well as the traits of the larvae in their fifth instar. The last instar consumed more than 80% of the mulberry leaves during its lifetime, so, the fifth instar larvae were fed mulberry leaves supplemented with stevia leaf extract in varied doses. They observed that when 0.05 followed by 0.1% was applied, there was a noticeably

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greater rise in the weights of the larva, silk gland, pupal cocoon shells, and the number of eggs laid as compared to the control. The stevia leaf treatment at 0.05% had the highest total hemolymph protein levels, and protease activity followed a similar pattern. Through enhancing digestion, which in turn boosts the production of protein and fertility, the usage of stevia leaves appears to have a good effect on increasing the amount of silk produced. It was concluded that stevia leaves may have the same impact as a juvenile hormone since the larval stage was prolonged by two days over the control.

Effect of plant extracts on non-mulberry silkworm:

Effect of plant extracts on larval growth parameters of Eri Silkworm, *Samia ricini*

Eri silkworms can be raised all year long, up to 6-7 times per year (Rajesh and Elangovan, 2012). It has been domesticated and raised indoors. In the 30-35 day period from hatching to mature cocoon-forming stages, the worms moult four times (Gogoi and Kalita, 2009). The polyphagous Eri silkworm is mostly raised on the leaves of the Castor (*Ricinus communis* L.) and Kesseru (*Heteropanax fragrans* Seem) plants. The research was carried out by Lalmuankimi et al. (2020) to investigate the impact of plant extracts on the larval growth characteristics of the eri silkworm, *Samia ricini*,by trating*Ricinus communis*, the host plant. For aqueous extraction, three distinct plant materials —*Mikania micrantha*, *Murraya koenigii*, and *Pongamia glabra* were used. The aqueous extracts of the leaves from each plant were then produced in distilled water at various strengths, namely 5, 10 and 15%. It was observed that feeding enriched castor leaves with plant extracts in various dosages had no discernible impact on the eri silkworm larval duration and larval weight compared to the control. However, the significant increase in the weight of mature larvae, as well as silk gland, was observed over the control batches of worms when the worms are fed with the fortified castor leaves with plant extracts. Thus, they found that among the concentrations 10 % exhibited better results in all the parameters.

Conclusion

Plant-based products are cheap, biodegradable and easily available and therefore environment friendly and cost-effective. Thus, it may be concluded that the treatment of mulberry and non-mulberry silkworms with different concentrations of plant extracts influence the economic traits of silkworm. However, the treatment of larvae with a moderate concentration of plant extract caused a beneficial effect on economic parameters, whereas the higher concentration of plant extract caused an adverse effect. Thus plant extracts, botanicals, essential oils or plant based products for

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nutritional fortification have emerged and has the potentiality to develop as an effective and sustainable alternative to uplift the silkworm health in a broad spectrum as well as prove to be a safe and cost effective method for the sericulture farmers for quality cocoon crop production.

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