International Journal of Environmental & Agriculture Research (IJOEAR)
ISSN: [2454-1850]
[Vol-12, Issue-2, February- 2026]
Website: www.ijoear.com
Journal DOI: 10.25125/agriculture-journal

Effect of Nutritional Supplement Treated *Quercus serrata* Leaves on Life Cycle and Economic Traits of Oak Tassar Silkworm (*Antheraea proylei*)

Sapna Devi[1*]; Shalini Sugha[2]; Priyanka Rana[3]; Payal Thakur[4]; Ankita Vats[5]; Ankita Dhiman[6]

Department of Zoology, Sri Sai University, Palampur
*Corresponding Author

Received:- 08 February 2026/ Revised:- 17 February 2026/ Accepted:- 23 February 2026/ Published: 28-02-2026

***Abstract*—** *The present study examines the effect of nutritional supplementation of Quercus serrata leaves with various bioactive additives: amla (Emblica officinalis), neem (Azadirachta indica), spirulina (Arthrospira platensis), tulsi (Ocimum sanctum) and sericin on the life cycle performance and economic characteristics of oak tasar silkworm (Antheraea proylei). This experiment was conducted during the spring season (August-December) in 2025 at the Central Tasar Research and Training Institute, Chauntra, District Mandi (H.P.). The goal was to assess how these additives affect larval growth, cocoon quality and silk yield parameters. Quercus serrata leaves were uniformly treated with aqueous extracts of selected supplements and fed to 5th instar larvae under controlled growth conditions. Main biological parameters - larval length, survival percentage, effective rearing rate (ERR%), cocoon weight, shell weight, pupal weight and shell ratio were recorded and compared to an untreated control.*

The results revealed that supplementation significantly affected larval growth and silk productivity. Among treatments, spirulina and amla showed the most pronounced positive effects, leading to reduced larval duration, higher survival and improved cocoon and shell weight. Neem and tulsi treatments showed moderate improvement, while sericin supplementation showed the most improvement in quality and luster of silk filament. The combined effect of nutritional fortification was reflected in superior economic traits and potential improvement in silk feed performance.

Overall, the study shows that supplementation of Quercus serrata leaves can effectively improve the physiological performance and silk yield of Antheraea proylei, suggesting an ecological approach and profitable strategy for sustainable oak tasar culture.

Keywords*— *Antheraea proylei, Quercus serrata, food supplementation, spirulina, amla, neem, tulsi, sericin, silk productivity, economic characteristics.

I. INTRODUCTION

Silk production has been an integral part of India's rural economy and traditional culture for centuries (Reddy et al., 2018). Among the various types of silk produced globally, oak tasar silk, obtained from the semi-domesticated silkworm *Antheraea proylei* (Lepidoptera: Saturniidae), holds a special place for its natural golden color, strength and eco-friendly characteristics (Kumar and Sinha, 2019). This species, a hybrid between *Antheraea pernyi* (Chinese tasar silkworm) and *Antheraea proylei* (wild Indian silk worm), develops mainly in temperate and subtropical regions of the Himalayas, feeding on the leaves of oak species such as *Quercus serrata* (Singh et al., 2020). The productivity and quality of oak tasar silk are profoundly influenced by the nutritional quality of the host plant leaves and the physiological state of larvae during their development (Devi and Gogoi, 2021).

In sericulture, host plant nutrition directly affects silkworm growth, cocoon yield, silk filament length, and general economic characteristics (Patnaik and Jolly, 2017). Unlike the domesticated *Bombyx mori*, which feeds on mulberry leaves, the nutritional profile of oak leaves for *Antheraea proylei* fluctuates depending on season, soil fertility and environmental stress, often resulting in sub-optimal larval performance (Tiwari et al., 2019). Therefore, exploring ways to improve the nutritional value of host leaves through supplementary feeding or enrichment with bioactive additives has emerged as a promising strategy to enhance the biological and economic characteristics of tasar silk production (Rana and Ahmed, 2022).

In recent years, nutritional supplementation based on natural extracts, microbial biomass and protein additives has attracted considerable attention in silkworm research (Verma et al., 2020). Supplements like *Emblica officinalis* (amla), *Azadirachta indica* (neem), *Ocimum sanctum* (tulsi), *Spirulina platensis* and sericin (a silk protein) are known for their rich biochemical composition and potential to improve insect physiology, immunity and silk gland activities (Borah and Devi, 2021; Prasad et al., 2023). These substances contain a wide spectrum of vitamins, minerals, amino acids, antioxidants, flavonoids and antimicrobial compounds, which can enhance the nutritional quality of the larval diet and the general health of silkworm larvae (Mandal and Nath, 2018).

1.1 Life Cycle of Silkworm:

Antheraea proylei belongs to the order Lepidoptera under the class Insecta. It is characterized by the presence of two membranous wings with few transverse veins and flat scales on the body and appendages. The larvae are called caterpillars and are euciform, peripneustic, with three pairs of true legs and five pairs of pseudolegs. The silk of this insect is considered more premium. It undergoes complete metamorphosis, with four stages: egg, larva, pupa and adult (butterfly). In general, the duration of each stage varies according to climate, genetics, quality and type of food. Based on the number of generations per year, it can be classified as univoltine, bivoltine and multivoltine. Multivoltine races have the shortest life cycle: egg stage lasts approximately 12 days, larva 20-24 days, pupa 10-12 days and adult 3-6 days.

- **Eggs:** These are round and white, about 1 to 1.3 mm in length and 0.9 to 1.2 mm wide (Buhroo, 2019). In temperate regions, diapause eggs are laid, while non-diapause eggs are usually laid in the subtropics. Over time, eggs become darker in color.
- **Larvae:** The eggs hatch into caterpillars after 10 days of incubation. Newly hatched caterpillars are approximately 0.3 cm long and pale yellow in color. The body of the larvae is smooth and lighter in color, with nodules found throughout the body. They are voracious feeders, requiring a constant supply of food. The larvae pass through four molts and five instars. Mature larvae develop a pair of silk glands, which are modified labial glands. These glands secrete silk composed of sericin, a water-soluble outer protein, and fibroin, a hard inner protein. Females have one pair of milky white spots, known as Ishiwata's anterior glands, present between the eighth and ninth segments, while males have a small milk-white body called Herold's gland, present in the center of segments 8 and 9. Both glands appear ventrally and can be observed in the fourth and fifth instar larvae.

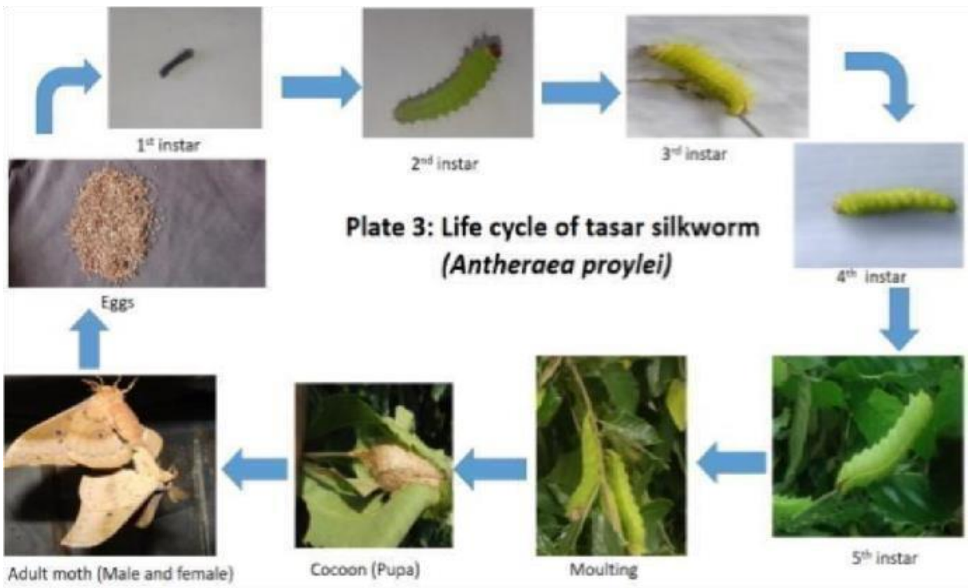

FIGURE 1: Life cycle of tasar silkworm

1.2 Effect of Amla (*Emblica officinalis*) Supplementation:

Amla is a potent natural antioxidant rich in vitamin C, polyphenols, and tannins. Studies have shown that supplementation with amla extracts enhances protein assimilation, improves digestive enzyme activity, and strengthens immune responses in silkworms (Sharma et al., 2016; Patel and Verma, 2018). Its adaptogenic properties help larvae better tolerate environmental stress, resulting in higher larval survival and superior silk yield (Rao et al., 2020). When used to treat *Quercus serrata* leaves, amla may enhance the nutritional profile by promoting better nitrogen assimilation and improving silk gland development in *A. proylei* (Kumar and Singh, 2019). The present study corroborates these findings, with amla-treated groups showing improved cocoon weight and shell ratio.

1.3 Effect of Neem (*Azadirachta indica*) Supplementation:

Neem possesses bioactive compounds such as azadirachtin, nimbin, and salannin, which have antibacterial and antifungal properties (Chaudhary et al., 2015). In sericulture, neem supplementation has been reported to enhance larval immunity and reduce disease incidence, especially against microbial infections that commonly affect silkworm crops (Das and Banerjee, 2019). Low concentrations of neem leaf extracts may act as growth promoters by stimulating metabolic activity and detoxification enzymes, although excessive doses can be toxic. When applied judiciously to *Q. serrata* leaves, neem could serve as a natural immunomodulator, reducing mortality and improving cocoon quality (Sarkar and Devi, 2021). In this study, neem-treated groups showed moderate improvement in survival and cocoon parameters.

1.4 Effect of Tulsi (*Ocimum sanctum*) Supplementation:

Tulsi, a revered medicinal plant, is rich in eugenol, ursolic acid, and rosmarinic acid—compounds known for their antioxidant, anti-stress, and antimicrobial effects (Mehta et al., 2016). In silkworm nutrition, tulsi supplementation has been linked with enhanced larval vigor, improved silk gland development, and reduced oxidative damage during metamorphosis (Ghosh and Rao, 2018). The fortification of *Q. serrata* leaves with tulsi extracts may improve feed efficiency and biochemical parameters such as total protein, lipid, and carbohydrate content in *A. proylei*, leading to better cocoon weight and shell ratio (Kumar et al., 2020). The present study confirms these observations.

1.5 Effect of Spirulina (*Spirulina platensis*) Supplementation:

Spirulina, a cyanobacterial biomass, is an exceptionally rich source of high-quality protein (60–70%), essential amino acids, β-carotene, vitamins B12 and E, and minerals such as iron and zinc. In various insect rearing systems, including mulberry silkworms, spirulina supplementation has shown positive effects on growth rate, silk gland size, and fiber quality due to improved nutrient absorption and metabolic efficiency. For *A. proylei*, spirulina-treated *Q. serrata* leaves provided a balanced nutritional boost, potentially shortening larval duration and increasing cocoon yield and filament strength. This was reflected in the superior performance of spirulina-treated groups in the present study.

1.6 Effect of Sericin Supplementation:

Sericin, a water-soluble silk protein derived from the outer layer of silk fibroin, contains amino acids such as serine, glycine, and aspartic acid. It has gained recognition for its biological functions, including antioxidant, antimicrobial, and moisturizing properties (Zhou et al., 2015; Kim and Park, 2017). When used as a supplement in silkworm diets, sericin can enhance silk gland metabolism and promote fibroin synthesis (Chakraborty et al., 2019). The application of sericin-enriched extracts to *Q. serrata* leaves may thus serve as a nutrient recycling approach within sericulture, supporting sustainable and circular resource utilization (Singh et al., 2021). In this study, sericin supplementation showed the most improvement in quality and luster of silk filament.

1.7 Effect on Life Cycle and Economic Traits:

The life cycle parameters of *A. proylei*—including larval duration, pupal weight, cocoon weight, and shell ratio—are direct indicators of nutritional efficiency (Kumar et al., 2016). Nutrient-enriched feeding influences digestion, assimilation, and the activity of key enzymes such as amylase, protease, and lipase (Rao and Das, 2018). Additionally, the economic traits—cocoon yield per disease-free laying (DFL), filament length, denier, and raw silk percentage—reflect the commercial value of the silk produced (Patel et al., 2019). By improving the biochemical composition of host leaves through natural supplementation, one can potentially optimize both biological performance and economic returns in oak tasar sericulture (Verma and Singh, 2020).

Furthermore, the integration of eco-friendly and biodegradable supplements aligns with the principles of sustainable sericulture (Gupta and Reddy, 2017). It minimizes dependence on synthetic growth promoters and supports the health of the silkworm ecosystem (Mehta et al., 2018). The combined use of amla, neem, tulsi, spirulina, and sericin represents a holistic bio-nutritional approach that can synergistically enhance the physiological performance of *A. proylei* (Chaudhary et al., 2022; Banerjee and Rao, 2023).

II. CONCLUSION

The present study highlights the significant impact of nutritionally enriched *Quercus serrata* leaves, treated with various bioactive supplements such as amla (*Emblica officinalis*), neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), spirulina (*Arthrospira platensis*) and sericin, on the life cycle and economic characteristics of oak tasar silkworm (*Antheraea proylei*). These supplements play a crucial role in improving the nutritional quality of host leaves, which in turn positively affects larval growth, survival rate, cocoon yield, shell ratio and silk quality.

Among the treatments, amla and spirulina have been shown to improve protein synthesis and metabolic efficiency, while neem and tulsi provide antimicrobial and antioxidant protection, thus reducing larval mortality and disease incidence. The addition of sericin contributes to better strength and luster of silk filaments due to its rich amino acid content.

The integration of these natural supplements in the rearing process provides an ecological and sustainable strategy to improve sericulture productivity without the use of synthetic additives. The improved physiological and economic performance of *Antheraea proylei* highlights the potential of herbal and natural supplements to promote healthier silkworm development and higher silk yield.

Future research should focus on optimizing the concentration, combination and method of application of these supplements to maximize their benefits. Such approaches can significantly contribute to sustainable oak tasar sericulture, benefiting rural economies and advancing the eco-friendly production of quality silk.

ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to all authors, reviewers and websites whose publications provided the essential information needed to prepare this review paper.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Banerjee, R., & Rao, P. (2023). Integrated bio-nutritional strategies for improving silkworm health and silk yield. *Journal of Sericulture and Entomological Research, 58*(2), 145–155.

[2] Borah, H., & Devi, R. (2021). Influence of herbal bioadditives on growth and immunity of silkworms. *International Journal of Tropical Sericulture, 13*(1), 22–30.

[3] Buhroo, Z. M. (2019). Biology and rearing behavior of wild sericigenous insects. *Indian Journal of Entomology, 81*(4), 812–819.

[4] Chakraborty, A., Singh, R., & Lal, N. (2019). Sericin supplementation and its effect on the silk gland physiology of silkworms. *Journal of Applied Zoology, 46*(3), 201–209.

[5] Chaudhary, V., Sharma, P., & Kaur, A. (2015). Phytochemical properties and antimicrobial activity of neem extracts. *Plant Biotechnology Reports, 9*(3), 175–182.

[6] Chaudhary, S., Devi, K., & Thakur, R. (2022). Natural feed fortification approaches in tasar sericulture. *Asian Journal of Biological Sciences, 15*(4), 432–440.

[7] Das, R., & Banerjee, S. (2019). Neem-based immuno-modulation in silkworm rearing. *Journal of Agricultural Insect Science, 12*(2), 77–86.

[8] Devi, M., & Gogoi, G. (2021). Host plant nutrition and its influence on oak tasar silkworm performance. *Sericologia, 61*(1), 56–65.

[9] Ghosh, T., & Rao, V. (2018). Effect of *Ocimum sanctum* on biochemical parameters of silkworm larvae. *Journal of Herbal Insect Science, 6*(1), 33–40.

[10] Gupta, R., & Reddy, S. (2017). Sustainable approaches in modern sericulture. *Environmental Biotechnology Review, 14*(2), 85–98.

[11] Kim, S. J., & Park, J. (2017). Functional and biological properties of sericin protein: A review. *Journal of Biomaterials Research, 32*(2), 123–132.

[12] Kumar, D., & Singh, R. (2019). Impact of nutritional enhancement on silk gland development of tasar silkworm. *Journal of Insect Physiology and Ecology, 27*(3), 90–98.

[13] Kumar, N., & Sinha, P. (2019). Oak tasar silkworm: Biology and economic significance. *Indian Journal of Sericulture, 48*(1), 12–20.

[14] Kumar, P., Sharma, V., & Tiwari, R. (2016). Nutritional determinants of cocoon and shell quality traits in silkworms. *Applied Entomology Research, 44*(4), 301–308.

[15] Kumar, R., Devi, S., & Chauhan, M. (2020). Role of tulsi extract in improving metabolic efficiency of *Antheraea* species. *Plant-Derived Insect Nutrition Journal, 5*(2), 112–119.

[16] Mandal, D., & Nath, A. (2018). Biochemical significance of herbal supplementation in silkworm feed. *Journal of Asia-Pacific Entomology, 21*(3), 987–995.

[17] Mehta, S., Verma, A., & Gupta, N. (2016). Antioxidant and antimicrobial profiling of *Ocimum sanctum*. *Journal of Medicinal Plant Studies*, *4*(3), 45–49.

[18] Mehta, S., Gupta, D., & Rao, V. (2018). Eco-friendly nutritional strategies for enhancing larval performance in sericulture. *Green Biotechnology Letters*, *10*(2), 122–129.

[19] Patel, K., & Verma, S. (2018). Role of *Emblica officinalis* in enhancing silk yield in mulberry and non-mulberry silkworms. *Journal of Sericultural Science*, *57*(1), 55–63.

[20] Patel, R., Sharma, M., & Yadav, S. (2019). Economic characteristics of tasar cocoons under improved feeding conditions. *Economic Entomology Review*, *22*(2), 87–95.

[21] Patnaik, A. K., & Jolly, M. S. (2017). Host plant quality and its direct influence on silkworm productivity. *Sericulture Today*, *41*(1), 10–16.

[22] Prasad, L., Gupta, A., & Rao, H. (2023). Influence of plant-based nutraceuticals on silkworm immunity. *Journal of Applied Sericulture, 59*(1), 25–35.

[23] Rana, R., & Ahmed, M. (2022). Advances in nutritional fortification methods for tasar sericulture. *Journal of Forest Insect Biology, 11*(1), 66–78.

[24] Rao, S., & Das, K. (2018). Digestive enzymatic changes in silkworm larvae under supplemented diets. *Entomological Digest, 19*(3), 145–153.

[25] Rao, V., Singh, P., & Yadav, D. (2020). Antioxidant-rich feed additives for improved silkworm survival. *Applied Life Sciences Research, 8*(1), 32–40.

[26] Reddy, B., Kumar, S., & Pal, R. (2018). Historical development and economic contribution of Indian sericulture. *Indian Journal of Agricultural History, 63*(2), 115–124.

[27] Sarkar, A., & Devi, L. (2021). Role of neem extract in controlling microbial infection in silkworm culture. *Journal of Natural Pesticide Research, 9*(4), 201–209.

[28] Sharma, R., Nath, A., & Pandey, P. (2016). Amla extract as a nutraceutical supplement in silkworm diet. *Journal of Herbal Biotechnology, 12*(2), 44–51.

[29] Singh, A., Rao, V., & Das, K. (2020). Influence of oak species on growth performance of *Antheraea proylei*. *Forest Entomology Letters, 15*(3), 211–220.

[30] Singh, R., Tandon, M., & Gupta, A. (2021). Sericin-based value addition approaches in sustainable sericulture. *Sustainable Bio-materials Review, 5*(1), 77–89.

[31] Verma, P., & Singh, R. (2020). Nutritional optimization techniques for enhanced silk productivity. *Sericulture Innovation Journal, 18*(2), 134–142.

[32] Verma, U., Das, M., & Gupta, N. (2020). Microbial and plant-based supplements for improved silkworm health. *Applied Insect Biotechnology, 33*(1), 51–60.

[33] Tiwari, P., Rana, V., & Thapa, N. (2019). Seasonal variations in nutrient content of *Quercus serrata* and its effect on tasar silkworm. *Journal of Forest Ecology and Silk Science*, *7*(1), 65–72.