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Effect of Nutrient Supplements on Economic Traits of Silkworm *Bombyx mori* L.: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Silk is a fantastic fabric that is appropriately referred to as "The Queen of Textiles." Silk is the fabric that has captivated man for millennia more than any other. Silk is still the best fibre, even after it has been around for over 5000 years. A mature silkworm larva constructs its cocoon in the pre-pupation stage, creating natural silk, an insect-derived fibre. The silk generated by the silkworm *Bombyx mori* stands out as one of the natural fibres, renowned for being the most sought-after and luxurious natural fabric available. This textile fibre of animal origin is esteemed for its role in creating high-quality textiles. The mulberry silkworm plays a vital role in the economy, significantly impacting the country's development. Silkworm is an exceptionally sensitive insect that exclusively consumes mulberry leaves, demonstrating a monophagous feeding behaviour. Among other things, the success of silkworm farming depends on the provision of adequate nourishment. Nutrition is a vital physiological factor that influences silkworm growth, development, and silk production. The

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nutrition of the silkworm, *Bombyx mori* L., has been crucial in sericulture since it has been demonstrated that the nutritional value of mulberry leaves influences not only larval growth and survival but also cocoon and egg production. Biological and economic parameters of silkworm *Bombyx mori* are determined by the nutritional value of feed. Dietary supplements such as milk, honey, amino acids,vitamins, probiotics etc., are useful to maintain and improve the overall health and growth of the silkworm to obtain the good quality of cocoons to fetch a better price in the market. Therefore, enriching mulberry leaves by nutrient supplementation is one of the ways to improve growth rate in silkworm *Bombyx mori.* and commercial characters of cocoon.
In view of the above, the authors scanned and reviewed the literature on the significance of different nutrient supplements on the growth and development of silkworm *Bombyx mori* and commercial characteristics of cocoons.

Keywords: Nutrition; supplementation; mulberry leaves and silkworm.

1. INTRODUCTION

The silkworm feeds only in the larval stage, which continues for a period of about 25–26 days. Silk produced at the end of the larval stage is important. Mulberry leaves play an important role in the larval stage of the silkworm, *Bombyx mori*. Benchamin and Jolly (1986) noticed the enhancement of silkworm growth by the quality of mulberry leaves, thus leading to the production of better cocoon crops. As the quality of mulberry leaf has an intimate relation to the healthy growth of the larvae and quality of their cocoon, the chemical composition of the leaves has a great scope in determining the food value (Anil Kumar and Sunil Kumar, 2018).

Successful rearing mostly depends on satisfying the nutritional demands of the silkworm, since there is a strong correlation between nutrition and the physiology of growth of the silkworms. Nutrition is an essential component of all living things. The quantity and quality of mulberry leaves have an impact on the larvae's growth rate, body weight, developmental stage, and survival rate. They also affect the longevity, mobility, competitiveness, and fertility of the adult silkworms. Like other species, silkworms are sensitive to nutritional factors. Supplemental nourishment can enhance the growth, health, qualitative and quantitative parameters of cocoon and silk producing capacity of silkworm *Bombyx mori*.

Sengupta et al. (1972) stated that the nutritional status of different mulberry genotypes can be improved by enriching with extra nutrients such as sugars, amino acids, and lipids to increase larval growth and cocoon characteristics of different silkworm races. Several attempts have been made to fortify the leaves with different beneficial nutrients and combinations of nutrients to enhance the quality of the cocoon crop, the silkworm (Rajegowda, 2002). To increase the economic value of cocoon, supplementation of mulberry leaves by using extra nutrients is a useful modern technique (Rahmathulla et al., 2007). Masthan et al. (2017) stated that silk production is mostly dependent on larval growth and the nutritive value of mulberry leaves. Anil Kumar and Jayaraju (2021) opined that supplementation of many dietary compounds such as proteins, sugars, aminoacids, vitamins, minerals, salts, etc. can enhance the growth and development of silkworm, further improving the quality of cocoons. Silkworm development and cocoon production may be enhanced by adding food supplements with high nutritional value. Several researchers investigated the influence of various nutritional supplements such as milk, protein sources, honey, amino acids, vitamins and minerals etc., on the growth and development of silkworm *Bombyx mori* and commercial traits of cocoons.

After scanning through the literature, the authors understood the significance of nutritional supplementation to silkworm *Bombyx mori* and were enthused to review the literature for the benefit of researchers working on similar lines.

2. NUTRITIONAL SUPPLEMENTS AND THEIR EFFECT ON SILKWORM GROWTH

2.1 Milk

Milk supplementation in silkworm rearing is an interesting approach aimed at enhancing growth and cocoon production. While traditional silkworm diets primarily consist of mulberry leaves, milk (often in the form of skim milk or milk

powder) can provide additional nutrients that might promote better growth and health.

Milk is rich in bioactive compounds such as proteins, carbohydrates vitamins, and minerals, which can help elevate the overall development of silkworms. Supplementation with milk may accelerate the growth rate, produce better-quality cocoons, and potentially increase silk yield. Haug et al. (2007) stated that polyamines, peptides, and enzymes in milk can modulate many regulatory processes of the silkworm. Ruiz-Erazo (2023) noticed elevation of larval weight in the silkworms fed with mulberry leaves dipped in the whole milk on alternate days (1, 3, and 5) in the fourth to fifth instar compared to untreated silkworms. Nikarika Konala et al., 2013 stated that casein present in milk has proven to be beneficial for the development of *Bombyx mori* as it contains glutamic acid, resulting in proper growth of the larvae, observed the 8% enhancement of cocoon weight in the milk-supplemented silkworms compared to untreated silkworms and suggest that silkworms can be supplemented with milk through mulberry leaves for good growth and development and enhancement of silk production. According to Md. Shakhawat Hossain et al. (2015), the larvae fed milk-treated mulberry leaves gained 208% of their body weight between days 1 and 5, whereas the larvae given fresh leaves gained 188% of their body weight over the same period. It was advised that silkworm larvae be fed mulberry leaves bathed in cow milk during the fifth instar to improve larval weight and reeling performances. Compared to the control, cocoon weight increased by 18% and shell percentage by 11%. Mohamed and Helaly (2018) suggested that growth and development of silkworm is may be due to the high lipid and protein content of milk. The efficacy of cow's milk as a protein supplement to enhance silkworm, *Bombyx mori* growth and expression of productive parameters was assessed by Ruiz et al.(2023). Growth and the assessed attributes are positively impacted by supplementation, increasing the silk output yield.

2.2 Honey

The main ingredient in honey is sugar, but it also includes a number of minerals, vitamins, amino acids, iron, zinc, and antioxidants. Honey is used as an antibacterial, anti-inflammatory, and antioxidant agent. As a result, honey may be a useful supplement for silkworms and may improve the nutritional content of mulberry leaves and positively impact various commercial characteristics of silkworms and protect the silkworms from different infections. Bhatti et al. (2019) revealed that with mulberry leaves supplemented with an aqueous solution of 2% honey, the digestive capacity of the experimental group was better when compared with the control; an increase in weight was observed in the experimental group up to 348.23% than in the control group with a weight gain of 204.54% and formed the cocoon earlier with uniform shape. Madhavi and Siva Prasad (2020) noticed a significant elevation of total proteins in the silkworms fed with mulberry leaf supplemented with honey. Thulasi and Sivaprasad (2015) observed a great improvement in silk gland weight (g) when compared to the control group in silkworms fed with mulberry leaves supplemented with honey. According to Gabriela-Maria Baci (2021) honey is a valuable supplement that may be applied to silkworms and improve the quality of silk biomaterials. Saeed Samarghandian et al. (2017) opined that honey possesses a wide range of therapeutic benefits due to the presence of more than two hundred bioactive compounds.

2.3 Probiotics

Probiotics are live yeasts and bacteria that are good for supplementation. Probiotic supplements increase the body's natural supply of beneficial microorganisms, strengthen resistance to infections, and aid in boosting the immune system. The characters of silkworms and cocoons were found to be enhanced with the mulberry leaf supplemented with spirulina (Venkataramana, 2003). According to Singh et al. (2005), probiotic *Lactobacillus* supplementation improved the cocoon production of mulberry silkworm *Bombyx mori*. Mala and Vijila (2018) stated the silkworms supplemented with *Bacillus licheniformis* recorded maximum larval weight, cocoon weight, shell weight, pupal weight, effective rate rearing, shell ratio, filament length, and silk productivity, followed by *Bacillus licheniformis* + *Bacillus niabensis* (106 cfu/ml). The same researchers reported that the body's innate defence mechanisms were stimulated by probiotics, increasing the production of the antimicrobial peptide defences in the intestines. Saranya et al. (2019) investigated and found that the economic parameters of the silkworm (bivoltine double hybrid (CSR6 x CSR26) x (CSR2 x CSR27)) fed with mulberry leaves treated with *Staphylococcus gallinarum* strain SWGB 7 (108 cfu/ml) recorded maximum larval

weight (4.12 g), cocoon weight (1.97 g), effective rate rearing (96.36%), pupal weight (1.60 g), shell weight (0.37 g), shell ratio (18.78%), silk productivity (4.81 g), filament length (1170.84 m), finer denier (2.38), and filament weight (0.31 g), besides reducing the larval mortality up to 3.64% due to a drop in incidence of the disease compared to control.The growth and economic parameters of silkworm has been elevated with the supplementation of probiotic bifilac at three different concentrations (1%, 2% and 3%), among which 2% recorded maximum effective rate rearing (96.85%), larval weight (5.39 g), cocoon weight (1.81 g), shell weight (0.408 g), silk weight (0.378 g), shell length (0.408 g) and finer denier (3.88) besides larval mortality being reduced (3.64%) when compared with control (Anisha et al. 2022). Kumar & Balasubramanian (2013 and 2014) observed the elevation of silkworm weight supplemented with spirulina through mulberry leaves. A significant elevation of fifth instar silkworm weight was observed when fed with spirulina supplimented through mulberry leaves compared with control (Shruti et al*., 2019*). Neha Panda et al. (2022) observed that mulberry leaf supplemented with spirulina increased the silkworm weight (3.3±0.365) compared to control (2.7±0.279) Sharada et al. 1956.

2.4 Amino Acids

Amino acids are biochemical compounds that are necessary for a variety of body processes. The creation of body protein and other significant nitrogen-containing substances, including creatine, peptide hormones, and certain neurotransmitters, depends on amino acids. Ayesha et al. (2023) revealed that the average weight of the 5th instar silkworm and the ratio of silkgland to body weight were significantly ($P<0.05$) higher in the experimental silkworms fed with mulberry leaves fortified with amino acids. Ayesha et al. (2023) reported that the average weight of the 5th instar silkworm and the ratio of silkgland to body weight were significantly ($P<0.05$) higher in the experimental silkworms fed with mulberry leaves fortified with amino acids and significant elevation of commercial traits of silkworms. Further, silkworms fed with 1% Alanine-supplemented mulberry leaves showed a positive effect on the commercial and biological traits of *Bombyx mori.* Murugesh et al. (2021) found the enhanced growth of the silkworm and cocoon characters by the supplementation of glycine, alanine, and serine at 10 ppm and 100 ppm concentrations. Various studies carried out by researchers revealed that the mulberry leaves supplemented with amino acids significantly improved the raw silk production. Mulberry leaves enriched with different amino acids like essential amino acids (Arai and Ito, 1964; Ito, 1967; and Inokuchi et al., 1967), glycine (Sharadha and Bhat, 1956; Ravi et al., 1994; and Saad et al., 2019), tyrosine, phenylalanine, and alanine (Nagarajan and Radha, 1990), glycine, serine, and alanine (Mustafa and Elkaraksy, 1990), aspatic acid (Kabila et al., 1994), glycine, phenylalanine, serine, and aspartic acid (Vadivel, 1995), alanine and asparginine (Radjabi et al., 2010), arginine, and histidine (Chakrabarthy and Kaliwal, 2012), and serine (Gokul, 2015) showed an elevation of silkworm growth, cocoon characters, reeling, and silk productivity (Kamada & Ito 1984).

2.5 Vitamins

Vitamins support regular growth, boost the immune mechanism, and are essential for various biological functions. Yasuhiro Horie and Toshio Ito (1963) studied the vitamin requirements of silkworms and observed the resumption of growth. Kayvan Etebari and Leila Matindoost (2005) studied the impact of multivitamins as food supplements on the biological and economic features of silkworm *Bombyx mori* and noticed a 4.7% elevation in cocoon weight and number of eggs, but the study also indicated a relatively low hatching percentage. Balasundaram et al. (2013) investigated the supplementation of Vitamin C on silkworms and observed feed efficacy and enhancement of growth and suggested that this elevation may be due to the presence of growth stimulants in Vitamin C. Ahsan et al. (2015) studied the impact of vitamins B and C on growth and development of silkworms during the 3rd to 5^{th} instar and noticed a significant increment of different growth indices. Usha Rani Brahma et al. (2018) investigated the effect of vitamin C and E on silkworm *Bombyx mori* and found that the vitamin C supplementation resulted in a higher concentration of silk gland protein than vitamin-E supplementation. Rania, S. Gad (2022) reported that the supplementation of folic acid (Vitamin B9) elevated the cocoon weight (1.98 g), shell weight (0.498 g), and silk percentage (25.15%) with reference to control (1.55 g, 0.369 g and 23.81%).

2.6 Plant Extracts

Plants have always been and still are a source of food and biochemical compounds present in the

plants are beneficial to human health. The numerous applications of plant extracts in the food, cosmetics, and other industries make them significant. Because plant extracts contain bioactive substances like carotenoids and polyphenols that have antioxidant and antibacterial properties, they are becoming more significant food additives these days. Many attempts have been made in recent years to supplement mulberry leaf with plant extracts to improve the quality of the leaf and the feeding efficiency of silkworms, which further helps in the production of the cocoons and the quality of the silk. Rajashekar Gouda (1991) studied the effect of plant extracts taken from weeds on silkworm *Bombyx mori* and observed the elevation of fecundity in *Bombyx.* L. Benchamin and Jolly (1986) and Murugan et al. (1999,1998) stated that the production of silk from silkworms has been influenced by the supplementation of plant extracts. Barthakur and Arnold (1991) noticed the effect of supplementation of ascorbic acid, minerals, vitamins, sugars, and amino acids on silk productivity. Murugan et al. (1999) stated that the growth and development of silkworm *Bombyx mori* has been increased by the supplementation of aqueous plant extracts of *Lantana camera, Tridax procumbens*, *Clerodendrum* species and *Croton sparsiflours.* Leaf extract supplemented through the mulberry leaf once during the 3rd and 4th instars and twice during the 5th instar showed higher larval weight, a decrease in larval mortality, and an increase in cocoon weight, shell weight, and shell ratio. Sujatha and Purushotham Rao (2003) reported that the rearing period of *Bombyx mori* has been reduced when silkworms were fed with the mulberry leaf supplemented with *Eucalyptus globulus* leaf extract (0.1, 1.0, 2.0, and 5%) Niharika et al. (2013).

2.7 Plant Growth Regulators

Plant growth regulators are hormones that can help improve crop yield and plant health. There are five groups of plant-growth-regulating compounds, viz., auxin, gibberellin, cytokinin, ethylene, and abscisic acid. The various studies indicate that plant growth regulators have a positive impact as an additive on silkworm *Bombyx mori*. Carlisle et al. (1963) reported that the plant growth regulators influence the developmental process of insects by the administration of plant growth regulators. Komada and Ito (1984) found that the larval and cocoon weight of *Bombyx mori* had been increased by feeding the mulberry leaves supplemented with GA3 during 4th instar larvae. Supplementation of IAA, GA3, IBA, and IPA for the pure mysore multivoltine breed of silkworm showed a significant improvement in the larvae weight and shell weight (Magadum and Hooli, 1989, 1991, 1991, a, b). Goudar and Kaliwal (2001) stated that the application of plant growth regulators like naphthoxy acetic acid (NOA) and 2,4-dichloro phenoxy acetic acid (2,4-D) improved the economic traits like silkgland weight, length of the filament, cocoon weight, and denier in the silkworm (Anil & Jayaraju 2021).

2.8 Homeopathic drugs

Homoeopathy is a medical philosophy and practice based on the theory that, using the right natural substances, the body can heal itself. Numerous ailments are treated with homoeopathic treatments. Homoeopathic medicines are derived from entirely natural substances such as minerals, plants, and animal matter, which stimulate the immune system and promote natural self-healing. Bhalerao (2022) stated that silkworm fed on the mulberry leaves supplemented with homoeopathic drugs like Chemidonium and Nux vomica mother tinctures showed positive results on most of the commercial characteristics. The results revealed that the silkworms supplemented with the drug Chelidonium significantly increased larval weight (3.387 g), shell weight (0.387 g), shell percentage (21.50%), filament length (998 m), and filament weight (0.268 g) compared to control. Similar results were observed in the silkworms treated with Nux vomica for all economic characteristics, viz., larval weight (3.524 g), shell weight (0.392 g), shell ratio percentage (21.838%), filament length (1008 m), and filament weight (0.284 g) over the control group. Overall, an elevation of cocoon economic parameters was observed in Chelidonium and Nux vomica-treated silkworms.

3. CONCLUSION

Silkworm *Bombyx mori* has precise food requirements and can be supplemented with a variety of food substances to obtain healthy growth and development with better commercial traits of the silk. Nutrition is a major factor in the culturing of silkworms, and the quality of the leaves fed to the silkworm has a large impact on creating high-quality cocoons. Food supplements are important for silkworms because they can improve their growth and development, which

leads to better qualitative, quantitative, and economical cocoon yield parameters. The scanning of literature on this line of research brings forth an overview of the applicability of various food supplements to silkworm *Bombyx mori,* and it very clearly indicates that the supplementation of different food additives through mulberry leaf has favorable effects on the growth and development of the silkworm, elevation of the qualitative and quantitative traits of the silk, and also enhancement of the biological functions of silkworms. With this background, there is a need to carry out comprehensive research on these lines to determine the optimum dosage and schedule of the supplementation of different food substances in order to optimize the commercial parameters of silkworm *Bombyx mori.* The review paper highlighted and summarized the studies conducted by the various researchers on different dimensions of dietary supplements, which may be helpful for future researchers working on these lines of research.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Ahsan MK, Khan AR, Ferdous T. Growth and development of the mulberry silkworm, *Bombyx mori* L. on vitamin B and c supplemented diet.(2015).*Bangladesh Journal of Zoology*, *41*(2), 199–206.

Anil Kumar MN, Jayaraju P. Impact of essential amino acids supplementation on the economic characters of the silkworm, *Bombyx mori* L. *Proteus J*. 2021; ISSN/eISSN: 0889-6348.

Anil Kumar MN, Sunil Kumar B. Influence of fortified mulberry leaf with methionine on the economic traits and amino transferase activity in *Bombyx mori* L. *Int J Curr Adv Res*. 2018; 5:995.

Anisha SP, Yasmin N, Sree Vaishnava Devi E. Supplementation of mulberry leaves with probiotic bifilac on economic traits of silkworm (*Bombyx mori* L.). *IJFANS*. 2022; 11(12): 86-90.

Arai N, Ito T. Amino acid requirements of silkworm, *Bombyx mori* L. *J Seric Sci Japan*. 1964; 33: 107-110.

Muzamil A, Tahir HM, Ali A, Bhatti MF, Munir F, Ijaz F, Adnan M, Khan HA, Qayyum KA. Effect of amino acid fortified mulberry leaves on economic and biological traits of *Bombyx mori* L. *Heliyon*. 2023; 9(10): e21053.

Balasundaram D, Ganesh Prabu P, Selvisabhanayakam V, Mathivanan, Ramesh V. Studies on the nutritional supplementation of Vitamin C treated MR 2 mulberry leaves fed by V instar larvae of silkworm, *Bombyx mori* (L.) in relation to feed efficacy and growth rate. *Int J Res Biotechnol Biochem*. 2013; 3(1): 11-18.

Barthakur NN, Arnold NP. Chemical analysis of emblic (*Phyllanthus emblica* L.) and its potential as a food source. *Scientia Horticulturae*. 1991; 47(1-2): 99-105.

Benchamin KV, Jolly MS. Studies on ingestion, digestion and conversion efficiency in polyvoltine and bivoltine silkworm breeds, *Bombyx mori* L. In: Original entomology symposium proceedings. 1986; pp: 195-206.

Bhalerao RS. Impact of fortification of mulberry leaves with homeopathic drugs on economic traits of silkworm *Bombyx mori* L. *Int J Adv Res Biol Sci*. 2022; 9(1): 54-57.

Bhatti MF, Azizullah, Shahzadi N, Tahir HM, Ali S, Zahid MT, Khurshid R. Effect of honey (*Apis dorsata* [Hymenoptera: Apidae]) on *Bombyx mori* (Lepidoptera: Bombycidae). *J Insect Sci*. 2019; 19: 1–5.

Carlisle DB, Osborne DJ, Eliss PE, Moorhouse JE. Reciprocal effect of insect and plant growth substances. *Nature*. 1963; 200: 1230.

Chakrabarthy S, Kaliwal BB. Application of arginine, histidine and their mixture on

economic traits of the silkworm, *Bombyx mori* L. *DAV Int J Sci*. 2012; 1(2): 107-111.

Baci G-M, Cucu A-A, Moise A-R, Dezmirean DS. Applicability of honey on silkworms (*Bombyx mori*) and quality improvement of its biomaterials. *Appl Sci*. 2021; 11(10): 4613.

Gokul M. Effect of exogenous supplementation of amino acids and minerals on economic traits of silkworm, *Bombyx mori* L. M.Sc. (Seri.) Thesis. Tamil Nadu Agricultural University, Coimbatore; 2015. p. 101.

Goudar KS, Kaliwal BB. Effect of potassium nitrate on the biochemical parameters of the silkworm *Bombyx mori* L. *Int J Indust Entomol*. 2001; 3: 93-117.

Haug A, Hostmark AT, Harstad OM. Bovine milk in human nutrition - a review. *Lipids Health*. 2007.

Inokuchi T, Horie Y, Ito T. Nutrition of the silkworm, *Bombyx mori* – XIX. Effects of omission of essential amino acids in each of the second to the fifth instars. *Bull Sericultur Experimental Station, Japan*. 1967; pp. 612-635.

Ito T. Nutritional requirements of the silkworm *Bombyx mori* L. *Proc Japan Academy*. 1967; 43: 57-61.

Kabila V, Subburathinam KM, Sulochanachetty J. Growth and economic characters of silkworm, *Bombyx mori* L. on feed enriched with neutralized aspartic acid. *Indian Journal of Sericulture*. 1994; 33(1): 80-81.

Kamada M, Ito S. Growth promoting effect of plant hormones on silkworms. *J Agr Chem Soc Jpn*. 1984; 58: 779-784.

Etebari K, Matindoost L. Application of multi-vitamins as supplementary nutrients on biological and economical characteristics of silkworm *Bombyx mori* L. *J Asia-Pacific Entomol*. 2005; 8(1): 107-112.

Kumar K, Balasubramanian U. Studies on the nutritional supplementation of spirulina treated MR2 mulberry leaves fed by V instar larvae of silkworm *Bombyx mori* (L.) in relation to feed efficacy and growth rate. *Int J Res Zool*. 2014; 4(2): 13-18.

Kumar K, Balasubramaniyan U. Studies on the impact of *Spirulina platensis* on the mulberry silkworm *Bombyx mori* (L). *Int J Res Phytochem Pharmacol*. 2013; 3(2): 99-102.

Madhavi R, Siva Prasad S. Impact of honey-enriched mulberry diet on the energy metabolism of the silkworm, *Bombyx mori*. *J Appl Nat Sci*. 2020; 12: 133–145.

Magadum SB, Hooli MA. Effect of indole-3-acetic acid on the polyvoltine silkworm, the pure Mysore breed of *Bombyx mori* L. *Sericologia*. 1989; 29: 507-517.

Magadum SB, Hooli MA. Effects of indole propionic acid (3 IPA) on the economic parameters of the silkworm, *Bombyx mori*. *Bull Sericult Res*. 1991; 2: 41-47.

Magadum SB, Hooli MA. Effects of gibberellic acid on the economic parameters of the silkworm, the pure Mysore breed of *Bombyx mori* L. *Sericologia*. 1991; 31: 667-676.

Mala N, Vijila K. Beneficial effects of *Bacillus licheniformis* and *Bacillus niabensis* on growth and economic characteristics of silkworm, *Bombyx mori* L. *Int J Chem Stud*. 2018; 6(2): 1750-1754.

Masthan K, Rajkumar T, Narasimha Murthy CV. Studies on fortification of mulberry leaves with probiotics for improvement of silk quality. *Int J Biotechnol Biochem*. 2017; 13(1): 73-80.

Hossain Md Shakhawat, Uddin Md Aftab, Islam Md Saiful, Alim Md Abdul. Effect of cow milk on the growth and economic traits of silkworm (*Bombyx mori* L.). *Int J Sci Eng Res*. 2015; 6(3): 517-520.

Helaly WM, Mohamed Y. Evaluation of two food additives on *Bombyx mori* L. characters. *J Entomol Zool Stud*. 2018; 6(2): 3119-3123.

Murugan K, Jayabalan D, Senthil Kumar N, Babu R, Siva Ramakrishnan S, Senthil Nathan S. Anti-feeding and growth inhibitory potency of neem limonoids against *Helicoverpa armigera* Hubner. *Insect Science and its Applications*. 1998; 18(3).

Murugan K, Jeyabalan D, Senthil Kumar N. Growth promoting effect of plant compounds on silkworm. In: *Proc Natl Sem Trop Seric*. 1999; pp: 107-108.

Murugesh KA, Aruna R, Chozhan K. Influence of amino acids on the economic characters of silkworm, *Bombyx mori* L. *Madras Agric J*. 2021; 376-382.

Mustafa SM, Elkaraksy IA. The effect of certain amino acids on silkworm, *Bombyx mori* L. *Agricultural Research Review*. 1990; 66(1): 105-109.

Nagarajan P, Radha NV. Supplementation of amino acids through mulberry leaf for increased silk production. *Indian Silk*. 1990; 29(4): 21-22.

Pande N, Sharma GD, Dixit R. Larval growth of silkworm (*Bombyx mori*) influenced by

spirulina supplemented mulberry leaves. *Int J Entomol*. 2022; 7(11): 96-97.

Niharika K, Praveena A, Venugopal Reddy B, Anitha Mamillapalli. The Effect of Bovine Milk on the Growth of *Bombyx mori*. J Insect Sci. 2013; 13: 98.

Radjabi R, Ebadi R, Mirhoseini SZ, Nair S. Effect of leaves enrichment with amino acid supplementary nutrients on *Bombyx mori* L. *Acad J Ent*. 2010; 3(1): 45-51.

Rahmathulla VK, Das MP, Ramesh, Rajan RK. Growth rate pattern and economic traits of silkworm, *Bombyx mori* L. under the influence of folic acid administration. *J Appl Sci Environ Manage*. 2007; 11(4): 81-84.

Gouda RR. Studies on methods to increase silk yield of *Bombyx mori* L. Ph.D. Thesis. Tamil Nadu Agricultural University, Coimbatore, India; 1991. 242 p.

Rajegowda. Impact of 'Seripro' on cocoon production and productivity in silkworm, *Bombyx mori* L. In: Proceedings of the National Conference on Strategies for Sericulture's Research and Development. 2002; 16: 264-266.

Gad RS. Impact of folic acid as dietary supplementation on biological and economic characteristics of mulberry silkworm *Bombyx mori* (Lepidoptera: Bombycidae). *Egypt J Plant Prot Res Inst*. 2022; 5(4): 420-425.

Ravi KN, Shankar KA, Puttaraju TB, Puttasamy B. Effect of feeds supplementation on silkworm growth, cocoon weight and silk quality. In: *Second National Symposium on prospects and problems of sericulture in India*. Dept of Zoology, Madras University, Postgraduate Extension Centre, Vellore, Tamil Nadu; 1994. p. 63-66.

Ruiz-Erazo X, Zambrano-González G, Castañeda-Vildozóla Á, Rodríguez-Ortega LT, Pro-Martínez A, Hernández-Guzmán FJ, Rodríguez-Ortega A. Silkworm (*Bombyx mori* L.) fed with mulberry (*Morus alba* L.) leaves and cow's milk. *Agro Productividad*. 2023; pp: 107-112.

Saad MSI, Helaly WMM, Sheikh EAE. Biological and physiological effects of pyriproxyfen insecticide and amino acid glycine on silkworm, *Bombyx mori* L. *Bull Nat Res Centre*. 2019; 43:145-151.

Saeed Samarghandian, Farkhondeh T, Samini F. Honey and health: A review of recent clinical research. *Pharmacognosy Res*. 2017; 9(2):121–127.

Saranya M, Krishnamoorthy SV, Murugesh KA. Fortification of mulberry leaves with indigenous probiotic bacteria on larval growth and economic traits of silkworm *Bombyx mori* L. *J Entomol Zool Stud*. 2019; 7(4): 780-784.

Sengupta K, Singh BD, Mustafi JC. Nutrition of the silkworm, *Bombyx mori* L. Studies on the enrichment of mulberry leaf with various sugars, proteins, amino acids, and vitamins for vigorous growth of the worm and increased cocoon crop protection. *Indian J Sericulture*. 1972; 11:11-27.

Sharada K, Bhat JV. Effect of chloromycetin and glycine on the growth and reproduction of silkworm, *Bombyx mori* L. *J Indian Inst Sci*. 1956; 38:196-197.

ShrutiAshoka J, Hadimani DK, Sreenivas AG, Beladhadi RV. Effect of probiotic feed supplements to mulberry silkworm, *Bombyx mori* L. for larval growth and development parameters. *Int J Chem Stud*. 2019; 7(3):3914-3919.

Singh KK, Chauhan RM, Pande AB, Gokhale SB, Hedge NG. Effect of use of *Lactobacillus plantarum* as a probiotic to improve cocoon production of mulberry silkworm, *Bombyx mori* (L). *J Basic Appl Sci*. 2005; 1:1-8.

Sujatha K, Purushotham Rao A. Effect of *Curcuma longa* on the commercial characters of multivoltine silkworm. *J Exp Zool India*. 2003; 6(1): 109-111.

Thulasi N, Sivaprasad S. Larval growth, silk production, and economic traits of *Bombyx mori* under the influence of honey-enriched mulberry diet. *J Appl Nat Sci*. 2015; 7, 286–292.

Brahma UR, Pattnaik S, Barik BP. Impact of vitamin C & E supplementation on 5th instar larvae of CSR2 x CSR4 silkworm *Bombyx mori* L. *Res J Life Sci Bioinformatics, Pharmaceutical and Chemical Sciences*. 2018; 4(6): 408-414.

Vadivel K. Effect of supplementation of amino acids on economic characters of silkworm, *Bombyx mori* L. M.Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore; 1995. pp. 32-49.

Venkataramana P, Rao TVSS, Reddy PS, Suryanarayana N. Effect of spirulina on the larval and cocoon characters of silkworm *Bombyx mori* L. *Proc Nat Acad Sci*. 2003; 73(1):89-94.

Horie Y, Ito T. Nutrition of the silkworm, *Bombyx mori*—X. Vitamin B requirements and the effects of several analogues. *J Insect Physiol*. 1965; 11(12): 1585-1593.

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