

Review on the effect of nutrient supplementation on the economic traits of silkworm and disease management

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Abstract

The quality of the cocoon depends mainly on the nutritional supplements fed during rearing. Feeding must satisfy both the appetite of the larva and nutritional requirement. Silk production is mainly dependent on the larval growth and nutritional distribution in mulberry leaves. The purpose of this review study is to investigate the effect of supplementation of various feed additives along with mulberry leaves, *Castor* and *Ricinus communis* to set a bench mark for the improvement of silk in quality and quantity. This review illustrates the research focusing on different races of *Bombyx mori* silk worms and Eri silkworm fed with mulberry leaves, *Castor* and *Ricinus communis* along with various supplemented feed additives like herbal extracts, turmeric extract, folic acid and probiotics at different concentrations to the worms at different instar stages. A control rearing set was also maintained with all these experimental set ups by all the researchers. This review paper, has focused few of those significant studies particularly focusing on the supplementation of folic acid, herbal plant extract, hormone extracts and probiotics with mulberry leaves and they observed the impact of these feed additives on the biological and physiological aspects of growth modifications in silk worm larvae and on the cocoon quality in terms of certain parameters like cocoon weight, shell weight, pupal weight, shell percentage and silk filament length of silk worm *Bombyx mori* and found that it was significantly higher than the control.

Key words: *Bombyx mori*, mulberry leaves, cocoon, feed additives, nutrient supplementation..

INTRODUCTION

Mulberry silkworm is a monophagous insect, which feeds only on mulberry leaves. The nutritive value and

palatability of each species will vary with the age of the leaf, type of cultivation, harvesting method adopted, duration of storage, season, fertigation and irrigation schedules, and affliction by pests and diseases. In temperate regions, leaves do not sprout in autumn and winter and are not available for rearing. Attempts were, therefore made to look for substitutes for mulberry as the sole diet of the silkworm. In addition to that the supplementation of extra nutrients along with mulberry leaves results in higher yield because the production of superior quality and quantity of silk depends mainly on nutritional status and healthiness of the larva. A series of studies has been established for the better feed supplementation, along with mulberry leaves with different nutrients such as proteins, vitamins, amino acids, minerals, hormones and antibiotics for better performance and to get high yield and quality cocoons (Kanafi, *et al.*, 2007; Sheeba *et al* 2006; Srivastava, 2010).

Effect of tender coconut water in supplementation with mulberry leaves:

As evinced in this study Kalyankar *et al.*, (2015) demonstrated that the fresh tender coconut water was administered along with mulberry leaves on second and fourth day of Vth instar silkworm *Bombyx mori*. They have observed that the economical parameters were highly influenced by coconut water supplementation and reported as the cocoon weight, shell weight, shell ratio and filament length were increased by 10.18 %, 19.49 %, 8.39 % and 22.4 %, respectively, as against that of control group.

Effect of folic acid with V1 Mulberry leaves and Nutrid diet recommended by CSRTI in *Bombyx mori* L:

Rahmathulla *et al.*, (2007) have demonstrated that when the silkworm *Bombyx mori* L (bivoltine hybrid CSR2 × CSR4) from CSR&TI, Mysore, was fed with the V1 mulberry leaf sprayed with folic acid had significantly improved larval weight, silk gland weight and growth rate. Higher larval and silk gland weight subsequently improved the economic parameters like cocoon weight,



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Table 1. Effect of Tender coconut water fed with mulberry leaves on Vth instar larvae of *Bombyx mori* L.

Treatment	Cocoon wt.(gm)	Cocoon shell wt.(gm)	Cocoon shellratio(%)	Filament length(m)
Control(C)	0.91± 0.125	0.136± 0.013	15.00 ± 0.070	570.00± 2.646
Tender Coconut water (T1)	1.002. ± 0.173*** (10.18%)	0.162 ± 0.033*** (19.49%)	16.14 ± 0.204*** (8.39%)	698.00 ± 0.577*** (22.4%)

***p<0.001

Table 2. Effect of folic acid on V1 Mulberry plant and Nutrid diet on Silkworm *Bombyx mori* L.

Parameters	Leaf batch					Diet batch				
	T1	T2	Control	CD@5%	SE±	T1	T2	Control	CD@1%	SE±
5th Instar Larval Duration (hrs)	148	147	146	- NS	-	148	147	146	- NS	-
Final Larval Weight 10 Nos. (g)	46.62	48.51	41.18	1.96 **	0.44	46.84	48.48	41.45	2.00 **	0.45
Growth Index	3.894	4.132	3.39	0.17 **	0.038	3.88	4.08	3.34	0.15 **	0.035
Single Cocoon weight (g)	1.91	1.94	1.73	0.08 **	0.02	1.92	1.96	1.75	0.12 **	0.02
Single shell wt. (g)	0.46	0.49	0.39	0.02 **	0.005	0.46	0.49	0.4	0.02 **	0.005
ERR No.	9472	9491	9506	- NS	-	9465	9484	9502	- NS	-
ERR Weight (kg)	17.97	18.4	16.33	0.90 **	0.2	17.83	18.42	16.3	0.90 **	0.2
Shell Ratio (%)	24.08	25.25	22.54	1.14 **	0.32	23.95	24.99	22.85	1.48 **	0.33

***p<0.001

Table 3. Effect of different concentration of folic acid fed with mulberry leaves on silkworm – *Bombyx mori* L.

Test Treatment with Different Supplemented				
T1	T2	T3	T4	T4
0.20%	0.40%	0.60%	Control (Leaves with Distilled water spraying)	Absolute control (only the leaves)

shell weight and shell ratio of folic acid treated batches. They have reared mass young age silkworm rearing of one batch by feeding with V1 mulberry variety. Parallely another batch was fed with semisynthetic diet (Nutrid) recently developed by CSR&TI, Mysore. After 3rd moult both batches of larvae were shifted to leaf feeding and continued separately up to 4th moult by providing with V1 mulberry variety. The freshly moult out 5th instar larvae of both batches (leaf and diet) were replicated in to three groups. In each group, 200 larvae were kept and reared at a temperature of 25 ± 1°C and a relative humidity of 75 ± 5 %. The group-1 (control) larvae was considered as carrier, fed with normal mulberry leaf sprayed with distilled water and the group 2 & 3 were the experimental groups (T1 & T2) and the larvae were fed with leaves sprayed with two different concentration

of folic acid solution (100 ppm and 150 ppm). The investigators used the commercial folic acid available in the market for their experiment (Central Drug house, Mumbai). The treatment was initiated on the first day of fifth instar by spraying folic acid solution in varying concentration separately and was continued up to maturation. The study concludes that the oral administration of folic acid during 5th instar silkworm significantly influences the growth pattern of silkworm larva and silk gland considerably, in turn it is observed that higher growth and development also influences the economic characters like cocoon weight, shell weight and shell ratio and subsequently quality of silk.

Effect of folic acid with mulberry leaves in multivoltine silkworm breeds MU-1 and Hosa Mysore.

Ravi Kumara and Anil Kumar (2016) have recorded that the effect of mulberry leaves supplemented with folic acid at different concentrations viz. mulberry leaf fed to the silkworms to understand the economic traits in multivoltine silkworm breeds MU-1 and Hosa Mysore. The treated leaves are fed to silkworms twice a day during fifth instar stage. T1 larvae received 0.2 % folic acid sprayed mulberry leaves, T2 larvae received 0.4 % folic acid sprayed mulberry leaves, T3 larvae received 0.6 % folic acid sprayed mulberry leaves, T4 larvae received mulberry leaves sprayed with distilled water (as it is the control) and T5 larvae were

reared on natural diet (absolute control). They concluded with a result that the observations on these factors like mature larval weight, cocoon weight, shell weight, shell ratio, filament length, filament weight, denier, renditta, and fecundity rate were considerably maximum in both the breeds at 0.6% folic acid concentrations than the other concentrations.

Effect of various plants with *Castor* and *Ricinus communis* on Eri silkworm

Lalmuankimi *et al.*, (2020) have demonstrated that *Castor* and *Ricinus communis* were dipped into aqueous extraction of *Mikania micrantha*, *Murraya koenigii* and *Pongamia glabra* at 5,10 and 15 percentage and dried at room temperature for five minutes and fed to Eri worms for four times per day from third instar onwards during rearing period. They concluded that all the plant extracts of 10 % concentration showed significantly maximum in larval weight, effective rate of rearing, larval mortality, silk gland weight compare to the control.

Effect of alcoholic extracts of *Moringa*, *Rosemary*, *Garlic*, *Cestrum durant*, and *Bostachia* on mulberry silkworm

Rateb and Abdel-Rahman (2015) have reported that they have studied two hybrids of silkworms from Bulgaria and Giza. Six alcoholic extracts (*Moringa*, *Rosemary*, *Garlic*, *Cestrum durant* "Bostachia", mulberry silkworm, and silk glands, and four aqueous extracts (*Moringa*, *Rosemary*, *Garlic*, and *Cestrum durant*, were tested on silkworms. Mulberry leaves were sprayed with (1%) of these extracts as feed additives and offered to 4th and 5th instar larvae and observations were made on the growth patterns of these silkworms. Growth characters were detected and calculated as initial, final and average and at the ranges and factors as 5th instar weight, growth index, silk glands weight, ratio between silk glands and larval weight, pupal weight, fresh and cocoon, shell weight and cocoon shell ratio per cent was calculated. In the case of the observations on the use of aqueous extracts of Rosemary on imported silkworms, it is found to be on the increased rate in cocoon shell ratio per cent. Considering the local hybrid, this increment was detected in *Cestrum durant*, *Moringa*, and *Garlic* treatments. All tested aqueous extracts are found to be effectively influencing on the increased cocoon shell ratio per cent only in local hybrid. Generally, in imported hybrid, the increment

Table 4. Effect of different plant extracts at different concentration with *Castor* and *Ricinus communis* on Eri silkworms.

Treatment	Plant extracts			
	Conc.	<i>Mikania micrantha</i>	<i>Murraya koenigii</i>	<i>Pongamia glabra</i>
Effect of plant extracts on Larval duration (days) of Eri silkworm	5	22.76	23	22
	10	22.67	23.33	22.67
	15	23.33	24	23
Effect of plant extracts on full grown larval weight (g) of Eri silkworm	5	7.63	7.46	7.21
	10	7.75	7.57	7.28
	15	7.52	7.43	7.2
Effect of plant extracts on mature larval weight (g) of Eri silkworm	5	4.65	4.55	4.42
	10	4.69	4.59	4.43
	15	4.43	4.45	4.41
Effect of plant extracts on silk gland weight (g) of Eri silkworm	5	1.92	1.87	1.82
	10	1.94	1.92	1.83
	15	1.85	1.86	1.77
Effect of plant extracts on SGTSI(%) of Eri silkworm	5	43.97	41.12	40.14
	10	44.67	41.73	41.94
	15	43.39	41.02	40.04
Effect of plant extracts on ERR (%) of Eri silkworm	5	86.33	90	77
	10	86.67	91.33	76.67
	15	86	88.33	76.33
Effect of plant extracts on larval mortality (%) of Eri silkworm	5	13.67	10	23
	10	13.33	8.67	23.33
	15	14	11.67	23.67

observed is only in the cocoon shell ratio per cent of aqueous extracts of Rosemary treatment. However, in local hybrid, this increment was found in alcoholic extracts of *Moringa*, *Garlic*, *Cestrum durant*. This clearly reveals that more response is observed only for local hybrid as compared with imported one. It is also found to be far more for aqueous extracts than for the alcoholic extracts in terms of response. Based on the results, they concluded that the use of local hybrid silkworm with the feed additive treatment of mulberry leaves with aqueous extract is considered to be available, easier and cheaper for feeding of mulberry silkworms, in Egypt.

Effect of various concentrations of turmeric powder extract in MR2 variety in *Bombyx mori* LxCSR2

In another study on the same lines by Karthikairaj *et al.*, in the year 2013, it is observed that the rhizomes of turmeric powder extract were taken in the rates as 0.2, 0.4, 0.6, 0.8, and 10 percent in 100 ml distilled water and were sprayed to MR2 *Morus alba*. The leaves were fed to 4th instar larvae of *Bombyx mori* LxCSR2. The extracts having 0.2 percent concentration resulted significantly in the higher larval growth and in increasing considerably the cocoon weight. Maximum shell weight and shell ratio were noted in the treatment with the turmeric powder extract treatments. The fibroin content also showed significant increase as a result of the dietary supplementation of turmeric powder extract.

Efficacy of nine different medicinal plant extracts for the management of late larval flacherie disease in the silkworm *Bombyx mori* :

Manjunath *et al.*, (2020) in his study, have studied the plant extract of Turmeric (*Curcuma longa*), Amruthaballi (*Tinospora cardifolia*), Coat buttons (*Tridax procumbens*), Kirunelli (*Phyllanthus niruri*), Amla (*Phyllanthus emblica*), Pomegranate (*Punica granatum*), Aloe vera (*Aloe vera*), Tulasi (*Ocimum tenuiflorum*), Asparagus (*Asparagus officinalis*) and distilled water control the nine medicinal plant extracts, *Asparagus officinalis* administration to CSR2 and PM x CSR2 silkworm breeds was found to be effective by enhancing the cocoon quality parameters viz., cocoon weight (17.92 and 13.63 g/10 cocoons), shell weight (3.743 and 2.480 g/10 cocoon shells), pupal weight (14.32 and 11.15 g/10 pupae), shell ratio (20.92 and 18.15 %/10 cocoon shells), silk filament length (1066.33 and 752.00 m) and denier (2.61 and 2.64) in both the breeds when compared to the control.

Effect of *Ocimum sanctum* plant hormone sprayed mulberry leaves on silkworm:

Surjeet *et al.*, (2010) found the plant hormones extracted from *Ocimum sanctum* showed significant effects on the

maturation of 5th instar silkworm. When leaf extract was spread after 3 days in 5th instar, maturation ranged from 77.3 % in control to 83.83 % in 15mg. per 50 larvae /100g mulberry leaf after 24 hours. After 30 hours of interval, it was noticed to be on the increased maturation from 83.83% to 96.60%. In both the periods of recording (24 and 30 hours), a significant increase of 8.3% was observed with treated larvae over the control. After 4 days of administration of plant extract in 5th instar larvae, maturation rate of larvae (after 24 and 30 hours) was noted to be significantly high over the control. It has been clearly established that most of the common phyto-ecdysteroids with 20-hydroxy ecdysone (20HE) like activity affects insect growth and development on ingestion.

Effect of probiotics with mulberry leaves in silkworm:

Masthan *et al.*, (2017) in his study revealed that in his study he has used four different feed additives namely (probiotics) *Spirulina*, Yeast (*Saccharomyces ciriviceae*), *Lactobacillus acidophilus* and *Lactobacillus sporogens*. Feed additives were prepared in the rates of 300 ppm and the feed additive in dispersed clean UV irradiated tap water. Freshly harvested mulberry leaves were soaked. 2nd instar larvae were fed with mulberry leaves and treated as control. Second batch of silk worms were with *Spirulina* in the rates of 300 ppm, third batch with Yeast, fourth batch with *Lactobacillus acidophilus*, and the fifth batch was fed with *Lactobacillus sporogens*. Silk quality parameters such as sericin and fibroin contents were estimated at the end of silkworm rearing. In addition to these, quantitative parameters of cocoon like Cocoon weight, shell weight, pupal weight, shell percentage and silk filament length of silk worm *Bombyx mori* were also observed. The results showed that the two blue green algae variants *Spirulina* and *Saccharomyces ciriviceae* yielded better fibroin content indicating the good quality silk when compared to *Lactobacillus acidophilus* and *Lactobacillus sporogens*.

Raja *et al.*, (2016) in his study revealed that silkworms which were fed with mulberry leaves fortified with *Chlorella* and *Scenedesmus* algal extracts showed significant results. Algal extracts were diluted at different concentrations like 2%, 4% , 6% and 8% and were fed at the scales of once in a day from 3rd instar stage onwards respectively. They concluded that 4% of *Chlorella* extract and 6% of *Scenedesmus* extracts significantly increased the larval growth rate, economic traits like cocoon weight, shell weight, pupa weight, shell percentage, filament length, fibroin, sericin and denier of silk filament.

CONCLUSION

Sericulture is an important Agri-based, export-oriented activity which is transforming and ensuring the livelihood of many in general and women in particular. This industry is deemed to a promising entrepreneurial venture, offering wide scope for skill enhancement to bridge the gap in the employment sector.

The internationally accepted minimum grade of silk for export is 2A to A while the Indian raw silk is classified only as grade H. In that line, some of these important research-based studies which were undertaken by various researchers worldwide, have given an insight and understanding on the significant impact of the usage of these feed additives with mulberry leaves could result in improving the traits in larval growth and in the cocoon quality.

Further this review study emphasizes and concludes two significant aspects that it may be due to the presence of certain bio-active compounds in the medicinal plant extracts, turmeric extract, folic acid and probiotics which would have reflected in the better performance of the silkworms for improved quality and quantity of cocoon production with desirable characters.

Further the review suggests that the enhancement in economic parameters like cocoon weight, shell weight, pupal weight, shell ratio, filament length and filament denier of silkworm will result in the quality cocoon production if explored further for applicability to raise and meet out the internationally fixed standards for silk quality.

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