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MORPHOMETRIC STUDIES OF SILKWORM, *BOMBYX MORI* (L.) FED WITH SPIRULINA TREATED MR2 MULBERRY LEAVES

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Abstract

Sericulture is one of the most important cottage industries, which involves the utilization of mulberry trees and rearing of silkworm on commercial basis to produced silk. The larval and pupal parameters of silkworm *Bombyx mori* fed with Spirulina treated MR2 mulberry leaves, the following works have been considered. The Spirulina in different concentration such as 100ppm, 200ppm and 300ppm fresh mulberry leaves of (*Morus alba* L.) aqueous extract by each concentration and were fed to silkworms from 3rd, 4th and 5th instar for five feeding were recommended. Then, group T1 larvae received MR2 mulberry leaves soaked with distilled water and served as control, group T2, T3 and T4, larvae received 100ppm, 200ppm and 300ppm Spirulina treated mulberry leaves, respectively. Silkworm larvae fed on MR2 leaves soaked with 300ppm concentration of Spirulina (group T4) was significantly increased the larvae and cocoon length, width and weight, cocoon shell weight, pupal weight, shell ratio and silk filament length as compared to those fed on control. It has been observed from the present study that 300ppm treated (group T4) leaves fed by silkworm have enhanced the larval and pupal growth and quantity of silk production than control

Keywords: Silkworm, spirulina, cocoon, Mulberry leaves.

Introduction

The silkworm, *Bombyx mori being a* monophagous insect, derives all the nutrients required for its growth from the mulberry leaf. The quality of silk produced by the silkworm depends on quality of yield of mulberry leaf as well as environmental conditions. The quality of mulberry leaf is reported to vary with the age, position, maturity, soil fertility, pruning, agronomic practices and environmental factors (Dutta, 1992). Among environmental factors, temperature is known to play a major role in growth and productivity in silkworm (Benchamin and Jolly, 1986). The productivity of silkworm in terms of cocoon crop depends on several factors that operate within and outside the body of silkworm (Benchamin and Jolly, 1986; Balasundram *et al.,* 2008). Nutritional studies in silkworm with respect to food utilization (Matsumura *et al.,* 1955), relation between growth, body weight, food digested and ingested silk gland weight (Ueda *et al.,* 1971), food consumption and relative rates (Mathavan *et al.*, 1987 and Centhilnayaki, *et al*., 2004) have been elucidated. Spirulina is a photosynthetic, filametous, spiral-shape, multicellular microalgae. It contains 18 amino acids and vital vitamins biotin, tocopherol, thiamine, riboflavin, niacin, folicacid, pyrodozoic acid, betacarotene and vitamin B12 etc. The nutrients which are very easy to digest protein, carbohydrate, 50different minerals and trace minerals, beta carotene, chlorophyll and many other nutrients found in Spirulina. Mulberry leaf supplemented with Spirulina as a feed to *Bombyx mori* (L.) orally found to be effective in enhancing the larval and cocoon characters (Venkataramana, 2003).

The amount and quality of food ingested in the larval phase affect the growth rate, developmental period, body weight and survival rate and also influence the fecundity, longevity and movement (Parra, 1991). Several studies on nutritional ecology, development of *Bombyx mori* in India and Japan revealed that, food consumption, digestion and food assimilation influence the cocoon production (Naik and Delve, 1987). The silkworm requires certain essential sugars, proteins, amino acids, fatty acids and vitamins for their normal growth and survival. These essential components are necessary for the growth of silk gland for higher production of seed and silk (Ito, 1978). Supplementation of glucose with mulberry leaf may influence, indirectly, the extent of protein synthesis in the silkworm as it has a protein sparing action. Sengupta *et al.,* (1972) have reported that the mulberry leaves enriched with glucose and molasses have significant beneficial effect on growth and cocoon production. The nickel chloride significantly increased the growth of larvae, pupa and adults. But higher salt concentrations produced

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deleterious effect on these parameters. Not only the larval and pupal growth in *Bombyx mori* were enhanced but also the economic characters of the mulberry were enhanced at 800ppm of nickel chloride (Rezuanul Islam, 2004).

Materials and Methods

Larval duration (days)

Larvae were reared carefully and larval period was recorded as day's total larval duration.

Larval weight (g)

Ten larvae were randomly picked from each treatment replication wise and their weight was recorded using electronic balance at the end of each instar for the last three instars (III, IV and V)

Results and Discussion

Larval length and width

The morphometric growth rate like length, width and weight of larval parameters of *Bombyx mori* fed with *Spirulina* treated MR_2 leaves and control MR_2 leaves in III, IV and V instar larvae were evaluated. The mean length of III instar larvae of (T_4) 400ppm *Spirulina* treated MR_2 leaves was found to be 2.482 cm and the least length was observed in (T_1) 100ppm. In these five observations, 400ppm (T_4) *Spirulina* treated III instar larvae length (2.482 cm) was significantly increased than the other four treatments 300ppm (1.924 cm), 200ppm (1.843 cm), 100ppm (1. 833 cm) and control (1.730 cm) respectively. The mean width of III instar larvae of (T_4) 400ppm *Spirulina* treated MR_2 leaves was found to be most in 0.541 cm. In these five observations, 400ppm (T_4) *Spirulina* treated III instar larvae width (0.541 cm) was significantly increased than the other four treatments 300ppm (0.495 cm), 200ppm (0.452 cm), 100ppm(0.446 cm) and control (0.419cm), respectively. (Table1)

Larval weight

The data on larval weight revealed that the *Spirulina* treated larvae T_4 (400ppm) exhibited maximum larval weight (1.595 gm). The least weight among the different treatments was observed in T_1 100ppm (1.027 gm) followed by 300ppm (1.158 gm), 200ppm (1.058 gm), 100ppm (1.027 gm) and control (0.894 gm). The data on larval weight as influenced by the larvae fed with *Spirulina* treated MR_2 leaves and control MR_2 leaves in IV instar larvae of *B. mori.* From the data it was revealed that the *Spirulina* treated larvae T_4 (400ppm) exhibited maximum larval weight. Average weight of IV instar larvae was found highest in the 400ppm (5.203 gm), followed by 300ppm(5.038 gm), 200ppm (4.530 gm), 100ppm (4.446 gm) and control (4.233gm). The data on larval weight as influenced by the larvae fed with *Spirulina* treated MR_2 leaves and control MR_2 leaves in V instar larvae of *B. mori.* From the data it was revealed that the *Spirulina* treated larvae T_4 (400ppm) exhibited maximum larval weight. Average weight of V instar larvae was found highest in the 400ppm (35.894 gm), followed by 300ppm (30.753gm), 200ppm (28.477gm), 100ppm (26.950gm) and control (26.270gm).

The mean length of IV instar larvae of (T4) 400ppm *Spirulina* treated MR_2 leaves were increased in 100ppm, 200ppm, and 300ppm *Spirulina* treated larvae as compared to control of larvae. In these five observations, 400ppm (T_4) *Spirulina* treated IV instar larvae length (6.127 cm) was significantly increased than the other four treatments 300ppm (5.973 cm), 200ppm (5.568 cm), 100ppm (5.545cm) and control (5.037cm) respectively

The mean width of IV instar larvae of (T_4) 400ppm *Spirulina* treated MR_2 leaves were increased in 100ppm, 200ppm, and 300ppm *Spirulina* treated larvae as compared to control of larvae. In these five observations, 400ppm (T_4) *Spirulina* treated IV instar larvae width (0.813 cm) was significantly increased than the other four treatments 300ppm (0.670 cm), 200ppm(0.566 cm), 100ppm (0.552 cm) and control (0.532cm) respectively (Table1)

The mean length of Vinstar larvae of (T_4) 400ppm *Spirulina* treated MR_2 leaves were increased in 100ppm, 200ppm, and 300ppm *Spirulina* treated larvae as compared to control of larvae. In these five observations, 400ppm (T_4) *Spirulina* treated V instar larvae length (7.956 cm) was significantly increased than the other four treatments 6.524, 6.628, 7.783 and 6.428 cm respectively.

The mean width of V instar larvae of (T_4) 400ppm *Spirulina* treated MR_2 leaves were increased in 100ppm, 200ppm, and 300ppm *Spirulina* treated larvae as compared to control of larvae. In these five observations, 400ppm (T_4) *Spirulina* treated V instar larvae width (1.554 cm) was significantly increased than the other four treatments 1.083, 1.187, 1.323 and 1.058 cm respectively.

Feeding trials conducted by several workers proved that the level of nutrients in different mulberry varieties have significant influence on growth and development of silkworm and cocoon production (Machii and Katagiri, 1990). In the present study, in general, it has been observed that the food consumption and utilization have found to be lowered in young instars than the subsequent stages of growth and development in both the feed like MR_2 and *Spirulina* treated leaves. In general, the present results are in agreement with the observations of earlier workers (Ramadevi *et al*., 1992). Chaluvachari and Bongale (1995) have evaluated that the quality of a few selected leaves showed significant difference of silkworm growth and development. Food ingestion and digestibility and growth in the larval stages are interrelated and the rate of digestion in silkworm increase with the advance of instar, which is highest, about 65% in the fifth instar (Ueda, 1982).

Table 1: Larval parameters (length, width and Weight) as influenced by supplement feed on *Bombyx mori* (III[rd], IV [th] and V [th] instar)

Treatments	Length (cm)			Width (cm)			Weight/10 larvae (gm)		
	III Instar	IV Instar	V Instar	III Instar	IV Instar	V Instar	III Instar	IV Instar	V Instar
T_1-MR2 mulberry leaves + 100 ppm *Spirulina*	1.833 ^{c} (1.353)	5.345^{c} (2.354)	6.524^{d} (2.554)	0.446 ^{c} (0.647)	0.542^{c} (0.743)	1.083^{d} (1.040)	1.027^{c} (1.013)	4.466^{c} (2.113)	26.950^{d} (5.191)
T_2-MR2 mulberry leaves + 200 ppm *Spirulina*	1.843 ^{c} (1.357)	5.568^{c} (2.359)	6.791^{c} (2.605)	0.452 ^{c} (0.672)	0.566^{c} (0.752)	1.187^{c} (1.089)	1.058^{c} (1.028)	4.530^{c} (2.128)	28.447^{c} (5.333)
T_3-MR2 mulberry leaves + 300 ppm *Spirulina*	1.924 ^{b} (1.387)	5.973^{b} (2.443)	7.183^{b} (2.680)	0.495 ^{b} (0.703)	0.670^{b} (0.818)	1.323^{b} (1.150)	1.158^{b} (1.076)	5.038^{b} (2.244)	30.753^{b} (5.545)
T_4-MR2 mulberry leaves + 400 ppm *Spirulina*	2.482 ^{a} (1.575)	6.127^{a} (2.475)	7.556^{a} (2.748)	0.541 ^{a} (0.735)	0.813^{a} (0.901)	1.554^{a} (1.124)	1.595^{a} (1.262)	5.203^{a} (2.281)	33.894^{a} (5.821)
T_5-Control	1.730 ^{d} (1.315)	5.037^{d} (2.244)	6.428^{d} (2.535)	0.419 ^{d} (0.667)	0.532^{d} (0.729)	1.058^{d} (1.028)	0.894^{d} (0.945)	4.233^{d} (2.057)	26.270^{d} (5.125)
SED	0.013	0.043	0.0579	0.030	0.015	0.0356	0.0318	0.0915	0.4917
CD (p=0.05)	0.029	0.950	0.1261	0.066	0.033	0.0776	0.0693	0.1994	1.0713

Values are means of Four replications: values in the parenthesis are square root transformed values; in a column, means followed by common letter(s) are not significantly different (P = 0.05) by Duncan's Multiple Range Test

The total body weight gain on wet weight bases was significantly higher in Spirulina treated leaves. The current findings are comparable with the results of Centhilnayagi (2004) and Balasundaram *et al*. (2007; 2008). The weight of cocoon was maximum in silkworm larvae when fed with spirulina treated mulberry leaves. Bose *et al*. (1995) has reported that succulent leaves with less fiber and higher mineral contents presumably stimulated the metabolic activities in silkworm, resulting in qualitative improvement of cocoon and silk. All other parameters governing yield and quality of cocoon were influenced significantly when the leaf was fed by the larvae. This might be attributed due to the better quality of spirulina treated mulberry leaves with respect to higher content of protein, carbohydrate and moisture content which ultimately resulted in the production of higher yield of better quality cocoon. Nutrition is known to play an important role on growth, development and overall performance of the cocoon components. Better quality of spirulina treated mulberry leaf variety, therefore, leads to the elevated value of growth and yield attributing parameters in the present investigation.

The productivity of silkworm in terms of cocoon crops depend on several factors within and outside the body of silkworm (Benchamin and Jolly, 1986). Therefore, maintenance of ideal environment with several variation and nutritional condition as influenced by the inherent character of any variety becomes crucial for the maximization of productivity. The present investigation revealed that the rearing performance of silkworm was significant when leaf was treated with spirulina supplying better nutritive favour, growth & development of larvae influencing the overall performance of silkworm*, Bombyx mori.*

In the present study, treated mulberry leaves may have helped the silkworm larvae in a beneficial way, leading to the there in conversion and silk synthesis. The findings of the present study on feeding leaves with spirulina influenced various economic characters of III[rd], IV[th] and V[th] instar larvae of *B. mori*. The results corroborate the earlier findings of Frasisse and Arnoux (1954) and Balasundaram *et al*. (2007). It may be thus inferred from the present study that the leaves treated with spirulina results in the production of improvement of the quality of cocoon and silk in respects to silk traits *viz.,* pupal weight, shell weight and cocoon weight.

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