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ORIGINAL ARTICLE

STUDIES ON THE MORPHOMETRIC AND ECONOMIC PARAMETERS ANALYSIS OF SILKWORM *Bombyx mori* (L.) (LEPIDOPTERA : BOMBYCIDAE) FED WITH AMINO ACID (LYSINE) TREATED MR2 MULBERRY LEAVES

[1]M. Meeramaideen, [1]P.Rajasekar, [1]K.Sumathi and [2]P. Ganesh Prabu

[1]Department of Zoology, Jamal Mohamed College, Tiruchirappalli-620 020
[2]Department of Zoology, Annamalai University, Annamalai Nagar, Chidambaram -608 002

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ABSTRACT

Nutrition is an important growth regulatory factor in silkworm. *Bombyx mori* is monophagous insect that feeds mainly on mulberry leaves. Significant advances in the research of silkworm nutrition began with development of artificial diets. This study was carried out to determine the morphometric and economic parameters analysis of silkworm *Bombyx mori* (IV and V instar larvae) fed by MR2 mulberry (*Morus alba*) leaves and Amino acids (Lysine (2.5%), Alanine (2.5%), Cysteine (2.5%) and Glycine (2.5%)) treated MR2 mulberry leaves in relation to growth and silk production. Morphometric parameters like length, width and weight of IV and V instar larvae. Economic parameters like shell weight (SW), shell ratio (SR), silk filament length (FL) and denier (D). The Amino acids were treated to throughout the larval period. In the present study, it has been observed that the morphometric and economic parameters of *B. mori* enhanced by 2.5% of Amino acid (Lysine) treated group (T1) than control and other treated groups (Alanine (2.5%), Cysteine (2.5%) and Glycine (2.5%)). This study has been indicated that the Amino acid (Lysine) exhibit the presence of more growth stimulant activity and can be used to increase the silk yield in commercial silkworm rearing.

Keywords: *Bombyx mori, Morus alba*, Amino acids, Lysine, MR2 mulberry.

1.INTRODUCTION

Bombyx mori is monophagous insect that feeds mainly on mulberry leaves. Significant advances in the research of silkworm nutrition began with development of artificial diets (Ito, 1978). The effect of artificial diets with different nutrition on better production of cocoon crops and silk were investigated by many workers like Fukuda and Higuchiy, (1963); Yokoyama, (1964) and Hamamura, (1964). The silkworms require 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 and 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. 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 the quality and 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 and agronomic practices and environmental factors (Krishnaswami *et al*., 1970; Dutta, 1992).

Nirwani and Kaliwal, (1998) have reported that the weight of larvae and silk glands in all the thiamine fed groups had not shown any significant changes. On the other hand, larval duration, cocoon weight, shell weight and fecundity increased significantly. Among environmental factors, temperature is known to play a major role on growth and productivity in silkworm (Benchamin and Jolly, 1986). 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 Delvi, 1987). Sengupta *et al*. (1972) have reported that the mulberry leaves enriched with glucose and molasses have significant beneficial effect on growth and cocoon production. From the above literature, the works in relation to the efficacy of mulberry leaves MR2 (control) and it treated with Amino acids on feed efficacy of *Bombyx mori* are scanty. Therefore, it has been programmed in the present study to find out the feed efficacy of mulberry

Corresponding author: **M. Meeramaideen, Department of Zoology, Jamal Mohamed College, Tiruchirappalli-620 020*

leaves (MR2) treated with Amino acids on *Bombyx mori* in relation to silk production.

Lysine is an essential amino acid in humans, it cannot be synthesize in the human body, it must be obtained from the diet. Lysine encoded by the codons AAA and AAG, is an α-amino acid that is used in the biosynthesis of proteins. Lysine is an important additive to animal feed because it is a limiting amino acid when optimizing the growth of certain animals such as pigs and chickens for the production of meat. Lysine supplementation allows for the use of lower-cost plant protein (maize, for instance, rather than soy) while maintaining high growth rates, and limiting the pollution from nitrogen excretion (Toride, 2011).

The present study has been aimed to find out the morphometric and economic parameters analysis of different amino acids (Lysine, Alanine, Cysteine and Glycine) treated MR2 mulberry leaves with regard to growh of larvae and ultimate impact on the cocoon parameters of silkworm so as to spot out the most nutritive one for bivoltine silkworm in Tamil Nadu climatic conditions. The work is related to the studies on the growth rate and silk production of *B. mori* fed with control and amino acids treated MR2 mulberry leaves are fragmentary.

2.MATERIALS AND METHODS

Silkworm Rearing

The first day of V instar of popular Indian bivoltine hybrid (CSR2×CSR4) silkworm *Bombyx mori* (Local Bivoltine) race were collected from Silkworm Culture Centre at 2nd Agraharam, Salem in Tamil Nadu. The larvae were reared simultaneously both in control and experimental groups separately on mulberry leaves dipped in Amino acids (Lysine (2.5%), Alanine (2.5%), Cysteine (2.5%) and Glycine (2.5%)) solution in the laboratory. Proper environmental conditions provided to the silkworms with photoperiod of 12:12 h light and darkness as recommended by Krishnaswamy *et al*. (1973). The first day of V instar larvae were placed at ambient temperature of 25 ± 27ºC and relative humidity of 70 to 80%. The larvae were reared in card board boxes measuring 22×15×5 cms covered with nylon net and placed in an iron stand with ant wells (Govindan, *et al*., 1981).

Economic Traits

The economic traits like cocoon parameters (length, width and weight), cocoon shell weight were measured by using scales and digital balance, the other economic traits like shell ratio, filament length and denier were calculated by following appropriate formulas. The economic traits were analyzed the control and Amino acids treated groups only (group 1 and 2).

Cocooning Percentage (CP) was calculated by following formula (Evans, 1939)

$$CP = \frac{\text{Number of cocoons formed}}{\text{Total number of larvae kept for rearing}} \times 100$$

Shell weight (SW)

Average shell weight of 6 cocoons, selected randomly from control and Amino acids treated groups (Pupae were removed from cocoons and only shell was weighed).

Shell Ratio (SR) was calculated by following formula (Evans, 1939)

$$SR = \frac{\text{Weight of cocoon shell}}{\text{Weight of whole cocoon}} \times 100$$

Filament Length (FL)

Six cocoons were taken randomly from control and Amino acids treated groups. The cocoon was socked in boiled water (after 6th day of spinning) to soften the sericin content. Cocked cocoons were reeled on epprouvette. The total number of revolutions were recorded and converted into meters by using the following formula (Evans, 1939).

$$FL = R \times 1.125$$

Where, FL = Total filament length (m/cocoon), R = Number of revolutions, 1.125 = Circumference of Epprouvette. The average filament length of 6 replications of control and Amino acids treated group was recorded.

Denier (D)

Denier is defined as the strength of silk thread. The reeled silk thread is taken from the epprouvette. It was dried for 15 days and weight of reeled silk was recorded.

The denier was calculated by following formula (Evans, 1939).

$$D = \frac{W}{L} \times 9000$$

Where, W= Weight of single cocoon reeled silk in grams, L = Total length of single cocoon reeled filament in meters, 9000= Constant value.

Selection of the Effective Concentration of Amino acids

The Amino acids, lysine, alanine, cysteine and glycine was diluted to 2.5% concentration separately. Fresh MR2 mulberry leaves were separately soaked with each amino acids for 15 minutes and then were dried in air for 10 minutes. The Amino acids treated leaves were used for feeding the IV and V instars larvae of silkworm *Bombyx mori* (Suleman, 1999). The *Bombyx mori* larvae were divided into two groups (Control and Treated). The treated group divided into four sub groups (T1, T2, T3 and T4) this sub groups were treated with Amino acids, lysine, alanine, cysteine and glycine respectively. The control and Amino acids treated MR2 mulberry (*Morus alba*) leaves were fed by V instar of silkworm *Bombyx mori*, five feedings/per day.

Experimental Groups

The V instars of *Bombyx mori* larvae fed with the following MR2 mulberry leaves. Control group (C) larvae fed with normal MR2 mulberry leaves, group T1 larvae fed with 2.5% of lysine treated MR2 mulberry leaves, group T2 larvae fed with 2.5% alanine treated MR2 mulberry leaves, group T3 larvae fed with 2.5% cysteine treated MR2 mulberry leaves and group T4 larvae fed with 2.5% glycine treated MR2 mulberry leaves (Rasool, 1995).

Statistical Analysis

All the data were analyzed by one way analysis of variance (ANOVA) followed by Duncan's multiple range test (DMRT) using a commercially available statistics software package (SPSS® for Windows, V. 16.0, Chicago, USA). Results were presented as mean ± standard deviation (SD).

3.RESULTS

Morphometric data of length, width and weight of larval, pupal and cocoon parameters of *Bombyx mori* larvae fed with control MR2 mulberry leaves and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves were presented in Tables 1, 2, 3, and 4 respectively.

Table 1 shows that the Morphometric data of length, width and weight of larval parameters of *B. mori* fed with control MR2 leaves and Amino

acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 leaves in IV instar larvae of *B. mori*. The mean length, width and weight of IV instar larvae of group 'C' were (5.2871±0.12171 cm, 0.4291±0.06113 cm and 0.6219±0.03449 gm), respectively. The mean length, width and weight of IV instar larvae of group T_1 were (6.4157±0.18721 cm, 0.5146±0.08568 cm and 0.9596±0.06185 gm), respectively. The mean length, width and weight of IV instar larvae of group T_2 were (5.8531±0.15706 cm, 0.4848±0.05946 cm and 0.7817±0.05693 gm), respectively. The mean length, width and weight of IV instar larvae of group T_3 were (5.7568±0.11716 cm, 0.4713±0.05417 cm and 0.7685±0.04618 gm), respectively. The mean length, width and weight of IV instar larvae of group T_4 were (5.6845±0.11972 cm, 0.4585±0.04409 cm and 0.7519±0.04809 gm), respectively. In these five observations, 2.5% (group T_1) Amino acid (Lysine) treated IV instar larvae length, width and weight were significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 2 shows that the Morphometric data of length, width and weight of larval parameters of *B. mori* fed with control MR2 leaves and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 leaves in V instar larvae of *B. mori*. The mean length, width and weight of V instar larvae of group 'C' were (6.2185±0.07812 cm, 0.6858±0.04845 cm and 2.9846±0.13571 gm), respectively. The mean length, width and weight of V instar larvae of group T_1 were (8.3573±0.19743 cm, 0.9195±0.09165 cm and 3.9176±0.20028 gm), respectively. The mean length, width and weight of V instar larvae of group T_2 were (7.0015±0.18898 cm, 0.7814±0.08096 cm and 3.7684±0.18765 gm), respectively. The mean length, width and weight of V instar larvae of group T_3 were (6.7675±0.09756 cm, 0.7663±0.06595 cm and 3.5284±0.17945 gm), respectively. The mean length, width and weight of V instar larvae of group T_4 were (6.6518±0.08349 cm, 0.7486±0.06187 cm and 3.3961±0.15375 gm), respectively. In these five observations, 2.5% (group T_1) Amino acid (Lysine) treated V instar larvae length, width and weight was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 3 shows that the Morphometric data of mean length, width and weight of the pupae of *B. mori* fed with Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 leaves were found to be more than that of the larvae fed with control MR2 leaves. The length, width and weight of the group 'C' larvae produced pupae were found to be about (2.5754±0.2002 cm, 2.2127±0.1086 cm and 1.1271±0.0712 gm), respectively. The length, width and weight of the group T_1 larvae produced pupae were observed to be about (3.2457±0.3033 cm, 2.9457±0.1242 cm and 1.8856±0.0902 gm), respectively. The length, width and weight of the group T_2 larvae producing pupae were observed to be about (2.9210±0.2865 cm, 2.6237±0.1017 cm and 1.7274±0.0974 gm), respectively. The length, width and weight of the group T_3 larvae produced pupae were observed to be about (2.8238±0.2601 cm, 2.6015±0.1076 cm and 1.6759±0.0886 gm), respectively. The length, width and weight of the group T_4 larvae produced pupae were observed to be about (2.8151±0.2298 cm, 2.4028±0.1027 cm and 1.5023±0.0842 gm), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae produced cocoon length, width and weight were significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 4 shows that the Morphometric data of mean length, width and weight of the cocoon of *B. mori* fed with Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 leaves were found to be more than that of the larvae fed with control MR2 leaves. The length, width and weight of the group 'C' larvae produced cocoon were found to be about (2.5574±0.10175 cm, 2.4587±0.02578 cm and 2.2547±0.25852 gm), respectively. The length, width and weight of the group T_1 larvae produced cocoon were observed to be about (3.0964±0.16641 cm, 2.9254±0.05124 cm and 2.8354±0.29451 gm), respectively. The length, width and weight of the group T_2 larvae producing cocoon were observed to be about (2.8478±0.16284 cm, 2.7958±0.05657 cm and 2.6957±0.27158 gm), respectively. The length, width and weight of the group T_3 larvae produced cocoon were observed to be about (2.7128±0.15654 cm, 2.7012±0.04348 cm and 2.6369±0.27725 gm), respectively. The length, width and weight of the group T_4 larvae produced cocoon were observed to be about (2.7420±0.15785 cm, 2.5023±0.04654 cm and 2.5482±0.25624 gm), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae produced cocoon length, width and weight were significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Economic characters like Cocooning Percentage (CP), Shell Weight (SW), Shell Ratio (SR), Silk Filament Length (SFL) and Denier (D-Silk filament Strength) data of control MR2 mulberry leaves and different concentrations of Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed *B. mori* larvae produced cocoon and silk filament were presented in Table 5.

Table 5 shows that the data of control and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed V instar larvae produced cocoon's cocooning percentage (CP). The cocooning percentage (%) of group 'C' larvae (81.8520±0.5120 %), group T_1 larvae (86.2450±0.7540 %), group T_2 (83.3750±0.6240 %) larvae, group T_3 (83.9640±0.8521 %) and group T_4 (83.8130±0.4950 %), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae cocooning percentage (%) was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 5 shows that the data of control and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed V instar *B. mori* larvae produced cocoon's shell weight (SW). The shell weight (gm) of group 'C' larvae (0.5621±0.2410 gm), group T_1 larvae (0.8127±0.3101 gm), group T_2 (0.7954±0.2102 gm) larvae, group T_3 (0.7364±0.1410 gm) and group T_4 (0.7712±0.1460 gm), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae shell weight (SW) was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 5 shows that the data of control and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed V instar *B. mori* larvae produced cocoon shell ratio (SR). The shell ratio (%) of group 'C' larvae (15.5201±0.2184 %), group T_1 larvae (18.3324±0.3214 %), group T_2 (17.6720±0.5410 %) larvae, group T_3 (17.2841±0.3695 %) and group T_4 (16.6210±0.2684 %), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae shell ratio (SR) was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 5 shows that the data of control and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed V instar *B. mori* larvae produced cocoon's silk filament length (SFL). The silk filament length (meters) of group 'C' larvae (864.3841±10.2471 mts.), group T_1 larvae (912.2961±09.0276 mts.), group T_2 (894.0254±05.3571 mts.) larvae, group T_3 (883.2841±12.0267 mts.) and group T_4 (872.9137±10.6421 mts.), respectively. In these five observations, the 2.5% (group T_1) Amino acid (Lysine) treated larvae silk filament length (meters) was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 5 shows that the data of control and Amino acids (Lysine (T1), Alanine (T2), Cysteine (T3) and Glycine (T4)) treated MR2 mulberry leaves fed V instar *B. mori* larvae produced cocoon's silk filament denier (D). The silk filament denier of group 'C' larvae (2.0721±0.0375 %), group T_1 larvae (2.8168±0.1265 %), group T_2 (2.6351±0.1126 %) larvae, group T_3 (2.5029±0.1942 %) and group T_4 (2.5340±0.1376 %), respectively. In these five observations, the 2.5% (group T_1) Amino acids treated larvae silk filament length (meters) was significantly increased than the other four groups ('C', T_2, T_3 and T_4).

Table 1. Morphometric data of IV instar larvae of *Bombyx mori* fed with control and Amino acids treated MR2 mulberry leaves

Experimental Groups / Concentrations	Larvae length (cm)	Larvae width (cm)	Larvae weight (gm)
Control (C)	5.2871±0.12171[b]	0.4291±0.06113[a]	0.6219±0.03449[a]
Lysine (2.5%) – T_1	6.4157±0.18721[c]	0.5146±0.08568[ab]	0.9596±0.06185[b]
Alanine (2.5%) – T_2	5.8531±0.15706[a]	0.4848±0.05946[ab]	0.7817±0.05693[a]
Cysteine (2.5%) – T_3	5.7568±0.11716[a]	0.4713±0.05417[b]	0.7685±0.04618[a]
Glycine (2.5%) – T_4	5.6845±0.11972[a]	0.4585±0.04409[b]	0.7519±0.04809[a]

Values are Mean ± Standard Deviation of six observations. Values in the same column with different superscript letters (a, b & c) differs significantly at P<0.05 (DMRT).

Table 2. Morphometric data of V instar larvae of *Bombyx mori* fed with control and Amino acids treated MR2 mulberry leaves

Experimental Groups / Concentrations	Larvae length (cm)	Larvae width (cm)	Larvae weight (gm)
Control (C)	6.2185±0.07812[a]	0.6858±0.04845[ab]	2.9846±0.13571[a]
Lysine (2.5%) – T_1	8.3573±0.19743[c]	0.9195±0.09165[b]	3.9176±0.20028[b]
Alanine (2.5%) – T_2	7.0015±0.18898[bc]	0.7814±0.08096[ab]	3.7684±0.18765[a]
Cysteine (2.5%) – T_3	6.7675±0.09756[bc]	0.7663±0.06595[ab]	3.5284±0.17945[ab]
Glycine (2.5%) – T_4	6.6518±0.08349[b]	0.7486±0.06187[a]	3.3961±0.15375[a]

Values are Mean ± Standard Deviation of six observations. Values in the same column with different superscript letters (a, b & c) differs significantly at P<0.05 (DMRT).

Table 3. Morphometric data control and Amino acids treated MR2 mulberry leaves fed *Bombyx mori* larvae produced pupae

Experimental Groups / Concentration	Pupal length (cm)	Pupal width (cm)	Pupal weight (gm)
Control (C)	2.5754±0.2002[ab]	2.2127±0.1086[a]	1.1271±0.0712[ab]
Lysine (2.5%) – T_1	3.2457±0.3033[c]	2.9457±0.1242[b]	1.8856±0.0902[c]
Alanine (2.5%) – T_2	2.9210±0.2865[ab]	2.6237±0.1017[a]	1.7274±0.0974[ab]
Cysteine (2.5%) – T_3	2.8238±0.2601[a]	2.6015±0.1076[a]	1.6759±0.0886[a]
Glycine (2.5%) – T_4	2.8151±0.2298[a]	2.4028±0.1027[a]	1.5023±0.0842[ab]

Values are Mean ± Standard Deviation of six observations. Values in the same column with different superscript letters (a, b & c) differs significantly at P<0.05 (DMRT).

Table 4. Morphometric data of control and Amino acids treated MR2 mulberry leaves fed *Bombyx mori* larvae produced cocoon

Experimental Groups/ Concentration	Cocoon length (cm)	Cocoon width (cm)	Cocoon weight (gm)
Control (C)	2.5574±0.10175[ab]	2.4587±0.02578[a]	2.2547±0.25852[a]
Lysine (2.5%) – T_1	3.0964±0.16641[c]	2.9254±0.05124[b]	2.8354±0.29451[b]
Alanine (2.5%) – T_2	2.8478±0.16284[ab]	2.7958±0.05657[a]	2.6957±0.27158[a]
Cysteine (2.5%) – T_3	2.7128±0.15654[a]	2.7012±0.04348[a]	2.6369±0.27725[a]
Glycine (2.5%) – T_4	2.7420±0.15785[a]	2.5023±0.04654[a]	2.5482±0.25624[a]

Values are Mean ± Standard Deviation of six observations. Values in the same column with different superscript letters (a, b & c) differs significantly at P<0.05 (DMRT).

Table 5. Economic traits of control and Amino acids treated MR2 mulberry leaves fed V instar larvae of *Bombyx mori* produced cocoon

Experimental Groups / Concentration	Cocooning Percentage (%)	Shell weight (gm)	Shell Ratio (%)	Silk filament Length (Meters)	Denier (%)
Control (C)	81.8520±0.5120[c]	0.5621±0.2410[ab]	15.5201±0.2184[b]	864.3841±10.2471[b]	2.0721±0.0375[b]
Lysine (2.5%) – T_1	86.2450±0.7540[d]	0.8127±0.3101[c]	18.3324±0.3214[c]	912.2961±09.0276[c]	2.8168±0.1265[c]
Alanine (2.5%) – T_2	83.3750±0.6240[bc]	0.7954±0.2102[a]	17.6720±0.5410[ab]	894.0254±05.3571[b]	2.6351±0.1126[b]
Cysteine (2.5%) – T_3	83.9640±0.8521[ab]	0.7364±0.1410[a]	17.2841±0.3695[ab]	883.2841±12.0267[a]	2.5029±0.1942[a]
Glycine (2.5%) – T_4	83.8130±0.4950[a]	0.7712±0.1460[b]	16.6210±0.2684[a]	872.9137±10.6421[a]	2.5340±0.1376[a]

Values are Mean ± Standard Deviation of six observations. Values in the same column with different superscript letters (a, b & c) differs significantly at P<0.05 (DMRT).

4.DISCUSSION

Nutrition plays an important role in improving the growth and development of *B. mori* (Kanafi *et al*., 2007). Subburathinam *et al*. (1990) have observed the enrichment of mulberry leaves with calcium chloride to increase the cocoon characters like cocoon weight, shell weight cocoon /shell ratio and silk proteins. Eswaran and Sevarkodiyone (2004) have reported that the 3 per cent suspension of wheat and Tapioca flours along with mulberry leaves showed greater shell weight, respectively by 28% and 15%. In the present study, it has been observed that increased silk ratio, silk output, cocoon weight in the Amino acids treated MR2 mulberry leaves than control MR2 mulberry leaves. Ascorbic acid had effect on the growth of silkworm (Javed and Gondal, 2002). Similar results are in parallel with the work of Sridhar and Radha, (1986) who have reported that the economic characters of the silk cocoon were improve by feeding the silkworm with mulberry leaves treated with amino acids. Majumdar and Medda, (1995) have reported the supplementation of tyrosine to enhance the cocoon weight due to the increased synthesis of silk proteins in silk gland. Alagumalai *et al*. (1991) have observed fortification of mulberry leaves with the flour of black gram and red gram to improve the larval growth and cocoon characteristics in *B. mori*. Amway protein supplemented (10%) mulberry leaf significantly improved larval growth and economic characters of silkworm (Amala Rani *et al*., 2011). Similarly, the growth of silkworm larvae improved significantly upon feeding them with mulberry leaves supplemented with different nutrients (Sarker, 1993). Chamudeswari and Radhakrishnaiah, (1994) have reported the increased of cocoon weight, when the silkworm larvae were fed with zinc and nickel fortified mulberry leaves. It was reported that cocoon weight and pupal weight were directly proportional to the concentration of JH and the feeding period (Akai *et al*., 1985 and Chowdhary *et al*., 1990).

In the present observations, it was also evident that consistently better rearing performance was obtained from feeding of leaves of Amino acids treated mulberry leaves over other variety namely, MR2. All the parameters governing yield and quality of cocoon were influenced significantly when the leaf was fed by the larvae. This might be attributed due to better quality of Amino acids treated mulberry leaves with respect to higher content of protein, carbohydrate and moisture content which ultimately resulted in the production of higher yield and better quality cocoon. The food consumption has a direct relevance on the weight of larvae, cocoon, pupae and shell, the independent parameters of consumption and productivity vary depending upon the type of nutrition (Shivakumar, 1995). In the present study, the Amino acids treated mulberry leaves may have helped the silkworm larvae in a beneficial way, leading to increase the conversion and silk synthesis. It is suggested that MR2 leaf variety influences the conversion of more food towards shell content as reported earlier (Radha *et al*, 1981; Tayade *et al*., 1988 and Govindan *et al*., 1990). The weight of IV and V instar larvae were found to be increased when the worms were fed with Amino acids treated mulberry leaves followed by MR2 leaf variety. Several researchers demonstrated phagostimulatory effect of ascorbic acid for insects (Dobzhenok, 1974; Ito, 1978). Sengupta *et al*. (1972) have reported that silk production increased with 1% ascorbic acid in the diet of silkworm.

The present investigation revealed that the rearing performance of silkworm was significantly influenced by the leaf variety with Amino acids. It is understood from the present investigation that the combination of favourable leaf variety like MR2 treated with Amino acids supplying better nutritive fervor, growth and development of larvae influencing the overall performance of silkworm, *Bombyx mori*. In silk worm, a gustatory stimulating activity has been observed to some extent (Ito, 1961). Gomma *et al*. (1977) have observed that ascorbic acid significantly increased the silkworm larvae. Tayade *et al*. (1988) have reported that the silkworm fed with mulberry variety S_{54} recorded less larval duration, higher mature larval weight and higher single cocoon weight when compared to MR2 variety. The total body weight gain on wet weight basis was significantly higher in Amino acids treated mulberry leaves followed by MR2 leaf variety. Among the mulberry leaves, Amino acids treated mulberry leaves has gained maximum body weight, cocoon weight and silk trait than the worms fed with MR2 leaf variety. The current findings are comparable with the results of Horie, (1978). Although, it is quite apparent that better leaf quality of Amino acids treated mulberry leaves resulted in better rearing performance of silkworms and it leads to maximum yield of silk. Since the quality of mulberry varieties significantly influence the different conditions to which the plant is exposed such as soil fertility, agronomic practices, planting system, prunning and environmental factors (Bongale *et al*., 1991; Dutta, 1992) position and maturity (Krishnaswami *et al*., 1970) in relation to growth and development of silkworms. Periaswamy and Radhakrishnan, (1985) have reported that leaves of MR2, S_{54} and C_1 varieties possess relatively more amount of crude protein, total soluble sugars, free amino acids and total minerals than MR2 variety. These findings are in accordance with Haq and Saleem, (1985) who have investigated that when silkworm larvae were fed on 0.2% N treated mulberry leaves, increased the cocoon weight. Further, it has been revealed from the present study that the weight of cocoon was maximum in silkworm larvae when fed with Amino acids treated mulberry leaves than MR2 leaf variety. Similar trend was observed by Udupa, (1986) and Tayade, (1987), on *B. mori* in relation to heterosis effect on economic traits of new hybrids. 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).

5.CONCLUSION

In the present study to be concluded that growth rate of IV and V instar morphometric analysis and economic parameters of silkworm *Bombyx mori* larvae was comparatively enhance the silkworm fed with 2.5% of amino acid lysine treated MR2 mulberry leave than the control and other amino acids treated groups such as alanine (T_2), cysteine (T_3) and glycine (T_4).

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