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Impact of spirulina and thyroxine fortified mulberry leaves on the rearing performance of silkworm, *Bombyx mori* L.

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Abstract
Nutrition plays an important role in the growth and development of silkworm *Bombyx mori L* which subsequently influences the cocoon production. Although the mulberry leaves are complete diet for silkworm, the supplementation with extra nutrients results in higher yields. Two fortificants *viz* Spirulina and Thyroxine with three different concentrations i.e., 300 ppm, 400 ppm, 500 ppm and 1.25 ppm, 2.50 ppm, 5.00 ppm respectively were utilized to determine their effect on weight of ten mature larvae, 5th age larval duration, total larval duration, single cocoon weight, single shell weight, shell ratio percentage, cocoon yield by number, cocoon yield by weight of Silkworm *Bombyx mori* L. The spirulina and thyroxine fortified mulberry leaves were fed to larva. Two groups experimental group and control group were taken. It was found that the treatment combination of spirulina 500 ppm and thyroxine 5.00 ppm recorded the highest values for these parameters. During spring season, the treatment combination of spirulina 500 ppm and thyroxine 5.00 ppm recorded the shortest 5th age larval duration (170.60 h), total larval duration (650.60 h), and recorded highest weight of ten mature larvae (51.36 g), single cocoon weight (2.30 g), single shell weight of (0.54 g), highest shell ratio percentage (23.30%), highest cocoon yield by number (9301.96) and highest cocoon yield by weight (21.44). During autumn season the treatment combination of spirulina 500 ppm and thyroxine 5.00 ppm recorded the shortest 5th age larval duration (216.24 h), total larval duration (696.24 h) and recorded highest weight of ten mature larvae (49.48 g), single cocoon weight (1.98 g), single shell weight of (0.46 g), highest shell ratio percentage (23.03%), highest cocoon yield by number (9033.46) and highest cocoon yield by weight (18.54). It was concluded that Spirulina and Thyroxine supplemented mulberry leaves showed increase in economic characters in experimental groups as compared to control groups hence it can be recommended for use to increase the yield of the farmers.

Keywords: Silkworm, spirulina, thyroxine, economic parameters

Introduction
One of the most well-known helpful lepidopteran insects is the silkworm (*Bombyx mori*). It only consumes mulberry leaves and is monophagous. The production performance of silkworms is a major factor in the sericulture industry, and producing high-quality cocoon is the main objective of silkworm rearing (Samami *et al*., 2019) [22]. The nutritional value of mulberry leaves has a major impact on larval growth and development as well as the subsequent generation of cocoons. Probiotics (Singh *et al*., 2005; Masthan *et al*., 2011a; Amalarani *et al*., 2011) [26, 12, 4], pre and probiotics (Lakshmi Bai and Ramani Bai, 2011) [11], and serifeed (Ananda Kumar and Michael, 2011) [5] have all demonstrated the effects of supplemental feed on intake and how it affects the quality and quantity of cocoon produced by silkworms. In sericulture, efforts have been undertaken recently to fortify mulberry leaves with botanical extracts so as to improve the mulberry leaf quality and feed efficiency of silkworm which in turn increase cocoon production and silk quality. The larval and cocoon characters of silkworm, *Bombyx mori* influenced by plant extract Xanthium indicum (Pardeshi and Bajad, 2014) [20]. Increase in larval and shell weight subsequently commercial characters of cocoon on oral administration of foliage mulberry and eri silkworm supplemented with cyanobacteria (Kumar *et al.*, 2009) [10]. It has been shown that silk quality can be raised by applying hormones to *Bombyx mori* (Akai *et al*., 1985; Ahmad *et al*., 2007; Mamatha *et al*., 2006) [2, 1, 13] For instance, Miranda *et al*. (2002) [15] found that topical administration of the juvenile hormone analog methoprene lengthened the larval stage and increased the weight of the *Bombyx mori* cocoon and silk gland.

The primary hormone produced into the bloodstream by the thyroid gland is called thyroxine. It is crucial for regulating the body's metabolism. According to Thyagaraja *et al*. (1991) [31], feeding thyroxine to *Bombyx mori* larvae increased the weight of the cocoon shell by up to 150% in certain situations, without lowering the quality of the silk. According to Ahmad *et al*. (2007) [1] found that giving thyroxine to *Bombyx mori* larvae raised the ecdysteroid titer 33.34% higher than the control; a greater ecdysteroid titer is likely to encourage the synthesis of sericin and fibroin proteins as well as larval development (Thagaraja *et al*., 1991). Furthermore, nutrition is known to have a significant impact on *Bombyx mori* growth and development, and different mulberry types have different nutritional qualities in their leaves (Kanafi *et al*., 2007) [9]. Eighteen amino acids, including glutamine, glycine, histidine, lysine, methionine, creatine, cysteine, phenylalanine, serine, proline, tryptophan, asparagines, and pyruvic acid, are found in spirulina, a blue-green algae. Other essential vitamins include biotin, tocopherol, thiamine, riboflavin, niacin, folic acid, pyrodozoic acid, beta-carotene, and vitamin B12. Spirulina supplemented mulberry leaf found to be efficient in increasing larval and cocoon characters when orally fed to *Bombyx mori* (Sangamithirai *et al.*, 2014) [23]. The growth rate of silkworm larvae and cocoon characters of silkworm *Bombyx mori* enhanced by Spirulina as it exhibits the presence of certain growth stimulant activity has been observed (Kumar and Balasubramanian, 2014) [32]. The present study is to investigate impact of Spirulina and thyroxine on economic parameters of silkworm *Bombyx mori* L *viz*, weight of ten mature larvae, 5th age larval duration, total larval duration cocoon weight, shell weight, shell percentage, cocoon yield by number and weight.

Materials and Methods

The silkworm rearing was carried out at College of Temperate Sericulture, Mirgund during the year 2021 and 2022.The silkworm rearing of bivoltine hybrid, CSR2 X CSR4 was conducted as per the recommended package of practices. After incubation, the hatched larvae were fed with normal leaf (Ichinose & Goshoerami) after 3rd moult silkworms were counted and for each treatment 150 silkworms were maintained for each replication. After 3rd moult silkworm were resumed with the treated leaves. The fortificants, Spirulina and Thyroxin prepared as per the treatment concentrations and combinations were sprayed on fresh mulberry leaves with the help of an automizer @ 60 ml/200 g/200 larvae and the treated leaves after 10-15 minutes were fed to the silkworm *Bombyx mori* L., daily once as first feed during 4th and 5th instar. Two controls *viz*. control-I (worms fed with mulberry leaves treated with distilled water) and control-II (worms fed with normal mulberry leaves without any treatment) were maintained for comparisons. The experiment was accomplished using a Completely Randomized Design with 3 replications for each treatment.

Treatment combination detail

Code	Symbol	Detail
T_1	S_1	Spirulina @ 300 ppm
T_2	S_2	Spirulina @ 400 ppm
T_3	S_3	Spirulina @ 500 ppm
T_4	T_1	Thyroxine @ 1.25 ppm
T_5	T_2	Thyroxine @ 2.50 ppm
T_6	T_3	Thyroxine @ 5.00 ppm
T_7	S_1T_1	Spirulina @ 300 ppm and Thyroxine @ 1.25 ppm
T_8	S_1T_2	Spirulina @ 300 ppm and Thyroxine @ 2.50 ppm
T_9	S_1T_3	Spirulina @ 300 ppm and Thyroxine @ 5.00 ppm
T_{10}	S_2T_1	Spirulina @ 400 ppm and Thyroxine @ 1.25 ppm
T_{11}	S_2T_2	Spirulina @ 400 ppm and Thyroxine @ 2.50 ppm
T_{12}	S_2T_3	Spirulina @ 400 ppm and Thyroxine @ 5.00 ppm
T_{13}	S_3T_1	Spirulina @ 500 ppm and Thyroxine @ 1.25 ppm
T_{14}	S_3T_2	Spirulina @ 500 ppm and Thyroxine @ 2.50 ppm
T_{15}	S_3T_3	Spirulina @ 500 ppm and Thyroxine T & 5.00 ppm
T_{16}	T_0	Distilled water only
T_{17}	Without any treatment	Normal rearing

The parameters were calculated by the following formulae

Weight of 10 mature larvae (g)

Ten mature larvae were randomly picked from each replication on 5th/6th day of 5th instar and weighed to determine the average larval weight.

5th instar larval duration (hours)

This was recorded as number of hours taken by 5th instar larva from day one of 5th instar till the Seriposition.

Total larval duration (hours)

This was recorded as the total number of hours taken by the larvae from the date of brushing till Seriposition

Single cocoon weight (g)

Twenty Cocoons (10 male and10 female) were selected randomly from each replicate and weighed to obtain average weight of a single cocoon.

Single shell weight (g)

The above cocoons were cut to separate pupae and weighed to get weight of a single shell.

Shell ratio (%)

The ratio between cocoon shell and whole cocoon from the above lot was determined by:

$$\frac{\text{Weight of silk shell(g)}}{\text{Weight of whole cocoon (g)}} \times 100$$

Cocoon yield /10000 larvae after 3rd moult (by number)

$$\frac{\text{No. of cocoons harvested}}{\text{No. of larvae retained after 3rd moult - No. of larvae taken for dissection}} \times 10{,}000$$

Cocoon yield /10,000 larvae after 3rd moult (by weight in kg)

$$\frac{\text{Weight of cocoons harvested}}{\text{No. of larvae retained after 3rd moult - No. of larvae taken for dissection}} \times 10{,}00$$

Results and Discussion

Weight of ten mature larvae (g)

Larval weight is one of the important parameter which determines not only the health of the larvae, but also the quality of the cocoon spun. During spring season. The weight of ten mature larvae (Table-1) was observed maximum (51.36 g) in the treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was significantly different from all other treatments. The minimum weight of ten mature larvae (45.83 g) was recorded in case of control–II Normal rearing (without treatment). During autumn again Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed maximum weight of ten mature larvae (49.48 g). The minimum weight of ten mature larvae (43.52 g) was recorded in case of control–II Normal rearing (without treatment).The increase in weight of ten mature larvae might be due to the enhancement of bio-availability of protein, trace minerals, vitamins and glucose that are beneficial to insect and also for their better growth and development. Sarker (1993) [24] also reported improvement in the growth of the silk worm larvae feedings with mulberry leaves supplemented with different nutrients. The present results are in agreement with the findings of (Narasimha Murthy *et al.*, 1987) [17] who reported that larvae which received Thyroxine hormone showed an increase of 10.9% in the larval weight compared with the control. The present findings are also in conformity with the findings of Alagumalai *et al.* (1991) [3] and Mala *et al.* (2017) [14]. Who supplemented the mulberry leaves with aloe vera.

5th instar larval duration (hours)

The fifth instar larval duration is considered as an important trait by sericulture as the reduction in larval duration would help in minimizing the quantum of total food consumption and labour requirement, besides completion of larval period within a desirable time period Rahmathulla and Suresh, (2012) [21]. during spring season (table-1). It was found that lowest 5th age larval duration of (170.60 hours) was recorded in the treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm).The highest 5th age larval duration of (177.40 hours) was recorded in control–II Normal rearing (without treatment). During autumn season again treatment combination of Spirulina (500 ppm and Thyroxine (5.00 ppm) showed lowest 5th age larval duration (216.24 hours) and the highest 5th age larval duration (220.32 hours) was recorded in control–II Normal rearing (without treatment).The results are in conformity with (Majumdar *et al.* 1975; Thyagaraja *et al.* 1985) [16, 28] who reported that dietary or topical application of Thyroxine on silkworm larvae significantly decreased the larval duration, might be due to the enhanced growth. Present findings are also in line with the findings of Horie and Watanabe (1983) [8] who reported shortening of larval duration by supplementation with soybean protein.

Total larval duration (hours)

Larval duration is an important attribute of economic value in sericulture as the reduction in larval duration would help in minimizing the quantum of the total food consumption and labour requirement, besides completion of larval period in desirable time period (Rahmathulla and Suresh, 2012) [21]. During spring season the total larval duration (Table-1) was recorded shortest (650.60 hours) in the treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was significantly different from all other treatments. The larval duration was longest (657.40 hours) in control–II Normal rearing (without treatment). During autumn again treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed shortest larval duration (696.24 hours). The larval duration was longest (700.32 hours) in control–II Normal rearing (without treatment). The shorten larval duration in case of treatment combination of spirulina (500 ppm) and thyroxine (5.00 ppm) might be through fortified leaves due to the increase availability of amino acids in the larval food and larval haemolymph which in turn led to shortening of larval duration. The results are in conformity with (Majumdar *et al.*1975; Thyagaraja *et al.* 1985) [16, 28] who reported that dietary or topical application of Thyroxine on silkworm larvae significantly decreased the larval duration might be due to the enhanced growth. The present findings are also in line with the findings of Horie and Watanabe (1983) [8] who reported shortening of larval duration by supplementation with soybean protein.

Cocoon parameters

Cocoon weight is an important commercial characteristic used to determine approximately the amount of raw silk that can be obtained. In the present study, during spring (Table-2) it was founded that highest single cocoon weight of (2.30 g) was recorded in treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was statistically higher than rest of the treatments. The lowest value of single cocoon weight of (1.97 g) was found in control–II Normal rearing (without treatment). During autumn season again treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed highest single cocoon weight (1.98 g). The lowest value of single cocoon weight of (1.65) was found in control–II Normal rearing (without treatment). During spring season (table 2) The single shell weight of (0.54 g) was recorded in treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was statistically higher than rest of the treatments The lowest value of single shell weight (0.38 g) was found in control–II Normal rearing (without treatment). During autumn season again treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed highest single shell weight of (0.46 g). The lowest value of single shell weight (0.30 g) was found in control–II Normal rearing (without treatment). During spring season (table-2) the significant difference was also observed for shell percentage after silkworm were fed on different

concentrations of Spirulina and Thyroxine. The highest shell percentage of (23.30%) was recorded in treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was statistically higher than rest of the treatments. The lowest value of shell percentage of (18.98%) found in control–II Normal rearing (without treatment). During autumn season again treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed highest shell percentage of (23.03%). The least value of shell percentage (18.42%) was found in control–II Normal rearing (without treatment).During spring season (Table-3) the cocoon yield by number shows significant difference. It was found that highest cocoon yield by number of 9301.96 /10000 larvae was observed in treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) which was significantly higher than other treatments. The lowest value of cocoon yield by number of 9047.34/10000 larvae was recorded in control–II Normal rearing (without treatment). During autumn again treatment combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed highest cocoon yield by number of 9033.46/10000 larvae. The lowest value of cocoon yield by number of 8172.99/10000 larvae was recorded in control –II Normal rearing (without treatment).During spring season (table-3) the highest cocoon yield by weight of 21.44 kg / 10000 larvae was observed in treatment combination of (Spirulina (500 ppm) and Thyroxine (5.00 ppm).The least value of cocoon yield by weight of 15.77 kg / 10000 larvae was found in control–II Normal rearing (without treatment). During autumn season combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) showed highest cocoon yield by weight of 18.54 kg/ 10000 larvae.The lowest value of cocoon yield by weight of 12.64/kg / 10000 larvae was recorded in control –II Normal rearing (without treatment). The present results are in agreement with the findings of (Venkataramana 2003 and Venkatesh *et al.*, 2009) [30, 31]. They suggested that Spirulina can be effective in enhancing the larval and cocoon characters of silkworm *Bombyx mori* L when Spirulina supplemented with mulberry fed during its 5th instar larval development. The findings of current study are also supported by the studies of (Nirwani and Kaliwal, 1996a, b and Etebari 2002) [18, 6] suggested that oral administration of folic acid during 5th instar silkworm significantly influences the growth rate pattern of silkworm larva and silk gland. This higher growth and development also influences the economic characters like cocoon weight, shell weight and shell ratio and subsequently quality of silk. The results are also supported by the (Ghosh and Medda 1969; Tata, 1970, singh 1972) [7, 27, 25] reported that the increase in the cocoon weight, shell weight, shell percentage, yield by number, by weight, may be due to the stimulatory effect of the Thyroxine since this hormone has been reported to be involved in synthesis of protein, lipid and nucleic acids in vertebrates.

Table 1: Effect of Spirulina and Thyroxine on Larval parameters of Silkworm *Bombyx mori* l during spring and autumn Seasons

	Spring			Autumn		
Parameters / **Treatment**	**Weight of 10 mature larvae (g)**	**5th age larval duration (hours)**	**Total larval durations (hours)**	**Weight of 10 mature larvae (g)**	**5th age larval duration (hours**	**Total larval durations (hours)**
T_1: Spirulina @ 300 ppm	47.17	175.08	655.08	45.30	217.44	697.44
T_2: Spirulina @ 400 ppm	47.35	173.96	653.96	45.37	217.12	697.12
T_3: Spirulina @ 500 ppm	47.50	173.96	653.96	45.51	216.80	696.80
T_4: Thyroxine @ 1.25 ppm	46.90	172.96	652.96	44.92	217.68	697.68
T_5: Thyroxine @ 2.50 ppm	47.15	173.52	653.52	45.16	217.52	697.52
T_6: Thyroxine @ 5.00 ppm	47.30	173.68	653.68	45.24	217.28	697.28
T_7: Spirulina @ 300 ppm & Thyroxine @ 1.25 ppm	47.85	172.28	652.28	45.86	218.32	698.32
T_8: Spirulina @ 300 ppm & Thyroxine @ 2.50 ppm	48.54	172.12	652.12	46.55	218.24	698.24
T_9: Spirulina @ 300 ppm & Thyroxine @ 5.00 ppm	48.98	173.08	653.08	46.77	217.92	697.92
T_{10}: Spirulina @ 400 ppm & Thyroxine @ 1.25 ppm	49.17	172.68	652.68	47.29	217.44	697.44
T_{11}: Spirulina @ 400 ppm & Thyroxine @ 2.50 ppm	49.26	172.96	652.96	47.45	217.20	697.20
T_{12}: Spirulina @ 400 ppm & Thyroxine @ 5.00 ppm	49.43	172.36	652.36	47.53	216.96	696.96
T_{13}: Spirulina @ 500 ppm & Thyroxine @ 1.25 ppm	49.96	172.12	652.12	48.27	216.74	696.74
T_{14}: Spirulina @ 500 ppm & Thyroxine @ 2.50 ppm	50.90	170.68	650.68	48.49	216.48	696.48
T_{15}: Spirulina @ 500 ppm & Thyroxine @ 5.00 ppm	51.36	170.60	650.60	49.48	216.24	696.24
T_{16}: Distilled water only (control-I)	46.17	176.84	656.84	44.01	219.76	699.76
T_{17}: Normal rearing (control-II)	45.83	177.40	657.40	43.52	220.32	700.32
C.D ($p \leq 0.05$)	0.615	0.610	0.611	0.990	0.538	0.515

Table 2: Effect of Spirulina and Thyroxine on Single cocoon wt, shell wt and Shell Ratio per-cent of silkworm *Bombyx mori* L during spring and Autumn Seasons

	Spring			Autumn		
Parameters / **Treatment**	**Single Cocoon weight (g)**	**Single Shell weight (g)**	**Shell Ratio %**	**Single Cocoon weight (g)**	**Single Shell weight (g)**	**Shell Ratio %**
T_1: Spirulina @ 300 ppm	2.11	0.41	19.48	1.79	0.33	18.28
T_2: Spirulina @ 400 ppm	2.14	0.44	20.37	1.83	0.36	19.53
T_3: Spirulina @ 500 ppm	2.15	0.46	21.22	1.84	0.38	20.51
T_4: Thyroxine @ 1.25 ppm	2.09	0.41	19.58	1.76	0.35	19.66
T_5: Thyroxine @ 2.50 ppm	2.12	0.42	19.94	1.80	0.34	19.04
T_6: Thyroxine @ 5.00 ppm	2.13	0.45	21.00	1.81	0.37	20.30
T_7: Spirulina @ 300 ppm & Thyroxine @ 1.25 ppm	2.14	0.46	21.37	1.82	0.38	20.73
T_8: Spirulina @ 300 ppm & Thyroxine @ 2.50 ppm	2.16	0.47	21.64	1.84	0.39	21.05
T_9: Spirulina @ 300 ppm & Thyroxine @ 5.00 ppm	2.18	0.48	21.90	1.86	0.40	21.36
T_{10}: Spirulina @ 400 ppm & Thyroxine @ 1.25 ppm	2.20	0.49	22.15	1.88	0.41	21.67
T_{11}: Spirulina @ 400 ppm & Thyroxine @ 2.50 ppm	2.22	0.50	22.37	1.90	0.42	21.93
T_{12}: Spirulina @ 400 ppm & Thyroxine @ 5.00 ppm	2.24	0.51	22.65	1.92	0.43	22.26
T_{13}: Spirulina @ 500 ppm & Thyroxine @ 1.25 ppm	2.26	0.52	22.83	1.94	0.44	22.47
T_{14}: Spirulina @ 500 ppm & Thyroxine @ 2.50 ppm	2.28	0.53	23.10	1.96	0.45	22.79
T_{15}: Spirulina @ 500 ppm & Thyroxine @ 5.00 ppm	2.30	0.54	23.30	1.98	0.46	23.03
T_{16}: Distilled water only (control-I)	1.98	0.39	19.44	1.66	0.31	18.51
T_{17}: Normal rearing (control-II)	1.97	0.38	18.98	1.65	0.30	18.42
C.D ($p \leq 0.05$)	0.020	0.011	0.543	0.012	0.025	0.410

Table3: Effect of Spirulina and Thyroxine on Cocoon Yield of Silkworm *Bombyx mori* L during spring and Autumn Seasons

	Spring		Autumn	
Parameters / **Treatment**	**Cocoon yield by number**	**Cocoon yield by weight (kg)**	**Cocoon yield by number**	**Cocoon yield by weight (kg)**
T_1: Spirulina @ 300 ppm	9132.68	19.29	8864.18	16.54
T_2: Spirulina @ 400 ppm	9167.69	19.61	8899.19	16.71
T_3: Spirulina @ 500 ppm	9191.05	19.81	8922.55	16.88
T_4: Thyroxine @ 1.25 ppm	9118.83	19.13	8850.33	16.24
T_5: Thyroxine @ 2.50 ppm	9165.05	19.62	8896.55	16.74
T_6: Thyroxine @ 5.00 ppm	9181.32	19.87	8912.82	17.01
T_7: Spirulina @ 300 ppm & Thyroxine @ 1.25 ppm	9147.34	19.84	8878.84	16.91
T_8: Spirulina @ 300 ppm & Thyroxine @ 2.50 ppm	9153.53	19.93	8885.03	17.02
T_9: Spirulina @ 300 ppm & Thyroxine @ 5.00 ppm	9163.31	19.87	8894.81	17.05
T_{10}: Spirulina @ 400 ppm & Thyroxine @ 1.25 ppm	9175.51	20.09	8907.01	17.19
T_{11}: Spirulina @ 400 ppm & Thyroxine @ 2.50 ppm	9182.27	20.38	8913.77	17.48
T_{12}: Spirulina @ 400 ppm & Thyroxine @ 5.00 ppm	9194.66	20.56	8926.16	17.66
T_{13}: Spirulina @ 500 ppm & Thyroxine @ 1.25 ppm	9223.91	20.87	8948.01	17.97
T_{14}: Spirulina @ 500 ppm & Thyroxine @ 2.50 ppm	9291.94	21.20	9023.44	18.25
T_{15}: Spirulina @ 500 ppm & Thyroxine @ 5.00 ppm	9301.96	21.44	9033.46	18.54
T_{16}: Distilled water only (control-I)	9057.81	15.89	8252.07	12.97
T_{17}: Normal rearing (control-II)	9047.34	15.77	8172.99	12.64
C.D ($p \leq 0.05$)	80.843	0.191	90.971	0.377

Conclusion

Silkworm (*Bombyx mori*) was found to feed on the fortified mulberry leaves. It can be concluded from the study that, Fortification on mulberry leaves with Spirulina and Thyroxine resulted in improvement in commercial characteristic of Silkworm (*Bombyx mori* L). There was improvement in larval weight and reduction in larval duration. Cocoon weight, Shell weight, Shell ratio, Shell percentage, Yield/10000 larvae by number and Weight, showed significant improvement over control. Among different concentrations of Spirulina and Thyroxine, combination of Spirulina (500 ppm) and Thyroxine (5.00 ppm) recorded increased results in most of the parameters. Spirulina and thyroxine can be used by the farmers to improve the leaf quality and in turn yield and quality of cocoons.

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