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Impact of Lentil Seed (*Lens culinaris*) fortified Mulberry Leaves on Silk Productivity of *Bombyx mori* L.

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ABSTRACT: The demand for the silk is increasing day by day and the current production of raw silk is not able to meet the required demands. In order to boost the raw silk production a lot of research is being conducted. Fortification of mulberry leaves with essential nutrients such as amino acids is latest trend. In this study, mulberry leaves were fortified with different concentrations of lentil (*Lens culnaris*) *viz.*, 2mg/ml, 4mg/ml, 6mg/ml, 8mg/ml and 10mg/ml and fed to 5th instar silkworm larvae. The highest weight of ten mature larvae (59.11 g), cocoon weight (2.4g), shell weight (0.52g), shell percentage (21.66%), cocoon yield/10000 larvae by weight (22.12 kg) and filament length (1210.66 m) were recorded in treatment (8mg/ml) in comparison with other treatments and control. The larval weight, cocoon weight, shell weight, shell percentage and filament length showed profound increase upon feeding of 8 mg/ml lentil fortified mulberry leaves which was significantly higher than other treatments and control respectively. The lentil seeds are readily available to farmers, hence, lentil fortified mulberry leaves can be used effectively to enhance the larval and cocoon parameters along with filament length.

Keywords: Sericulture, fortified mulberry, larvae, cocoon weight, filament length.

INTRODUCTION

Nutrition is the major physiological factor influencing silkworm growth and silk production. Silkworm (*Bombyx mori*) being monophagous insect feeds only on mulberry leaves. Mulberry leaves represent both the source of water and nutrients necessary for growth and development of silkworm (Samami *et al.,* 2019). Nutrition and selection of mulberry variety for rearing plays important role in healthy growth of silkworm and successful cocoon crop production. The success of sericulture activity depends on the quality mulberry leaves and favourable environmental conditions required for the silkworm rearing (Majid and Islam 2022). The mulberry varieties vary in the biochemical constituents (Islam, 2023) and feeding on these influence the dietary efficiency (Islam *et al.*, 2022a), growth and development of silk gland (Islam *et al.*, 2023) and reeling characters of silkworms (Islam *et al.*, 2022b). The amino acid plays an important role in the growth, development and production of silk by the silkworm, *Bombyx mori*. Silkworms switch 72-86 % of the mulberry leaf proteins into silk proteins and 30 % is derived from tissue and blood and 60 % of the absorbed amino acids are used for silk production. In the Union territory of Jammu and Kashmir, there exists two distinct sericultural zones *viz*., temperate and sub-tropical zone based on agroclimatic conditions (Qadir *et al.*, 2022b). The silkworm rearing is conducted twice a year, in spring and autumn. Spring season is considered as ideal for silkworm rearing because of availability of nutritious mulberry leaves. Summer is not congenial for rearing because of rise in temperature and humidity in potential sericulture pockets. No silkworm crop is reared in summer, the un-utilization and over-maturity of mulberry leaves deteriorates the nutritional quality of leaves. Hence, there is need of supplementing nutrients to mulberry leaves in autumn season. Fortification is an ingenious strategy which involves supplementing nutrients to mulberry leaves for silkworm feeding (Masthan *et al*., 2017). The improvement in the nutritional value of mulberry leaves by adding the nutrients boosts the quality cocoon production (Saranya *et al.*, 2019). The fortification of nutrient supplements *viz.*, carbohydrates, proteins, vitamins, amino acids, sterols, antibiotics and hormones etc., enhance the crop production and improve the fibre quality (Aparupa, 2015; Hassan *et al.*, 2020). Many attempts have been made to supplement the mulberry leaves with additional nutrients to get more cocoon yield and silk production (Islam *et al.*, 2020b) after fortification of mulberry leaf with egg albumin.

Lentils (*Lens culinaris)* are a rich source of high-quality protein. Lentils are a nutrient-dense food legume, having high protein content, complex carbohydrates (consisting of slowly-digestible starch and less crude fiber), essential minerals, vitamins, and high energy value (Dhull *et al.*, 2022; Joshi *et al.*, 2017). Lentil seeds are highly rich in protein (20–30%), low digestible carbohydrates (20%), fat (1.0%), and vitamins. Lentils are rich in phenolic content compared to other legumes, which shows its relatively higher antioxidant activity. Lentils also contain a number of bioactive phytochemicals, such as flavonoids, phyticacid, phenolics, tannins, and saponins (Oomah *et al.*, 2011; Paranavitana *et al.*, 2021). Lentil production is one of the important rabi crop in India and stands the second largest producer after Canada producing around 10 lakh tons of Lentils every year. The lentil plant, *Lens culinaris* L., is a member of the Leguminoceae family and constitutes one of the most important traditional dietary components. An attempt was made to fortify mulberry leaves with lentil seed to study its influence on the biological and commercial parameters of silkworm (*Bombyx mori*).

MATERIAL AND METHODS

Location of the research trial and methodology: The present investigation was conducted at Department of Sericulture, Govt. Degree College Sopore, J&K during spring season of June, 2022. The silkworm double hybrid (CSR6 × CSR26) × (CSR2 × CSR27) eggs were procured from College of Temperate Sericulture, SKUAST-Kashmir. Silkworms were reared on normal mulberry diet till 4th moult. In 5th instar, fortified mulberry leaves with different concentrations were fed to silkworms as one feed daily. Different parameters *viz.,* larval weight, cocoon weight, shell weight, shell percentage, filament length etc were studied to ascertain the influence of lentil seed powder on biological and commercial parameters of silkworm *Bombyx mori.*

Protein source and treatment details: Lentil seeds (*Lens culinaris)* were grinded to get lentil seed in powder form. The powdered lentil seeds were sieved in sieve to extract the powder in fine form. Different concentrations of lentil powder were prepared by dissolving the required quantity of powder in distilled water. The aqueous solutions of different concentration *viz.,* 2mg/ml, 4mg/ml, 6mg/ml, 8mg/ml and 10mg/ml were used to fortify the mulberry leaves. The prepared fortified mulberry leaves of different concentrations were fed to silkworm (*Bombyx mori*). The different parameters were calculated by the following formula (Islam *et al*., 2020b):

Total larval duration (days). The total larval duration was calculated as the time taken by the larvae from hatching to mounting.

Weight of ten mature larvae (g). Ten mature larvae were taken randomly per replication per treatment and weighed on a digital balance to record the weight.

Single cocoon weight (g). Twenty cocoons (ten male and ten female) were picked randomly from each replication/treatment from the harvested cocoons. The cocoons were weighed on digital balance to calculate the cocoon weight.

Single shell weight (g). Cocoons used for cocoon weight were cut open in order to remove pupae. The weight of each shell was taken on a digital balance in order to calculate the shell weight.

Shell percentage (%). It was calculated by the formula:

$$\text{Shell percentage (\%)} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

Cocoon yield/ 10000 larvae by number

It shows the rearing performance and expresses the yield in number of cocoons and was calculated by the formula:

Cocoon yield/10000 larvae by No. =

$$\frac{\text{No. of worms retained after 3rd moult}}{\text{No. of worms retained after 3rd moult}} \times 10000$$

Cocoon yield/10000 larvae by weight (kg). It also shows the rearing performance and expresses the yield by weight. It was calculated by the formula:

Cocoon yield/10000 larvae by weight (kg) =

$$\frac{\text{Weight of cocoons harvested}}{\text{No. of worms retained after 3rd moult}} \times 10000$$

Filament length (m). It is the length of silk filament reeled from the cocoons. Ten cocoons were taken randomly from each treatment and reeled on an epprovette and total length of the filament was recorded and expressed into meters.

It was calculated by the formula:

$$\text{Filament length (m)} = \frac{\text{Total filament length (m)}}{\text{Total number of cocoons reeled}}$$

RESULTS

The silkworms did not differ significantly for total larval duration after fed on treated leaves (Table 1). The significantly highest weight of ten mature larvae (59.11 g) was recorded in T_4 and lowest was recorded in T_0 (47.15 g) (Table 1). The cocoon weight differed significantly from other treatments and highest was recorded in T_4 (2.4 g) which was at par with T_1, T_2, T_3 and T_5. The lowest was however recorded in T_0 (1.98 g) (Table 1). The significantly highest shell weight (0.52 g) was recorded in T_4 which was at par with T_2, T_3 and T_5 and lowest was however recorded in T_0 (0.39g) (Table 1). The shell percentage varied significantly after fed on different treatments. The significantly highest shell percentage (21.66 %) was recorded in T_4 which was at par with T_1, T_2, T_3 and T_5 and lowest was however recorded in T_0 (19.69 %) (Table 1). The cocoon yield/10000 larvae by number did not show any significant difference after fed on different treatments (Table 1). The significant difference was found for cocoon yield/10000 larvae by weight and highest was recorded in T_4 (22.12 kg), moreover lowest was recorded inT_0 (18.08 kg) (Table 1). The filament length in different treatments differed significantly and highest was recorded in T_4 (1210.66 m) and lowest was recorded in T_0 (1084.38 m) (Table 1).

Table 1: Effect of Lentil seed fortified mulberry leaves on rearing and cocoon parameters.

Treatment	Total larval duration (hours)	Weight of ten mature larvae (g)	Cocoon weight (g)	Shell weight (g)	Shell percentage (%)	Cocoon yield/ 10000 larvae by number	Cocoon yield/ 10000 larvae by weight (Kg)	Filament length (m)
T_0 (0 mg)	632.92	47.15^{e}	1.98^{b}	0.39^{c}	19.69^{b}	9,222	18.08^{e}	1084.38^{f}
T_1 (2 mg)	628.77	53.8^{d}	2.15^{ab}	0.45^{bc}	20.93^{a}	9,235	19.52^{d}	1118.42^{e}
T_2 (4 mg)	626.64	54.64^{d}	2.2^{ab}	0.46^{ab}	20.9^{a}	9,244	20.1^{c}	1144.73^{d}
T_3 (6 mg)	620.48	57.52^{b}	2.35^{a}	0.5^{ab}	21.27^{a}	9,264	21.48^{b}	1170.97^{c}
T_4 (8 mg)	613.56	59.11^{a}	2.4^{a}	0.52^{a}	21.66^{a}	9,280	22.12^{a}	1210.66^{a}
T_5 (10 mg)	614.24	55.67^{c}	2.18^{ab}	0.46^{ab}	21.1^{a}	9,272	20.16^{c}	1182.32^{b}
CD ($p \leq 0.05$)	NS	0.95	0.25	0.04	1.03	NS	0.43	34.30
SE(d)	9.64	0.43	0.11	0.02	0.46	23.50	0.19	15.57

DISCUSSION

The nutritional quality of mulberry leaves fed to silkworms determines the silk production (Etebari, 2002). Feeding of protein fortified mulberry leaves to silkworms plays a pivotal role to improve silk production and can be corroborated by enhanced larval weight, cocoon weight, shell weight, shell percentage and filament length. In this study, larval weight was found significantly higher upon feeding of 8 mg/ml of lentil seed fortified mulberry leaves followed by 6 mg/ml, 10mg/ml, 4mg/ml, 2mg/ml of lentil seed fortified mulberry leaves and control respectively. The increased larval weight may be due to the fortification of mulberry leaf with the lentil seed protein supplement. The larval weight is directly proportional to the cocoon weight and shell weight. In the present investigation, cocoon weight, shell weight and shell percentage was significantly higher when 8 mg/ml of lentil seed fortified mulberry leaves were fed to silkworms. Since lentil seeds are good source of endogenous amino acids (Khazae *et al.,* 2019), the fortification of alanine at certain concentration may possibly be effective in improving silkworm growth and enhancing its cocoon parameters, however when these amino acids are fed at higher concentration, it may not show positive effects on growth and economic parameters of silkworm (Rajdabi *et al.,* 2009). The increase in cocoon shell percentage can be attributed to the assimilation of essential amino acids supplemented with the lentil seed fortified mulberry leaves and utilized for increasing cocoon weight and shell weight. These amino acids are necessary for synthesis of silk. The results are in agreement with the research findings of Gobena and Bhaskar (2015) who recorded significantly highest larval weight, cocoon weight, shell weight and shell percentage in *P. coryleifolia* fortified mulberry leaves followed by *P. niruri and P. hysterophorus* respectively. The current results are in agreement with the findings of Bhat *et al.* (2022) who fed zea mays fortified mulberry leaves to silkworms. The higher cocoon weight, shell weight and shell percentage is correlated with the effective rate of rearing. It means that the total number and total weight of cocoons harvested from the 10,000 larvae reared. The effective rate of rearing determines the income of sericulture farmers. In the current investigation, significantly higher cocoon yield per 10000 larvae by weight was recorded upon feeding of 8mg/ml of lentil seed fortified mulberry leaves. The similar findings were assessed by Shivkumar *et al.* (2020) upon feeding of 0.1% aspartic acid and 0.5% glycine fortified mulberry leaves. The total filament length is one of the important economic character depends on quality of cocoon and contributes to silk yield. The application of lentil seed fortified mulberry leaves enhanced the filament length. In the present investigation, higher filament length was recorded when silkworms were fed with 8mg/ml lentil seed fortified mulberry leaves. The current results were found in conformity with the findings of Murugesh *et al.* (2022) who found higher filament length upon feeding of amino acid fortified mulberry diet. Our results are also supported by the findings of Khedr *et al.* (2013) who recorded highest filament length after silkworms were fed on multivitamin fortified mulberry leaves as compared to control.

CONCLUSIONS

India being the 2nd largest producer of lentil crop contributing 27% to global production. The feeding of lentil seed fortified mulberry leaves to silkworms significantly increased the larval weight, cocoon weight, shell weight, shell percentage, cocoon yield per 10,000 larvae and filament length. Hence, the fortification of mulberry leaves with lentil seed can play an important role to improve silk production. Also, it is advocated that the intercropping of lentil with mulberry crop can be effective strategy to facilitate additional net income along with enhanced silk production at farming level.

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Conflict of interest. None.

REFERENCES

Aparupa, B. (2015). Nutritional supplement and its effect on mulberry silkworm *Bombyx mori* L. *International Journal of Innovative Research in Science, Engineering and Technology*, *4*(8), 6961-6962.

Bhat, M. A., Khajuria, N., Chanotra, S., Kapoor, S. and Aziz, A. (2022). Impact on Augmentation of *Zea mays* Flour on Growth and Monetary Traits of the Silkworm, *Bombyx mori. Biological Forum – An International Journal*, *14*(2a), 141-148.

Dhull, S.B., Kinabo, J. and Uebersax, M.A. (2022). Nutrient profile and effect of processing methods on the composition and functional properties of lentils (*Lens culinaris* Medik)–A review. *Legume Science,* e156.

Etebari, K. (2002). Effect of enrichment of mulberry leaves (*Morus alba*) with some vitamins and nitrogenous compounds on some economic traits and physiological characters of silkworm, *Bombyx mori* (Lepidoptera : Bombycidae). Isfahan University of Technology. Iran.

Gobena, W. S. and Bhaskar, R. N. (2015). Fortification of Mulberry Leaves with Medicinal Botanical Plant Extracts Effect on Silkworm, *Bombyx mori* L. (PM×CSR_2) (Lepidoptera: Bombycidae) Larval Growth and Cocoon Traits. *Journal of biological sciences*, *15,* 199-206.

Hassan, S. I., Rateb, S. H., Mohanny, K. M., Hussein, M. H. (2020). Efficiency of some plants powder mix as a dietary supplement for silkworm (*Bombyx mori* L.). *SVU-International Journal of Agricultural Science, 2*(2), 378–383.

Islam, T. (2023). Biochemical Evaluation of Different Mulberry varieties-a review. *International Journal of Theoretical & Applied Sciences*, *15*(1), 12-17.

Islam, T., Bhat, S. A., Malik, F. A., Khan, F. A., Mir, S. A., Nazir, N. and Wani, S. A. (2022a). Evaluation of some mulberry genotypes for nutritional consumption parameters of silkworm, *Bombyx mori* L. under temperate conditions of Kashmir, India. *Plant Archives*, *22*(2), 136-139.

Islam, T., Bhat, S. A., Malik, F. A. Wani, S. A., Khan, F. A., Mir, S. A. and Nazir, N. (2023). Feeding of different Mulberry Varieties and its Impact on Silk Gland of Silkworm, *Bombyx mori* L. *Biological Forum – An International Journal, 15*(1), 488-492.

Islam, T., Khan, I. L., Ganie, N. A., Sahaf, K. A., Jan, N. and Gora, M. M. (2020b). Impact of egg albumen (egg white) fortified mulberry leaf on rearing and some cocoon parameters of silkworm, Bombyx mori L. (CSR6 × CSR26) × (CSR2 × CSR27) double hybrid. *International Journal of Chemical Studies*, *8*(4), 267-271.

Islam, T., Bhat, S. A., Malik, F. A., Khan, F.A., Mir, S. A., Nazir, N. and Wani, S. A. (2022b). Rearing of silkworm, *Bombyx mori* L. on different mulberry genotypes and its impact on post cocoon parameters. *Plant Archives*, 22 (2), 380-382.

Joshi, M., Timilsena, Y., and Adhikari, B. (2017). Global production, processing and utilization of lentil: A review. *Journal of Integrative Agriculture, 16,* 2898–2913.

Khazaei,H., Subed, M., Nickerson, M., Martínez-Villaluenga, C., Frias, J. and Vandenberg, A. (2019). Seed Protein of Lentils: Current Status, Progress, and Food Applications. *Foods, 8*(391), 1-23.

Khedr, M. M. A., El-Shafiey, S. N. and Mead, H. M. I. (2013). Influence of fortification of mulberry leaves with natural and synthetic multivitamins on growth and development of *Bombyx mori* L. *J. Plant Prot. and Path*, *4*(1), 111-123.

Majid, N. and Islam, T. (2022). Analysis of quantitative parameters of mulberry plant in various zones of Kashmir valley, India. *Plant Archives*, *22*(2), 376-379.

Masthan. K., Rajkumar, T. and Narasimhamurthy, C. V. (2017). Studies on fortification of mulberry leaves with probiotics for improvement of silk quality. *International Journal of Biotechnology and Biochemistry*, *3*(1), 73-80.

Murugesh, K. A., Chozhan, K. and Aruna, R. (2022). Enhancement of larval and cocoon traits of silkworm, *Bombyx mori* L. through the application of amino acids. *Journal of Entomology and Zoology Studies*, *9*(1), 2198-2203.

Oomah, B. D., Caspar, F., Malcolmson, L. J. and Bellido, A. S. (2011). Phenolics and antioxidant activity of lentil and pea hulls. *Food Research International*, *44*, 436–441.

Paranavitana, L., Oh, W.Y., Yeo, J. and Shahidi, F. (2021). Determination of soluble and insoluble-bound phenolic compounds in dehulled, whole, and hulls of green and black lentils using electrospray ionization (ESI)-MS/MS and their inhibition in DNA strand scission. *Food Chemistry, 361*, 130083.

Qadir, J., Sudan, N., Gupta, D., Dar, R.S., Singh, H. and Murali, S. (2022b). Impact of high temperature during chawki stage on the biological and cocoon parameters of silkworm *Bombyx mori* L. *International Journal of Agricultural Sciences*, *14*(12), 12111-12113.

Radjabi, R., Ebadi, R., Mirhoseini, S. Z. and Nair, S. (2009). Effects of feeding alanine-enriched mulberry leaves on the economic characters of the silkworm *Bombyx mori* (Lepidoptera: bombycidae), *Formosan Entomol*, *29*, 73–81.

Saranya,M., Krishnamoorthy, S.V. and Murugesh, K.A. (2019).Fortification of mulberry leaves with indigenous probiotic bacteria on larval growth and economic traits of silkworm (*Bombyx mori* L.). *Journal of Entomology and Zoology Studies, 7*(4), 780-784.

Samami, R., Seidavi, A., Eila, N., Moarefi, M., Ziaja, D. J., Lis, J. A., Rubiu, N. G. and Cappai, M. G. (2019). Production performance and economic traits of silkworms (*Bombyx mori* L., 1758) fed with mulberry tree leaves (*Morus alba,* var. Ichinose) significantly differ according to hybrid lines. *Livestock Science*, *226*, 133-137.

Shivkumar, Kumar, N. B., Ravindra, M. A., Ahmad, M. N. and Chowdhury, S. R. (2020). Supplement of Amino Acids on Mulberry Leaf Influence the Cocoon Yield and Silk Production in the Temperate Region of Jammu & Kashmir. *Research Journal of Agricultural Sciences, 11*(1), 87-91.

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