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Tajamul Islam
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Irfan Latif Khan
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Mehreen Manzoor Gora
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Mohd Younis Khan
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Tariq A Bhat
Division of Environmental Sciences, SKUAST-K Shalimar, Jammu & Kashmir, India

Nayeema Jan
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Corresponding Author:
Tajamul Islam
College of Temperate Sericulture, Mirgund, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SKUAST-K, Shalimar, Jammu Kashmir, India

Influence of egg albumen supplemented mulberry leaf on some reeling parameters of Silkworm, *Bombyx mori* L.

Tajamul Islam, Irfan Latif Khan, Mehreen Manzoor Gora, Mohd Younis Khan, Tariq A Bhat and Nayeema Jan

Abstract
The silkworm nutrition has a major role to play in the growth and development of silkworm larva, and finally it reflects in the cocoon and reeling parameters of the silkworm, *Bombyx mori* L. The silkworm double hybrid (CSR6 × CSR26) × (CSR2 × CSR27) was reared on mulberry leaves fortified with aqueous egg albumen solution after third moult onwards. Egg albumen concentrations *viz.*, 5%, 10%, 15% and 20% were tested. 20% egg albumen significantly improved average filament length and raw silk percentage registering 1252.36m and 19.92% as against 1070.52m and 16.60% in control respectively.

Keywords: Egg albumen, supplemented, mulberry leaf, Silkworm, reeling parameters

Introduction
Insects are diverse in nature some are beneficial as pollinators (, natural enemies, lac insects and silkworm and majority of them are pest (Mir *et al*. 2014, Dar *et al*. 2014; Mir *et al*. 2017, Dar *et al*. 2015a, 2015b, 2015c, Dar *et al*. 2016; Dar *et al*. 2017a, 2017b, 2017c; Dar *et al*. 2018a, 2018b) [23, 32, 19, 21, 22, 24, 28, 20, 26, 29, 33, 25, 27] of crops and animals. Among the beneficial insects silkworm is one the most important one having a great industrial importance. Silkworm, *Bombyx mori* which belongs to the Bombycidae family is a monophagous insect and feeds only on the mulberry leaves. During its life cycle it undergoes four moults and five instars and finally spins cocoons to produce raw silk. Major silk producing countries in the world are China, India, Uzbekistan, Brazil, Japan, Republic of Korea, Thailand, Vietnam, DPR Korea, Iran etc. Silk is also produced in minute quantities by the countries *viz.*, Kenya, Botswana, Nigeria, Zambia, Zimbabwe, Bangladesh, Colombia, Egypt, Japan, Nepal, Bulgaria, Turkey, Uganda, Malaysia, Romania, Bolivia etc (International Sericultural commission, 2018). India which is the second largest producer of silk after china recorded total raw silk production of 35,468 MT annually (Anonymous, 2019) [2, 3]. 2800 villages in the union territory of Jammu and Kashmir are associated with the sericulture activity producing 118 MT of raw silk, providing livelihood to 30,300 families (Anonymous, 2019) [2, 3].
Due to various factors like disease, pests, market value the rearing of beneficial insects e.g. apiculture industry (Ullah *et al*. 2020) [30] and the silkworm industry had shown a decline trend in Asia. However, due to govt. efforts the industry had recently shown a good progress to motivate more and more farmers towards it. Silkworm rearing in Kashmir valley is mostly practiced by the marginal and landless farmers. The source of mulberry leaf for silkworm rearing is mostly from the stray plantation along the roads, river bunds, departmental blocks etc. The mulberry leaf of such unmaintained mulberry plantation is of poor quality because of lack of inputs in the shape of fertilizers and manures. Feeding silkworms on poor quality mulberry leaves, the farmers end up with poor quality cocoon crop, and less returns. Among the various strategies for improving the mulberry leaf quality, fortification of silkworm feed with nutrient supplements is of considerable importance. It is general that crops generally need good agro-climatic conditions for their proper seed and leaf yield (Dar *et al*. 2014b, 2017d, 2018c) [32, 33, 31]. The nutritional status of different mulberry genotypes can be improved by enriching with extra nutrients such as sugars, amino acids and lipids to increase larval growth and cocoon characteristics of different silkworm races (Sengupta *et al.*, 1972) [4]. Several nutritional supplementation studies on different products at different levels of concentrations on different mulberry genotypes are available but scanty.

Various studies on nutrient supplementation of silkworm fed with proteins, vitamins and minerals has shown favorable effect not only on the growth and development of silkworm but also on the commercial characteristics of cocoons. Soya bean has been used as a protein source in artificial silkworm diet (Ito and Arai, 1965; Ito *et al.*, 1975; Ito 1978 and Horie and Wantanabe, 1983) [5-7]. Krishnan *et al.* (1995) [99] reported that hydrolyzed Soya bean (*P. Soyatose*) is an ideal nutrient for sericulture industry. At 2 per cent concentration larval weight, cocoon weight, shell ratio, fecundity and haemolymph protein was found to be maximum. Shifa (2016) [10] observed significant enhancement of the economic characters of *Bombyx mori* L. through supplementation of silkworm feed with *Zea mays* flour. Silkworm larvae showed improvement in larval and coccoon parameters by supplementation of farm yard manure and ammonia with the mulberry leaves (Mahmood *et al*., 2002) [11]. Javed and Gondal (2002) [12] found by forifification of mulberry leaf with nitrogen and ascorbic acid the silkworms recorded maximum larval growth. Powrie (1973) [13] reported that egg albumen consists of proteins (9.7-10.6%), lipids (0.03%), carbohydrates (0.4-0.9%), ash (0.5-0.6%) and water (87.9-89.4%). The important proteins in the egg albumen are ovalbumin (54%), conalbumin (13%), ovomucoid (11%), Lysozyme (3.5%), Globulins (G2, G3-8.0%) and ovomucin (1.5%). Egg albumen is found to contain 18 amino acids including all the essential amino acids, which can be utilized by the silkworm, *Bombyx mori* for silk synthesis in the silk gland during growth and development of the silkworm.

Materials and methods

Location of research trial and proper methodology

The research trial was carried out at College of Temperate Sericulture, Mirgund, SKUAST-K, J&K and silkworm rearing was done as per package of practices for silkworm rearing (Anonymous, 2003) [14]. The rearing of silkworms was done in the spring season. Silkworm, *Bombyx mori* was fed on the leaves of Ichinose variety of mulberry plant from hatching upto 3rd moult. After 3rd moult the leaves of Goshoerami variety of mulberry plant was fortified with aqueous egg albumen solution in both 4th and 5th instars. Fortified mulberry leaves were properly dried under shade before feeding to silkworms. In 4th and 5th instar daily one egg albumen fortified mulberry feed was given upto the maturation of worms, when they started spinning of cocoons. Four concentrations of egg albumen were tested and among these concentrations 20% egg albumen significantly improved the reeling parameters of silkworm, *Bombyx mori* L.
The parameters were calculated by the following formulae:

Average filament length (m)

Ten cocoons were taken randomly from each treatment of each replication and reeled individually on an epprouvette. The average filament length was calculated by the following formula:

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

Total filament length = R×1.125
R = Number of revolutions recorded on epprouvette
1.125 = Circumference of epprouvette (m).

Raw silk (%)

It was calculated by the following formula:

$$\text{Raw silk (\%)} = \frac{\text{Weight of silk reeled (g)}}{\text{Green cocoon weight}} \times 100$$

Denier

It indicates the thickness of the silk filament.
It was calculated by the following formula

$$\text{Denier} = \frac{\text{Weight of silk reeled (g)}}{\text{Length of reeled silk(m)}} \times 9000$$

Statistical analysis

The data was compiled and the statistical analysis of the data was done by standard method and the significance was checked at 5% level of significance.

Results and Discussion

Average filament length (m) and Raw silk percentage (%)

The average filament length was maximum (1252.36m) in T_5 (20% egg albumen) which was significantly different from other treatments. The average filament length was minimum (1070.52m) in T_0 (control). Likewise the raw silk percentage was highest (19.92%) in T_5 (20% egg albumen) which was significantly different from other treatments but statistically at par with T_4. The raw silk percentage was lowest (16.60%) in T_0 (control) (Table 1) (fig1). Maximum average filament length and highest raw silk percentage recorded might be due to positive effect of fortification on larval, cocoon and shell weight which lead to long average filament length and highest raw silk percentage. The nutrients present in egg albumen might have stimulated the metabolic activities of silkworm. The present findings are in line with the findings of Amit *et al*. (2015) [15] who reported that filament length and raw silk percentage increased by 28.96% over control. The present findings are in conformity with the findings of Patil *et al.* (1997) [16], Murugan *et al.* (1999) [17] and Bhaskar *et al.* (2004) [18] who supplemented mulberry leaf with Parthenium leaf extract, *Croton sparciflorus* and *Tridax procumbens* spray and medicinal plant extract respectively.

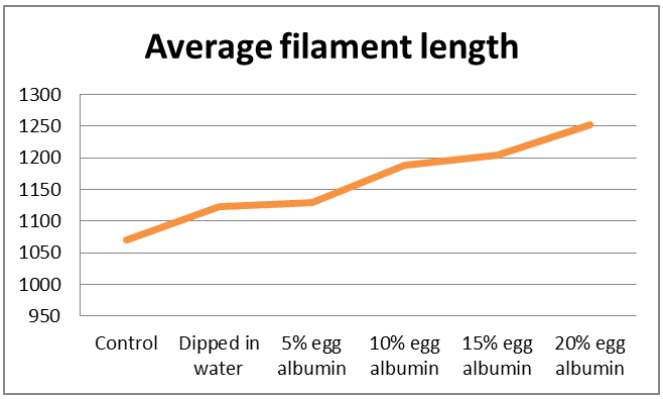
Denier

The treatments with respect to denier did not exhibit significant difference. The values were, however maximum (3.26) in T_4 (15% egg albumin) and the lowest (3.08) in T_1 (Dipped in water) (Table 1) (fig2).

Table 1: Influence of egg albumen supplimented mulberry leaf on some reeling parameters of Silkworm, *Bombyx mori* L.

Treatments	Average filament length (m)	Raw silk percentage (%)	Denier
T_0 (Control)	1070.52^d	16.60^c	3.20
T_1 (Dipped in water)	1123.59^c	17.61^b	3.08
T_2 (5% egg albumin)	1128.60^c	17.67^b	3.19
T_3 (10% egg albumin)	1189.23^a	18.29^b	3.21
T_4(15% egg albumin)	1205.06^a	19.60^a	3.26
T_5(20% egg albumin)	1252.36^a	19.92^a	3.19
CD at 5%	50.29	0.72	NS

NS-non significant at 5% level of significance



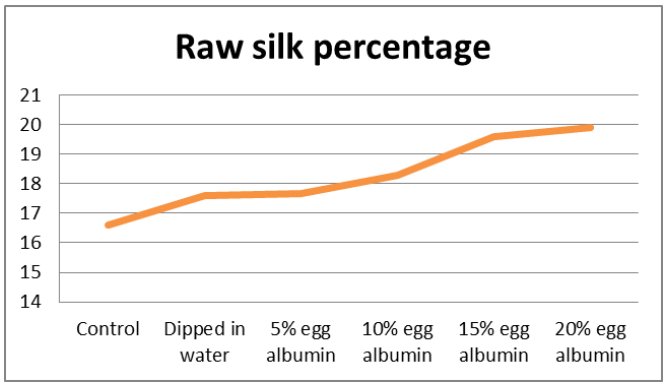


Fig 1: Average filament length (m) and Raw silk percentage (%)

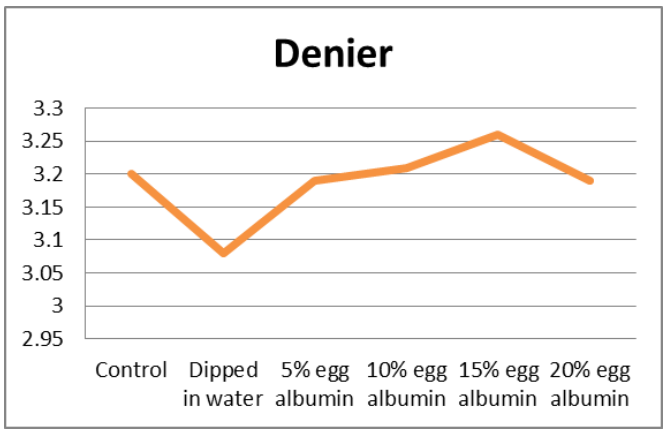


Fig 2: Denier

Conclusion

The nutrition has the predominant role in the success of silkworm rearing, quality mulberry leaves are very important for the growth of silkworm larva. Supplementation of mulberry leaves with different nutrients like egg albumen has positive effect on the growth and development of silkworm. There was significant improvement in the reeling parameters like Average filament length and raw silk percentage compared to the control. Therefore, supplementation of mulberry leaves with egg albumen can improve the cocoon and reeling parameters of silkworm, *Bombay mori* L.

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