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Effects of supplementary nutrients of amla and lime fruit extract on growth of silkworm *Bombyx mori* L

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Abstract
Sericulture depends on rearing of silkworm on mulberry leaves. For this reason, Silk production has direct relationship with larval growth. One of the alternative ways of improvement of larval growth and cocoon production is enrichment of mulberry leaves with supplementary nutrients. In order to investigate the effects of supplementary nutrients on silkworm, Bombyx mori, an experiment was conducted with multi-vitamins treatments. Leaves enriched with amla and lime fruit juice (1, 2 and 3%) were fed once a day to 5th instar silkworm larva. The supplementation of the leaves was done by spraying the treatments on them. These treatments resulted in a significant increase in biological and economical parameters such as larval weight, female and male cocoon weight, Oral supplementation of vitamin C (ascorbic acid) rich botanical extract to V instar silkworm *Bombyx mori* L. resulted in a significant increase in growth. Amla and lime fruit are the highest source of vitamin C (ascorbic acid). The supplementation of amla juice and lime juice different concentration had the positive impact on larval growth. The supplementation of amla juice at 2% and lime juice at 3% had the positive impact on larval growth that resulted in increased larval length (7.44 and 6.95 cm) and larval weight (42.21 and 39.33g). Vitamin C in the form of supplementation of amla juice at 2% and lime juice at 3% yielded significant gain in economic parameters like cocoon weight (16.72 and 16.67 g), pupal weight (14.74 and 14.88 g), shell weight (3.88 and 3.83 g) and shell ratio (23.21 and 22.98 %). The study showed that From above finding it can be said that maximum 2% amla fruit juice (T2) and 3% lime fruit juice (T6) after treatment significant increase in biological and economical parameters. So it can be said that positive impact on larval growth due to amla and lime fruit juice.

Keywords: Amla and lime fruit, supplementation, mulberry leaves, economical parameters, B. mori. L.

1. Introduction
Sericulture is sustainable, eco-friendly and agro based cottage industry with combination of rural, agricultural and industry based activities with high employment potential and economic benefits. The silkworm *Bombyx mori,* is a monophagous insect derives almost all the nutrients required for its growth from mulberry leaf. It is one of the most labor-intensive sectors and has played a critical role in rural development and economic growth. Most of the marketable silk around the world is being produced from the mulberry silkworm, *Bombyx mori* L. (Yogananda-Murthy *et al*., 2013) [14]. Development of silkworm is greatly influenced by the nutrient composition of the mulberry host leaves, which is also the determining factor of the quality of silk. The performance of silkworm is evident by the digestion and assimilation of the nutritional materials present in mulberry leaves (Jyothi *et al*., 2014) [5].

When nutritionally enriched leaves were fed to the silkworm, its influence is clearly observed on quality and quantity of silk, while any deficit reflects the silkworm's health. Silkworm requires essential sugars, protein, amino acid fatty acid micronutrients and vitamins for its growth reproduction and production of good quality silk. The silk production from silk gland and development of silk vitamins c is necessary for rapid development silk gland in V instar larva (Lalfelpuii *et al*., 2014a) [7]. Therefore, it is of vital importance to supplement of vitamins with the chiefly available sources amla and lime fruit juice, which is rich source of vitamins C and also other nutrient such as carbohydrate, minerals phenols and alkaloid which are efficient growth promoter and booster of silk production Kayvan Etebaria and LeilaMatindoostb (2005) [6].

As a complementary and alternative supplementation, the use of certain plant fruits have increased last two decades and one among them amla and lime fruit is a powerhouse of nutrients which play important role in nutrition of silkworm and silk production and it is described as Divya Naik and patil, (2016) [3]. The objective of this study was to evaluate whether the supplementation of amla juice and lime juice different concentration in the diet of the silkworm larva interferes on the cocoon production and on the structural and mechanical properties of the ensuing silk. Hence, this study was undertaken.

2. Materials and Methods
The present experiment was carried out at department of Zoology, Jijamata College of Science and Arts, Bhende, Tal-Newasa Dist- Ahmednagar (Maharashtra). The diseased free eggs of CSR-Double hybrid were purchased from sericulture Centre, Ahmednagar district, Maharastra, India and used for the study. Mass young age silkworm rearing of one batch was conducted by feeding with V1 mulberry variety as per the standard rearing package (Rajan *et al*, 2001) [11]. After 3rd moult batches of larvae were shifted to leaf feeding and continued separately up to 4th moult by provide with V1 mulberry variety. The freshly moult out 5th instar larvae of batches (leaf and diet) were replicated in to seven groups. In each group, with 100 larvae were kept and reared in laboratory. The group- 7 (control T_7) larvae was considered as carrier, control fed with normal mulberry leaf

sprayed with distilled water however the group 2 to 6 were the experimental groups (T_2 to T_6) and the larvae were fed with leaves sprayed with three different concentration of amla and lime fruit solution (1%, 2% and 3%). All these solution were prepared freshly every day. Mulbery leaves were dipped in different of concentration of lime and amla juice. The fresh amla and lime fruits shade dried and crushed using an electrically operated mixer grinder and were taken into petridishes and kept in a hot air oven maintained at 60^0C for a period of 48 –72 hours.. The commercial amla and lime fruit available in the market was used in the present experiment. The growth parameters such as V instar larval length and larval weight and cocoon parameters such as cocoon weight, pupal weight shell weight, shell ratio were recorded and statistically analyzed. Certain parameters was calculated using following formula

$$\text{Growth index} = \frac{\text{Final wt of the larvae(g)} - \text{Intial wt of the larvae(g)}}{\text{Intial wt of the larvae(g)}}$$

$$\text{Weight of Single Cocoon} = \frac{\text{Wt of 20 male Cocoon(g)} + \text{Wt of 20 female Cocoon(g)}}{\text{Number of Cocoon Taken(40)}}$$

$$\text{Weight of Single Shell} = \frac{\text{Total Shell Wt of 20 Male Cocoon(g)} - \text{Total Shell Wt of 20 Male Cocoon(g)}}{\text{TotalNumber of Cocoon Taken(40)}}$$

$$\text{Shell Ratio (\%)} = \frac{\text{Single Shell Weight (g)}}{\text{Single Cocoon Weight(g)}} \text{x } 100$$

3. Results and Discussion

Supplementation of amla and lime fruit juice at six different concentration show positive impact on growth and economic Parameters of silkworm, B. mori L. A significant increase in the larval length, larval, cocoon, pupal and shell weight, was observed in T1-T6 and the increase was found to be relatively more in T2 and T3.The mean body weight of the 5th instar larvae showed significant increase in T2 and T3 treatments when compared with the control. The data on selected economic characters of the silkworm, B mori reared on mulberry leaves fortified with 1%, 2% and 3% of amla and lime fruit juice to V Instar larvae are presented on Table 1. Among the six supplementation provided to silkworm maximum Larval Length, Larval Weight, cocoon weight, pupal weight and shell weight was recorded in mulberry leaves supplemented with 2% amla fruit juice (7.44 cm, 40.21g, 16.72g 14.74g and 3.88g) and lowest one was recorded in 1% amla fruit juice (6.22 cm, 37.21g, 15.03g, 13.35g and 2.88g), 1% lime fruit juice (6.30 cm, 36.41g, 14.95g, 13.05 and 2.34g) and also lowest was recorded in control (5.85 cm, 33.33g, 14.91g, 13.05g, and 2.30g) (Table 1).

Table 4: Impact of fortification of amla and lime fruit juice to V Instar silkworm Bombyx mori. On its growth and economical parameters during February 2018 to May 2018

Treatments	Larval Length (cm)	Larval Weight g/10 larvae	Cocoon Weight g/10 cocoon	Pupal Weight g/10 pupae	Shell Weight g/10 shell	Shell Ratio (%)
1% amla fruit juice (T_1)	6.22	37.21	15.03	13.35	2.88	19.16
2% amla fruit juice (T_2)	7.44	40.21	16.72	14.74	3.88	23.21
3% amla fruit juice (T3)	6.70	39.41	16.21	14.36	3.65	22.52
1% lime fruit juice (T_4)	6.30	36.41	14.95	13.05	2.34	15.65
2%. lime fruit juice (T_5)	6.40	38.04	15.91	14.05	2.65	16.66
3% lime fruit juice (T_6)	6.95	39.33	16.67	14.88	3.83	22.98
Water Control	5.85	33.33	14.91	13.05	2.30	15.43

Thulasi and Shivaprasad (2013) [13] reported that the effect of ascorbic acid and lemon juice on the silkworm, Bombyx mori has been studied with reference to larval growth, protein synthesis and silk production. Both these exogenous factors, when supplemented with mulberry diet, showed positive impact on larval growth during the fourth and fifth instar developmental stages and synergetic effect of ascorbic acid and lime juice on growth and protein synthesis in the silkworm Bombyx mori L. and its influence on economic characters of sericulture. Divya Naik and Patil (2016) [3] reported that amla and lime juice nutritionally rich in vitamin C that might be contributed to increased growth parameters of cocoon in silkworm. Present study is comparable with the Tantray and Trivedy (2011) [12] who reported that supplementation of viatmins C at concentration 0.05% daily during V-instar silkworm increased shell weight as compared to the control. The present results are in confirmation with Etebari *et al*. (2004) [4], Rahmathulla *et al*. (2007) [10] and Divya Naik and Patil (2016) [3] who reported increase in commercial characters when treated with botanicals. Balasundaram *et al*. (2013) [2] similar finding were observed in 0.2 percent of vitamin C was determined as effective concentration that increased cocoon weight as comparative with control. Rahmathulla *et al*. (2007) [10] noticed that influence of oral administration of folic acid to 5th instar silkworm larvae of a popular Indian bivoltine hybrid (CSR2 x CSR4) was studied. Folic acid solution spraying on mulberry leaf and feeding to silkworm significantly improved larval weight, silk gland weight and growth rate. Higher larval and silk gland weight subsequently improved the economic parameters like cocoon weight, shell weight and shell ratio of folic acid treated batches. It is imperative to substitute this vitamin with the chief and easily available lemon juice which is a rich source of not only vitamin C and many more nutrients (Markus and Sass, 2003: Albertini *et al.*, 2006) [9, 1].

5. Conclusion

The present study on silkworm growth and nutritional effects of amla and lime fruit juice enhancement in economic parameters like cocoon weight, shell weight, pupal weight and shell ratio. Thus it can be concluded that these amla and lime juice play an important role in embryonic development, hatching, larval growth and pupation.

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