Effect of Cow Milk on the Growth and Economic Traits of Silkworm (*Bombyx mori* L.)

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Abstract— Silkworm Bombyx mori L. (Lepidoptera: Bombycidae), is a domestic insect which produce silk through spinning. Silkworm is a monophogous insect and major portion of successful silk production as well as quality of silk cocoon depends on nutritional value of mulberry leaf. The present study was undertaken to find out the effect of cow milk on increasing the growth rate and economic traits of silkworm. Silkworm became voracious in the last fifth stages and it consumed about 94% of its total fed and major portion of raw silk (fibroin & sericin) is secreted in the last stage. The mulberry leaves were dipped in milk and air dried before giving them as feed to the silk larvae. Larval weight, cocoon weight and shell weight was measured. The result showed that the larvae fed with milk treated leaves gained 208% weight from day 1 to 5, while the larvae fed with fresh leaves gained 188% weight in the same span. Cocoon weight increased by 18% and shell percentage by 11% when compared to the control. These result suggested to fed silkworm larvae with mulberry leaves dipped in cow milk at fifth instar for better larval weight and reeling performances.

Index Terms— Growth effect, Silkworm, *Bombyx mori* L., Cow milk, Fifth instar, Economic traits. Reeling performance.

1 INTRODUCTION

TheSilkworm *Bombyx mori* L. (Lepidoptera: Bombycidae), is a domestic insect which produce silk through spinning. It feeds on the leaves of mulberry tree *Morus alba* which is only the host plant for silkworm. Mulberry leaves is only the source of silk protein because silkworm is a monophogous insect. A major portion of successful silk production as well as quality of silk cocoon depends on nutritional value of mulberry leaf. Sericulture is an agro based labour intensive sector. Many people especially women in Bangladesh are involved in sericulture. Now it has become a concern issue to study and identify the factors that can improve the growth, yield, raw silk quality and larval resistance to pathogens. Though mulberry is the one and only food for silkworm so enriching nutritional status of mulberry leaves by nutrient supplementation would be one of the ways to improve growth rate in silkworm (*Bombyx mori* L).

The nutritional status of mulberry leaves can be improved by enriching them with extra nutrients to increase larval growth and improve cocoon characteristics [1].

Several Scientists studied the effect of mulberry leaves enriched with amino acids on the growth of *B. mori* [2] [3] [4]. Masthan et al. 2011, [5] found the growth and development of larvae, and subsequent cocoon production, are greatly influenced by the nutritional quality of mulberry leaves. Different combinations of mineral nutrients were found to improve larval growth and silk production [6]. Casein contains fatty acids, cholesterol, sugars, vitamins, and minerals [7]. The presence of casein in a diet has enhanced the growth rate of *Manduca sexta* caterpillars and was observed to stimulate the feeding efficiency of *B. mori* [8] [9].

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Artificial diets rich in amino acids are required for optimal growth of an insect, and casein has been widely used as it contains all amino acids [10]. Islam et al. 2004, [11] found positive effect on cocoon weight with nickel chloride and/or potassium iodide enriched mulberry leaves at low concentrations. The protein content of the silk gland, fat body, and muscles was found to increase significantly when larvae were fed with ascorbic acid [12]. Diet supplements containing fatty acids and carbohydrates were shown to have a regulatory effect on fatty acid synthesis in larval stages of *B. mori* [13]. Sterols including cholesterol had a positive influence on dietary efficiency in *B. mori* [14]. Milk is a source of proteins, carbohydrates, fatty acids, minerals, and other nutrients that facilitate healthy growth and development. Peptides, polyamines, and enzymes also comes from it. Active modulator of various regulatory processes like bioactive proteins and peptides also derives from milk. Haug et al. 2007, [15] mentioned that the physiological significance of these substances is not yet fully understood, but both the mineral binding and cytomodulatory peptides derived from bovine milk are now claimed to be health-enhancing components. Hughes et al. 2000, [16] also stated that one such bioactive compound identified in human and bovine milk is transforming growth factor (TGFβ), which helps in differentiation, development, and immune response. Konala et al.2013, [17] suggest that *B. mori* larvae can be fed with bovine milk treated mulberry leaves for increased growth rate and silk production. Considering the beneficial properties of milk, the importance of protein, carbohydrates, and lipids in the insect diet, and the economic importance of *B. mori,* the present study was undertaken to find out the effect of cow milk on increasing the growth rate of silkworm. Silkworm became voracious in the last fifth stages and it consumed about 94% of its total fed and major portion of raw silk (fibroin & sericin) is secreted in the last stage. Further, body volume increase by 29 times, body weight by 25 times and silk gland weight by 200 times [18]. In this experiment, the treatment was applied in the fifth stage only.

2 Material and Method

This experiment was done in Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi, Bangladesh on 2013. Silkworm (*B. mori*) race Urboshi were taken from silkworm section of BSRTI. The larvae were reared in cardboard boxes at 23-24^{0}C and 70% RH. They were fed with fresh mulberry leaves until the fifth instar. Fresh cow milk was used as treatment for this experiment. The nutritional constituents per 100 gm cow milk were as follows: Water 87.8 gm, Protein 3.2 gm, Fat 3.9 gm, saturated fatty acid 2.4 gm, Monosaturated fatty acid 1.1 gm, Polysaturated fatty acid 0.1 gm, Carbohydrate 4.8 gm, Cholesterol 14 mg, Calcium 120 mg, Energy 66 kcal, [19].

The fifth instar is considered as the most important stage for silk production. The mulberry leaves were dipped in milk and air dried before giving them as feed to the silk larvae, and no mortality or frass was observed. Newspaper was laid, and the larvae were reared in cardboard boxes. Bed cleaning was followed every day in the morning to remove the letter, faeces, exuviae, unconsumed leaves and waste to provide hygienic conditions for healthy growth. Disinfection of rearing house and appliances was followed by the procedure of [20]. For the purpose of comparative analysis, the larvae were divided into 2 groups. Each group contained three replications with 25 larvae each. Group 1 was fed with fresh mulberry leaves throughout the fifth instar and was considered as the control group. Group 2 was fed with mulberry leaves dipped in cow milk on alternate days (days 1, 3, and 5) of the fifth instar. On the other days (days 2, 4, and 6), larvae were fed with fresh mulberry leaves. The weights of the larvae in the 2 groups were recorded daily from day 1–6 of the fifth instar until cocoon formation. Cocoon weights were also recorded, as cocoon weight is an important parameter in determining the amount of silk that can be produce.

3 Result and Discussion

3.1 Effects of fresh mulberry leaves and mulberry leaves dipped in milk on larval weight:

Silkworms were treated with fresh mulberry leaf and mulberry leaf dipped in milk. The possibility of using milk as a growth enhancer in silkworm was examined in this experiment. The treatment was carried out from day 1 through day 6 of the fifth instar, after which the silkworms were started spinning and cocoons were formed. The silkworms were fed with the milk treated leaves on the alternative days (1st, 3rd and 5th days). Weights were recorded from day 1 through day 6. The whole experiment was repeated for two times rearing with same treatments and method. The average values of two times rearing data three replications were used for comparative analysis.

Larvae that fed on the leaves treated with milk showed more weight gain after the first treatment (day 1). The second treatment (day 3) showed in a mentionable increase in weight from day 4. The trend continue till day 6 but in case of milk treated leaf the larval weight was stabilized after day 5 because 92% of them were matured and were prepared for spinning. This observation clearly shows that treatment saves three times feeding and labour cost also.

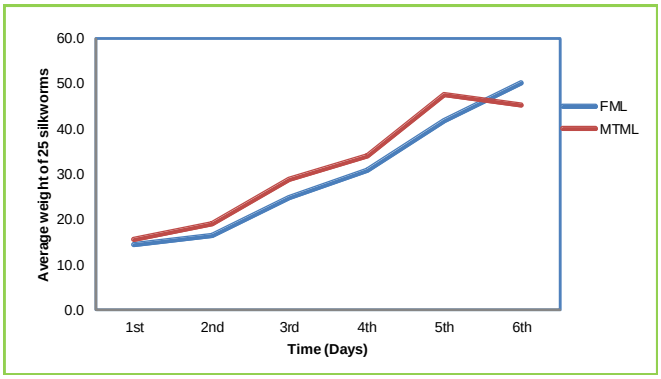

Fig. 1. Relationship between weight of the larvae during different days of the fifth instar when fed with fresh mulberry (FML) and milk treated mulberry leaf (MTL). The X-axis in the graph indicates the days of the fifth instar. The Y-axis indicates the average weight of 25 larvae in each group.

The larvae fed with milk treated leaves gained 208% weight from day 1 to 5, while the larvae fed with fresh leaves gained 188% weight in the same span (Figure 1). However, in case of day 6 the larval weight was declined which fed with the milk treated leaves because due to the early maturity they stopped consuming food. The results showed that milk had a positive effect on the growth of *B. mori* larvae.

3.2 The effects of the treatments on cocoon weights and reeling performances:

Cocoons are the desired product of silkworm rearing. High quality cocoon contains higher amount of silk. The weight of the cocoon decreases gradually as moisture evaporates from the body of the pupa and the stored fat is consumed during the metamorphosis process [21].

Table 1
Effect of cow milk on economic traits of green silk cocoons.

Treatments	Avg. wt. of Cocoon	Avg. wt. Shell	Avg. Sh%
Control	1.119	0.139	12.8
MTL	1.330	0.148	14.3
CV (%)	2.19	1.10	0.34
LS	*	**	**

*LS= Level of significance *significant at P<0.05 and ** at P<0.01, Values given are the average of 6 data's.*

The results showed that cocoons formed by the silkworm treated with milk treated mulberry leaves weighted more than those formed by the silkworms fed with fresh mulberry leaves. Cocoon weight increased by 18% and shell percentage by 11% when compared to the control.

Table 2
Effect of cow milk on the reeling performances of dry silk cocoons.

Treatments	SFL (m)	SFD	SCR %	RS (%)	Renditta
Control	367*	3.13*	93.94 NS	30.04	8.84**
MTL	385**	3.16*	96.97 NS	33.69**	8.17**
SE	3.71	0.03	4.29	0.26	0.04
CV (%)	1.21	1.00	5.50	1.00	0.64

**significant at P<0.05, ** at P<0.01 and NS = Not significant, Values given are the average of 6 data's*
SFL= Single Filament Length, SFD= Single Filament Denier, SCR= Single Cocoon Reelability, RS= Raw Silk.

Denier is important as it indicate the number of cocoon filaments to be assembled for obtaining the required size of the reeled silk. It also indicates the quality of reeled silk that can be expected in a unit time. Higher value of SFD needs lower No. of cocoons to achieve the targeted Denier 20/22. The amount of silk cocoons need to get one kg raw silk is consider as its Renditta. Result shows that the value of Renditta with milk treated leaf is lower compared to the Fresh mulberry leaf. Table 2 present the single reeling performance so further mass reeling is needed to ensure the actual reeling performances.
Sericulture is a specialized agricultural practice involves low cost input with moderate output within shortest period time. A successful cocoon crop in sericulture depends mostly on healthy larval growth [11]. Islam et al. 2011, observed that nickel chloride can be used at low concentrations for enhancing the economic traits of B. mori larvae. Quraiza et al. 2008, [12] reported that fed with 1% and 2% ascorbic acid significant increase in the protein content of the silk gland, fat body, and muscles. Aspargine- and alanine enriched diets for larvae did not result in a significant increase in silk production [4]. Lactose is the main carbohydrate component in milk and *B. mori* was shown to have a betaglucosidase enzyme that is active on cellobiose and lactose [22]. The presence of this enzyme shows a possibility to fed silkworm larvae with milk though lactose does not shows any problem for digestion. Ito, 1960, [8] found that casein the major protein component is beneficial for B. mori development. Ito and Arial, 1965 also reported that casein contains a high amount of glutamic acid and B. mori larvae need glutamic and aspartic acid for proper growth. Konala et. al, 2013, [17] showed that bovine milk had a positive effect on the body weight and cocoon weight of *B. mori* larvae. [23] Kanafi, 2007 studied on the effect of different vitamins on the nutritional enrichment of mulberry leaves and it was found that all the vitamins showed a positive effect on B. mori growth and development. Our study showed that cow milk increase the body weight and cocoon weight of *Bombyx mori* L.

4 Conclusion

The result of our study agree with the earlier studies of bovine milk and growth [24] [25] [17]. For high nutritional value of milk the silkworm larvae may gained weight but to find out the exact cause it needs further investigation. These result suggested to fed silkworm larvae with mulberry leaves dipped in cow milk at fifth inster for better larval weight and reeling performances.

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