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Comparison of green tea and moringa fortification on post-cocoon parameters of mulberry silkworms, *Bombyx mori* (L.).

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Abstract
The post-cocoon (economic) parameters of the mulberry silkworm *Bombyx mori* L. commercial double hybrid bivoltine breed race: FC1x FC2 during its fourth and fifth instars were examined in relation to the nutritional supplementation of green tea and moringa. The current study was carried out at Tumkur University's University College of Science's Zoology Research Lab. The post-cocoon characteristics of this silkworm generally responded better when the mulberry leaves were treated with aqueous solutions of green tea and moringa and fed to the fourth and fifth instar larvae. In particular, green tea at a 3% concentration produced greater silk filament length, weight, denier, raw silk percentage, and renditta of the silk worm, *Bombyx mori* L., when compared to moringa solution. The evaluation index values calculated and the overall performance of *Bombyx mori* in response to the green tea and moringa herbal treatment observed in the current study demonstrated that the post-cocoon parameters could be improved with the supplementation of green tea herbal formulation as in comparison to a moringa solution.

Keywords: *Bombyx mori*, Green tea, Moringa

Introduction

Silkworm larvae (*Bombyx mori* L.) rely solely on mulberry leaves for nutrition. This insect is monophagous. Sericulture is a traditional land-based practice in India that provides significant employment opportunities and economic benefits to agricultural households. India is the world's second largest producer of mulberry silk, following China. Plants contain the optimum amount of organic substances on the earth and phytochemicals have been linked to improved insect performance. Supplementing the silkworm *Bombyx mori* (L) with medicinal plant extracts resulted in changes in body weight, silk gland weight, and silk thread length (Rajkumar *et al*., 2012) [10]. In addition to mulberry leaves, silkworms are fed nutrients to enhance their economic properties (Jayapaul, 2003; Sheeba, 2006) [11]. Often referred to as the "Miracle Tree," moringa is a nutritional powerhouse that includes essential amino acids, protein, minerals (such as calcium, potassium, and iron), and vitamins A, C, E, and B-complex (Islam *et al*., 2021) [6]. Additionally, it has antioxidants that improve immunological and metabolic processes as well as phytochemicals that promote growth. For both insects and mammals, moringa has been demonstrated to improve feed efficiency, growth rate, and physiological performance (Anusha *et al*., 2025; Simi Simon *et al*., 2026a) [2, 13, 14]. Supplementing*Bombyx mori* larvae with Moringa oleifera leaf, flower, and pod extracts, together with chitosan solution, resulted in varying cellular responses. Numerous compounds found in green tea leaves, such as polyphenols, have been reported to have anticancer, antioxidant, and anti-diabetic properties (Shimizu *et al*., 2008; Cabrera *et al*., 2006). According to Alagawany *et al*. (2020) [3, 1, 12], green tea has anti-oxidative, anti-inflammatory, anti-arthritic, anti-stress, hypolipidemic, hypocholesterolemic, skin/collagen protective, hepatoprotective, anti-diabetic, anti-microbial, anti-infective, anti-parasitic, anti-cancerous, inhibition of tumorigenesis and angiogenesis, anti-mutagenic, and bone health and memory (Simi Simon *et al*., 2026b) [13, 14]. Green tea solutions (1%, 2%, and 3%) and moringa (2.5%, 5%, and 7.5%) were fortified on V1 mulberry leaves and fed to FC1×FC2 larvae during the fourth and fifth instars, which are ideal for high metabolism and silk production. In order to improve the biochemical composition and commercial qualities of FC1×FC2 silkworms, this study suggests supplementing V1 mulberry leaves with green tea and moringa leaf powder. The objective is to create an organic, sustainable process that includes cocoon development and silk yield, which will help small-scale farmers and sustainable sericulture.

Materials and methods

Experimental Design

Silkworm Rearing: The lab was sterilized with limestone powder before the investigation was carried out. The research was conducted at the University College of Science's Zoology Research Lab at Tumkur University in Tumakuru. The Chawki rearing center in Hollanahalli, Tumakuru, provided DFL silkworms (II instar larvae) of the FC1×FC2 breed, which were reared in a lab with a temperature of 25±3℃ and a relative humidity of 72±2%. The larvae were sorted into seven groups, each containing twenty larvae, at random. From the first day of the fourth instar until they reached the spinning stage, each group was given enough V1 mulberry leaves, treated with commercially available moringa powder (2.5%, 5%, and 7.5%), and green tea (1%, 2%, and 3%) fed twice a day. Standard growing conditions were applied to the larvae (Krishnaswami, 1973) [8].

Economic parameter: The commercial characteristics of the *Bombyx mori* species FC1×FC2 were determined based on the subsequent parameters: Post cocoon parameters (Silk filament length, Silk filament weight, Denier, Raw silk percentage, Renditta).

Post cocoon parameters

1. Silk filament length (m)

L = R × 1.125

Where, L = total length of the filament in meter per cocoon

R = number of revolutions recorded by epprouvette

1.125 = circumference of eprouvette

2. Silk filament weight (g)

obtained filament is weighed using electronic balance

3. Denier (filament size)

$$\frac{\text{Filament weight (g)} \times 9000}{\text{Filament length (m)}}$$ (Harendra Kumar *et al*., 2013) [5]

4. Raw silk percentage (%)

$$\frac{\text{Mean weight of raw silk} \times 100}{\text{Mean weight of cocoon}}$$

5. Renditta

$$\frac{100 \times 100}{\text{Shell Percentage} \times \text{Raw silk percentage}}$$

Biostatical Analysis

The supplied data was assessed using two-way analysis of variance (ANOVA) and Dunnett's Multiple Comparisons test using a commercially available statistical tool (Graph Pad Prism 8 for Windows). The results were shown as Mean±SD. P values < 0.001 were considered statistically significant.

Table 1: Comparison of different concentrations of Green tea and Moringa on post-cocoon parameters in FC1× FC1 race of *Bombyx mori*. L. The values are expressed in grams for silk filament weight, cm for silk filament length, and percentage for Raw silk percentage.

Characteristics	Control	Green tea			Moringa		
		1%	2%	3%	2.5%	5%	7.5%
Silk filament length (cm)	412±0.11	758±0.03	902±0.28	1100±0.45	480±0.04	732±0.52	980±0.18
Silk filament weight (gm)	0.05±0.12	0.11±0.28	0.23±0.11	0.45±0.22	0.09±0.01	0.15±0.28	0.28±0.11
Denier (d)	1.09±0.23	1.30±0.11	2.29±0.71	3.68±0.53	1.68±0.12	1.84±0.11	2.57±0.12
Raw silk percentage (%)	0.96±0.22	1.83±0.21	3.52±0.22	6.18±0.18	1.60±0.11	2.48±0.41	4.13±0.11
Renditta (r)	10.8±0.14	2.58±0.03	1.77±0.41	1.46±0.11	5.64±0.33	2.12±0.5	1.65±0.03

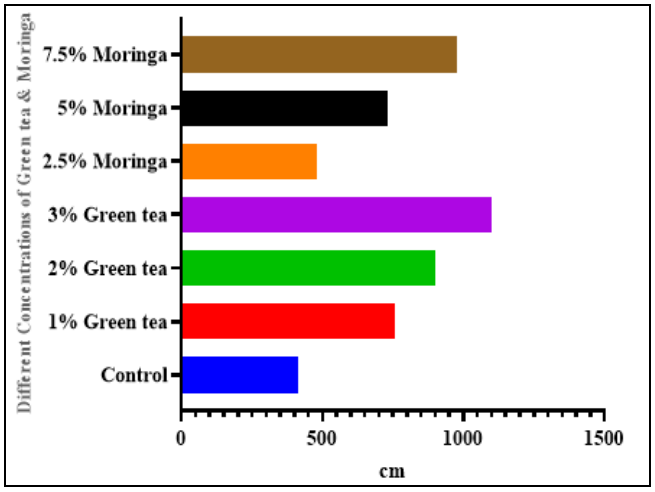

Fig 1

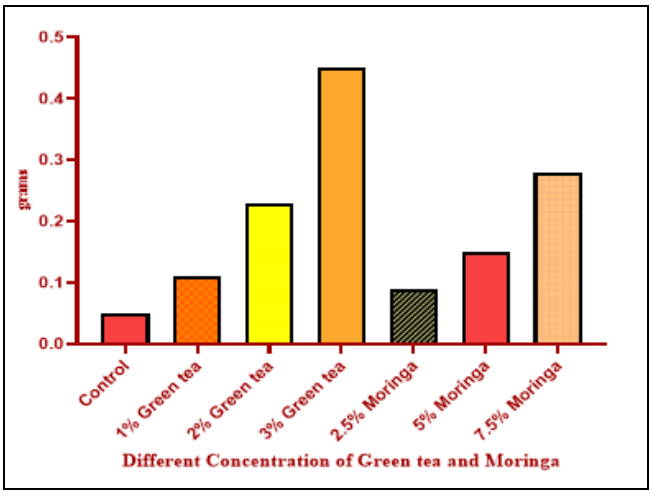

Fig 2

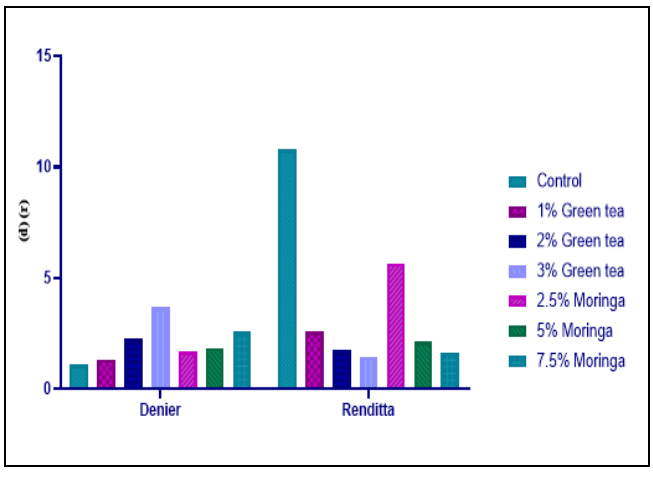

Fig 3

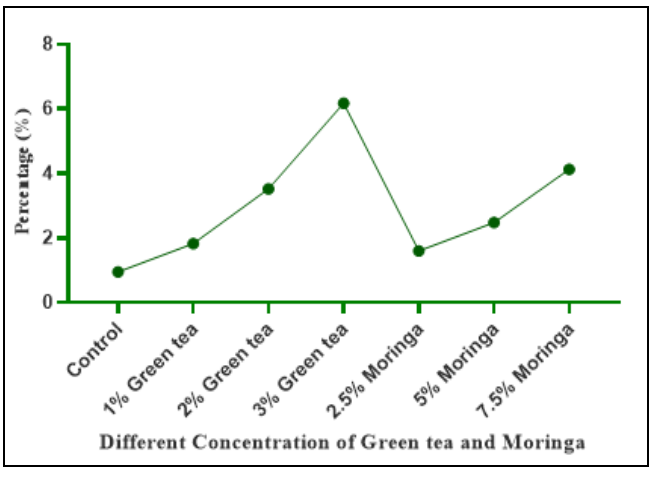

Fig 4

Fig (1), (2), (3), (4): Silk filament length, silk filament weight, Denier, Renditta and Raw silk percentage in FC1×FC2 race of *Bombyx mori*. L fed V1 mulberry leaves treatment of Green tea and *Moringa*

Result

The post-cocoon parameter was observed in FC1×FC2 breed of silkworm under study which includes Silk filament length, Silk filament weight, Denier, Raw silk percentage, Renditta. The economic parameter of FC1×FC2 breed of silkworm is given in Table 1 and figure 1, 2, 3 &4. The table 1 and figure 1 summarizes comparison of silk filament length gained by silkworms treated with 3% green tea shows high value to that to moringa and least in control. Figure 2 shows comparison of silk filament weight gained by silkworms treated with 3% green tea shows high value to that to moringa and least in control. Figure 3 shows comparison of denier gained by silkworms treated with 3% green tea shows high value to that to moringa and least in control. Renditta when comparison shows high value in control and least in silkworms treated with 3% green tea to that to moringa. Figure 4 shows comparison of raw silk percentage gained by silkworms treated with 3% green tea shows high value to that to moringa and least in control.

Discussion

Filament weight, length, and denier are examples of qualitative metrics that are referred to as filament characters. They are essential indicators of the thickness, fineness, and quality of silk. The improvement in filament length is indicated by increased shell weight and shell ratio, which are reflected in the filament length (Manu *et al*., 2020) [9] When compared to the moringa supplemented silkworm's Green tea fortified silkworm displays the highest values. Renditta shows how many cocoons are needed to make one kilogram of raw silk; compared to other cocoons, 3% green tea fortified silkworm can meet the minimum weight requirement. *Moringa's* proteinaceous supply can increase cocoon and shell weight (Anusha *et al.*, 2025) [2]. Mulberry leaves supplemented with 3% *green tea* demonstrate increased larval weight than the control, which could be owing to *green tea's* high protein, amino acid, and mineral content (Cabrera, Artacho & Giménez, 2006) [3]. Green tea contains minerals including manganese, aluminum, and potassium, as well as vitamins like ascorbic acid and chlorogenic acid (Graham, 1984) [4]. Proteins (15–20% dry weight), minerals and trace elements (5% dry weight), carbohydrates (5-7% dry weight), trace amounts of vitamins B, C, and E, xanthic bases and lipids (linoleic and linolenic acid), pigments (carotenoids, chlorophyll), and volatile substances (alcohols, lactones, aldehydes, esters, and hydrocarbons) are also present in green tea. The ideal concentration of feed additive may have a stimulating impact on silkworms, leading to increased food consumption. Feed supplements contain carbohydrates, vitamins, minerals, and phenolic substances that can significantly impact larval growth at specific concentrations. The current study supports earlier studies on the use of *green tea* in sericulture, demonstrating that feeding silkworms' *green tea* improved silkworm post-cocoon qualities.

Conclusion

A useful and bio-rational approach to modern sericulture is to add green tea throughout the IV and V instar stages of the bivoltine double hybrid FC1×FC2. It transforms a naturally robust breed of silkworm into a high-performing commercial variety. In economic metrics like silk filament weight, length, denier, raw silk percentage, and renditta, it shows good yield. The bivoltine double hybrid breed FC1×FC2 is excellent for seed crop yield, stability, and recovery. The current study compares the effects of supplementing with green tea to those of moringa on the economic parameters of silkworms.

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Declaration of Competing Interest

The author's states that they have no known challenging financial interests that could have seemed to impact the work reported in this paper.

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