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Influence of *Phyllanthus emblica* Extract Fortified Mulberry Leaves on the Commercial Parameters of the Silkworm *Bombyx mori*. L

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In recent years, a variety of plant extracts in varying concentrations have been utilized in commercial silk farming to observed their effects on commercial parameters of *Bombyx mori* L. In the present investigation, the effects of ethanolic extract of *Phyllanthus emblica* Linn. was studied with different concentrations on the larvae of silkworm, *Bombyx mori* L. The results show increasing trend in some important commercial parameters. The effective increase in single cocoon weight, filament length and filament weight was observed with the use of 1: 2, 1: 4 and 1: 8 concentrations of *Phyllanthus emblica* Linn.

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Keywords: Phyllanthus emblica; Bombyx mori; ethanolic extract; growth rate; commercial parameters.

1. INTRODUCTION

Sericulture is an excellent enterprise for socio-economic framework of India. Supplementing mulberry leaves with extra nutrients can improve silk cocoon production and quality. The expansion of sericulture, or the cultivation of silk, to produce and export silk, is becoming more essential to the economic development. Sericulture is an essential component of agro-based enterprises. India is the second-largest producer of mulberry silk work, after China, the motherland of silk (Vijay Prakash & Dandin, 2005). It possesses a tremendous potential for employment, growth and financial advantages The silkworm *Bombyx mori* L., a common monophagous insect, consumes exclusively mulberry leaves.

Sericulture relies solely on a lepidopteran insect called a silkworm. Mulberry, Tropical Tasar, Oak Tasar, Eri, and Muga are the five commercial silk kinds that are exclusively found in India (Bhattarcharjya et al., 2020). Mulberry silk accounts for 79% of India's total raw silk production, surpassing all other silk varieties. Eri, Tasar, and Muga silk follow with 13.2%, 7.3%, and 0.5% of the total, respectively. *Bombyx mori* is a monophagous insect that only consumes the leaves of mulberries (*Morus alba*). The sericulture industry depends significantly on the production performance of silkworms, and producing high-quality cocoons is the primary goal of silkworm rearing (Samami et al., 2019). Mulberry leaf quality is crucial for the development of silkworms, sustaining cocoon creation, and increasing silk productivity (Kumar & Arunachalam, 2009). The nutrient content of mulberry leaves must be enhanced to increase the amount and quality of cocoons; this can be done by supplementing mulberry leaves with additional nutrients. For proper growth and development, silkworms need a certain type of sugar, an amino acid, proteins, and vitamins (Sengupta et al., 1972). According to Krishnaswami et al., (1971), the nutritional content of silkworm leaves significantly impacts their health and economic performance.

Several attempts have been executed in recent years to improve the quantity and quality of silk by feeding the leaves more nutrients, spraying vitamins, hormones, analogues of hormones, plant products, and plant extracts. Phytochemicals have been found to affect the survival and behaviour of several insects, and plants are the planet's most abundant source of organic compounds (Rajshekhar Gauda et al., 1997). Plant extracts have been shown to be a good alternative to synthetic chemicals because their antibiotic properties are of great interest given the ongoing threat of bacterial strains developing resistance to conventional antibiotics (Priyadharshini et al., 2009). According to the current research, it has been observed that the supplementary nutrition is an important growth regulating factor in silkworm along with the mulberry leaves. So, the current study was conducted to determine the efficacy of an ethanolic extract of *Phyllanthus emblica* L. on larvae of *Bombyx mori* L.

2. MATERIALS AND METHODS

Collection of Plant Material:

- Plant material i.e., *Phyllanthus emblica* Linn. (branches) were collected from local agricultural fields / gardens of Aurangabad district.
- The collected plant part i.e., (stem - it has rich antioxidant content, particularly vitamin C and polyphenols) were dried and grinded into a fine powder using an electric grinder.
- The powder was carefully stored in airtight polythene bags to preserve freshness and protect against moisture and pests.

Preparation of Plant Extract:

- The 40-gram powder obtained from *Phyllanthus emblica* stems was subjected to extraction using 400 ml of Ethanol via a Soxhlet extraction apparatus by following the methodology suggested by Lolge et al., (2016).
- After the extraction process, the resultant extract was exposed to air for solvent evaporation.
- The remaining extract was stored as a stock solution in a refrigerator until further use.

Treatment of Plant Extract:

- Dissolving 1 ml of the crude extract in 100 ml of distilled water yielded concentrations of 1:2, 1:4 and 1:8 respectively.

Plate 1. Filed and laboratory analysis

- Fifty larvae were taken in 5 labelled trays (One for control group, 1 for Experimental Control with distilled water and 3 trays as per the conc.)
- These concentrations were obtained by modifying the volume of ethanol with the appropriate amount of distilled water.
- The solutions were then sprayed separately onto air-dried mulberry leaves with a sprayer and fed to the larvae under study.
- Throughout the investigation, numerous metrics such as larval weight, total mortality, cocoon weight, shell weight,

pupal weight, and shell ratio were rigorously measured to determine the impacts of the various concentrations on the larvae.

- This research technique sought to investigate the impact of different doses of *Phyllanthus emblica* extract on the different parameters.
- The following formulae were used for calculating specific parameters related to cocoons and silk reeling:

Cocoon shell weight = Weight of shell / Total no. of shell

Cocoon shell ratio = Weight of shell / Weight of cocoon x 100

Denier = Weight of raw silk reeled (g) / Length of raw silk reeled (m) x 9000

These formulas are essential for studying the characteristics and quality of the silk obtained from cocoons, providing insights into the shell weight, shell ratio, and denier of the silk produced (Avhad & Hiware, 2016).

3. RESULTS AND DISCUSSION

According to Table 1 and Graph 1, effects of ethanolic extract of *Phyllanthus emblica* Linn. on the larvae of silkworm, *Bombyx mori* L. show increasing trend in case of important commercial parameters viz., filament length, filament weight and single cocoon weight (1:4 Concentration.) But, some concentrations of this extract show a decreasing trend in case of some biological characters such as pupal weight and shell weight. No breakages and mortality were observed at 1:4 and 1:8 conc. of this extract. So, it can be said that the ethanolic extract of *Phyllanthus emblica* shows a positive effect on some biological characters and commercial parameters of *Bombyx mori* L.

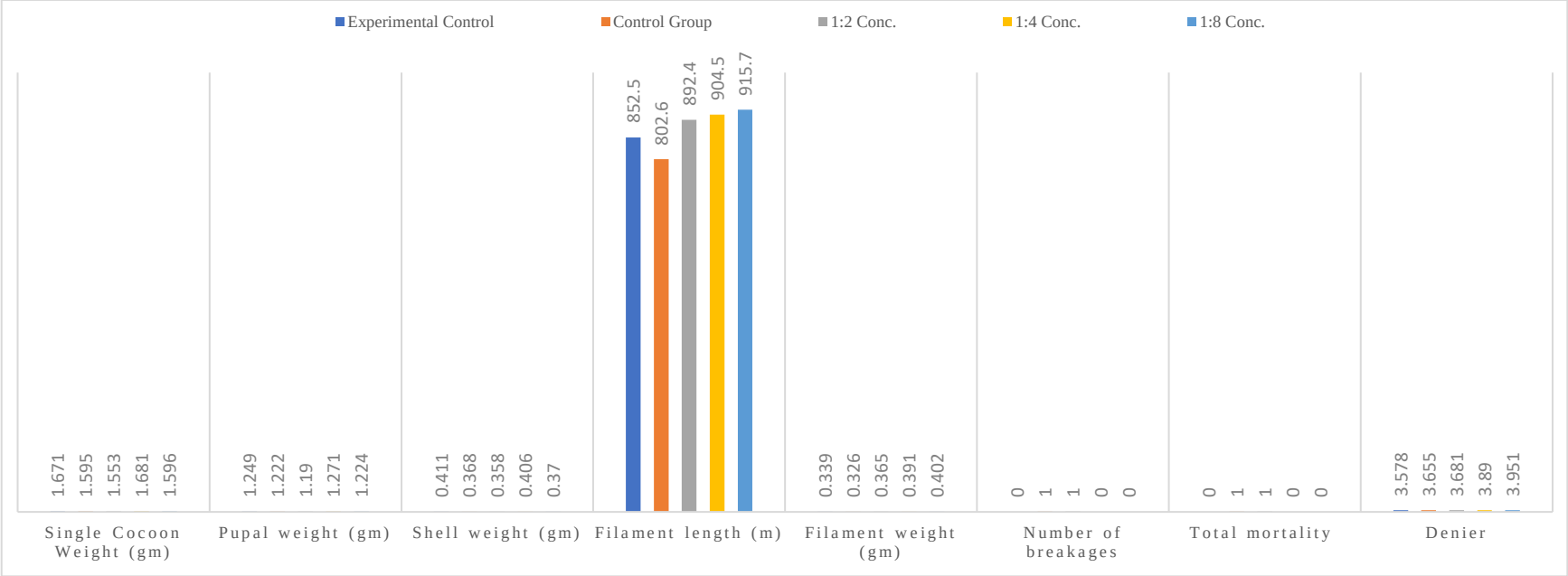
Many researchers have conducted similar studies on the effectiveness of artificial feeding and plant extracts on the growth and development of silkworms. Krishnaswami et al., (1971) observed that feeding nutritious leaves allowed better growth and development of silkworms as well as improved the economic characteristics of the cocoons. Bajpai et al., (2005) concluded that nutritional supplements and plant extracts are chemicals that when added to conventional food make it more nutritious and beneficial. Laskar & Datta (2000) concluded that silkworm nutrition is the only factor that increases silk quality and quantity almost individually. Hiware & Bhalerao (2008) studied the effect of plant extract of *Phyllanthus niruri* on biological characters of *Bombyx mori* and found positive results. Umarani (2009) observed that the increasing dose of supplementary diet soyabean is directly proportional to the quality of cocoons. Avhad & Hiware (2016) concluded that plant extracts exhibit the presence of several growth stimulants and can be used to increase silk yield in commercial silkworm farming.

Bhattacharyya et al., (2017) evaluated the antioxidant activity of artificial feed ingredients and found that soybeans had a greater impact on increasing cocoon shell weight and silk quality than mulberry leaves. Hassan et al., (2020) observed the improvement in the development and cocoon properties of *B. mori* when larvae were supplemented with a plant powder mix may be linked to the therapeutic compounds of the plant and increased dietary protein in nutrition feed, allowing for the enhancement of bio-productive parameters. Indrani Nath et al., (2023) conducted a review on the role of plant extracts in the growth and development of mulberry and non-mulberry silkworms, concluding that treating mulberry and non-mulberry silkworms with different concentrations of plant extracts influences silkworm economical traits. Khade et al., (2024) conducted a study on the influence of *Spinacia oleracea* extract on silkworm development and silk characteristics. They observed a concentration-dependent relationship between the extract and multiple developmental parameters. Hajam et al., (2024) studied the influence of plant extract-fortified mulberry leaves on certain silkworm reeling parameters. They observed that fortifying mulberry leaf with plant extracts of *Aloe vera*, *Ocimum sanctum*, and *Withania somnifera* considerably increased silk production parameters in silkworm *B. mori* L. Sivalingam and Pandian (2024) conducted a study on characterization of silver nanoparticles (AgNPs) synthesized using polyphenolic compounds from *Phyllanthus emblica* L. and their impact on cytotoxicity in human cell lines. They observed that the *P. emblica* leaf ethanol extract showed potential secondary metabolites, such as alkaloids, flavonoids, and saponins. There are many reports providing information on the positive effects of nutritional supplementation on the economic characteristics of silkworms.

Table 1. Effect of *Phyllanthus emblica* Linn. (1:2, 1:4 & 1:8) ethanolic plant extract on biological characters of silkworm *Bombyx mori* L.

Sr. No.	Characters	Experimental Control with Distilled water	Control group	Experimental Group		
				A	B	C
1.	Single Cocoon Weight (gm)	1.671±0.27	1.595±0.14	1.553±0.12	1.681±0.22	1.596±0.23
2.	Pupal weight (gm)	1.249±0.29	1.222±0.11	1.19±0.11	1.271±0.22	1.224±0.21
3.	Shell weight (gm)	0.411±0.076	0.368±0.075	0.358±0.041	0.406±0.077	0.370±0.035
4.	Filament length (m)	852.5±79.64	802.6±40.08	892.4±74.97	904.5±95.59	915.7±70.92
5.	Filament weight (gm)	0.339±0.038	0.326±0.028	0.365±0.027	0.391±0.015	0.402±0.017
6.	Number of breakages	00	01	01	00	00
7.	Total mortality	00	01	01	00	00
8.	Denier	3.578±0.679	3.655±0.339	3.681±0.398	3.890±0.296	3.951±0.224

A - 1: 2 conc., B - 1: 4 conc., C - 1: 8 conc., Std – Standard Deviation



Graph 1. Effect of *Phyllanthus emblica* inn. (1:2, 1:4 & 1:8) plant extract on biological characters of silkworm *Bombyx mori* L

4. CONCLUSION

From the present investigation it can be concluded that, the silkworm diet supplementation with *Phyllanthus emblica* (Amla) extract at certain levels may be effective to economic traits. The commercial characteristics of the silkworm such as cocoon characters (cocoon weight, pupal weight, shell weight, shell ratio), silk characters (filament length, filament weight and denier), were enhanced by using extracts for supplementation with mulberry leaves. It will help to the farmers to increase their productivity and economics.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that generative AI technologies such as Quill Bot software has been used during the writing or editing of manuscript for grammar checking and summarizing.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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