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# Impact of *Ganoderma* and noni extract on the economic parameters of silkworm, *Bombyx mori* L

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**Abstract**
Silkworm is a monophagous insect and major portion of successful silk production as well as quality of silk cocoon depends on nutritional value of mulberry leaf. Hence in the present investigation an attempt is made to study the impact fortification of mulberry leaf with *Ganoderma* and Noni to increase economic parameters of silkworm *Bombyx mori*. *Ganoderma* and Noni are the most famous traditional value medicinal plant used for prevention and cure of much illness. The silkworm larvae were fed on mulberry leaves treated with 0.1%, 0.2%, 0.3%, 0.4%, 0.5% concentrations of *Ganoderma* and noni extracts from 3rd instar onwards fed once a day. The economical parameters like matured cocoon weight, shell weight, pupa weight, shell percentage, filament length, fibroin, sericin and denier were recorded. These result showed that silkworm larvae fed with mulberry leaves spray in *Ganoderma* and noni extract increase economic parameters when compared with control treated group.

**Keywords:** Economic parameters, *Bombyx mori*, Cocoon, *Morinda citrifolia*, *Ganoderma lucidum*

## 1. Introduction
Sericulture or silk farming is the rearing of silkworms for the production of raw silk although there are several commercial species of silkworms, *Bombyx mori* is the most widely used and intensively studied. The silkworm is an of economic insect used for silk production. Sericulture depends on mulberry leaves as the sole natural food of the silkworm *Bombyx mori* L., and the quality of the mulberry leaves has a direct bearing on the normal growth of the larvae and the quality of the cocoon (Horie *et al*., 1967) [9]. Nutrition is the single most factor that influences the growth and development of *B. mori* (Kanafi *et al*., 2007) [12]. Enriching the silkworm diet (i.e., mulberry leaves) with exogenous nutrients such as proteins, carbohydrates, amino acids, vitamins, minerals, hormones, antibiotics and assessing their impact on larval growth, metabolism and silk production has become the order of traditional research in sericulture (Chakrabarty and Kaliwal, 2011).
Plants are the richest source of organic chemicals on earth and phytochemicals have been reported to influence the life and performance of different insects (Rajshekhar gauda, et al., 1997 and Khyade, 2004) [22, 13]. Recently many attempts have been made to fortify mulberry leaves with botanical extracts so as to improve the mulberry leaf quality and feed efficiency of silkworm, which inturn help to increase cocoon production and silk quality. Previous studies confirmed the effect of many extracts on various metabolic activities resulting in accelerated of silk cocoon formation and spinning (Shivakumar, *et al*.,1995 and Murugan, *et al*.,1998) [24, 16] and increase in larval, cocoon as well as shell weight (Sridevi, *et al*.,2003 and Pardesh *et al*.,2004b) [25, 18]. Dietary supplementation of the leaf, flower and pod extracts of *Moringa oleifera* (Rajeshwari and Isairasu, 2004) [23] and chitosan solution (Bin Li, et al., 2010) [3] elicited varied responses in final instar larvae of *Bombyx mori* (L). A commercial herbal tonic 'logen" having the extracts of some selected medicinal plants reflected into better response from the larvae of *Bombyx mori* (L) (Balamurugan and Iasirasu, 2007) [2]. The *Xanthium indicum* plant extract influenced the larval and cocoon characteristics of silkworm, *Bombyx mori* (Pardeshi and Bajad, 2014) [19].
*Ganoderma lucidum* is one of the most famous traditional medicinal mushrooms. It has a long history of use for promoting health and longevity in China, Japan, and other Asian countries. It is a large, dark mushroom with a glossy exterior and a woody texture. The Latin word lucidus means "shiny" or "brilliant" and refers to the varnished appearance of the surface of the mushroom. In China, *G. lucidum* is called lingzhi, whereas in Japan the name for the *Ganoderma*taceae family is reishi or mannentake. *Ganoderma lucidum*, composed of protein, fat, carbohydrate, fiber, ash, and some vitamins and minerals, with potassium, calcium,

phosphorus, magnesium, selenium, iron, zinc, and copper accounting for most of the mineral content (Borchers *et al*., 1999) [4].

*Morinda citrifolia* L. (family Rubiaceae), commonly known as noni, has been used in Polynesia for food and medicine for thousands of years (Morton, 1992) [15]. As medicine, it was used by traditional healers for a variety of ailments, including diabetes, hypertension, gout, bruises, cuts, boils, pain, cancer, and much more (Wang *et al*.,2002) [28]. The fruit contains dietary fibres, proteins, aspartic acid, glutamic acid and isoleucine, potassium, sulfur, calcium, phosphorus and traces of selenium have been reported in the juice (Chunhieng, 2003) [6].

There has been no attempt so far to study the impact of *Ganoderma* and Noni plant extract on the silkworm *B. mori***.** The present study is an attempt to evaluate the impact of *Ganoderma* and Noni extract on the economic parameters of silkworm, *Bombyx mori* L.

## Materials and Method

The diseased free bivoltine hybrid (CSR2) eggs of *Bombyx mori* silkworm were procured from district sericulture office, Konam, Nagercoil. Reared under standard environmental conditions of 26+2 ºC, 75% RH as per Krishnaswami, 1986. After hatching, the worms were fed with MR2 variety of mulberry leaves.

### Plant extract and Treatment

*Ganoderma* and Noni plant extracts were procured from Vestige Marketing Private Limited, Nagercoil. After the second moult, the third instar larvae were divided into six group of 50 worms each. The first group was given normal feedings 4-5 times a day and treated as the control. The remaining group was considered as the experimental group and fed with the mulberry leaves fortified with *Ganoderma* and Noni plant extract. Different concentration of plant extracts were prepared (0.1%, 0.2%, 0.3%, 0.4%, 0.5%) for the treatment. Fresh mulberry leaves were sprayed with each concentration and then dried in air for 15 minutes. Treated leaves of various concentrations were fed to III, IV and V instar larvae, once in a day.

### Analyses of economic parameters

By the end of seventh day of 5th instar, mounting of the silk worm larvae on the chakra was started. After the cocoons were completely formed (in 7-10 days), the below given economic parameters were analyzed in control and the experimental groups of silk worms. Cocoon parameters like cocoon weight, shell weight, pupal weight, shell ratio and silk characters like fibroin content, sericin content, filament length and denier were recorded and the data were calculated by the following formulas.

$$\text{Cocoon shell ratio (\%)} = \frac{\text{Cocoon shell weight}}{\text{Cocoon weight}} \times 100$$

$$\text{Fibroin \%} = \frac{\text{Weight of fibroin}}{\text{Weight of shell}} \times 100$$

$$\text{Sericin \%} = 100 - \text{fibroin\%}$$

$$\text{Denier} = \frac{\text{Weight of the single cocoon filament (g)}}{\text{Length of single cocoon filament (m)}} \times 9000$$

### Statistical analysis

Data were analyzed by two way analysis of variance (ANOVA) and results were presented as means ± SD. P values < 0.05 were regarded as statistically significant.

## Results and Discussion

The results showed that impact of *Ganoderma* and Noni fortified mulberry leaves fed to silkworm, on economic parameters are shown in Table 1 and 2 and Fig. 1 and 2. The over changes were analyzed with reference to economic traits of sericulture, viz, Cocoon weight, Shell weight, Pupal weight, Shell ratio, Filament length, Fibroin, Sericin and Denier.

Of all five different concentration experimental studied, the most effective concentration was found in *Ganoderma* 0.2% and Noni 0.3%. In Table 1 and Table 2 shows the data of control and *Ganoderma lucidum* and *Morinda citrifolia* (Noni) treated mulberry leaves fed III, IV and V instar *B.mori* larvae produced economic parameters. The mean weight of the cocoon was maximum (1901±35.07mg) in 0.2% of *Ganoderma* extract treatment and (1786±60.76mg) in 0.3% of Noni extract treatment. The cocoon weight of the control was only (1650±63.14mg). The mean weight of the pupa was maximum in 0.2% of *Ganoderma* extract treatment (1590±21.96mg) and (1496±52.51mg) in 0.3% of Noni extract treatment, the pupal weight of the control was only (1391±61.50mg). The shell weight of the control larvae was (258±25.64mg), 0.2% of *Ganoderma* extract treated larvae was maximum (309±28.37mg) weight and 0.5% Noni extract treated larvae was maximum (294±12.94mg) shell weight. The shell ratio is an important commercial characteristic of *B.mori*, the mean weight of the shall ratio was maximum (16.25±1.25%) in 0.2% of *Ganoderma* extract treatment and (16.82±0.48%) in 0.5% of Noni extract treatment. The cocoon weight of the control was only (15.63±0.86%). 0.2 % *Ganoderma* extract treated larvae showed significant increase of silk characters such as, filament length (918.72±31.45m) and denier (3.10±0.061). The corresponding control values were 831.55±43.37 (m) and 2.50±0.07 respectively. Noni extract treated larvae showed filament length high in 0.5% (900.30±22.13m) and denier 0.3% (3.28±0.06). The corresponding control values were 831.55±43.37 (m) and 2.50±0.07 respectively.

The data on selected economic characters of the silkworm, *B. mori* fed on *Ganoderma lucidum* and *Morinda citrifolia* (Noni) extract fortified mulberry leaves are presented on Table 1 and Table 2. It indicated that there was a significant improvement in the quality and quantity of cocoon and silk characters in the plant extract treated group.

The main reason of nutritional supplementation for silkworms is to enhance the economic traits such as cocoon weight, pupal weight, shell weight and cocoon shell percentage. There are numerous reports containing the positive effects of nutritional supplementation on the economic traits of silkworms (Rajabi *et al*., 2007) [21]. The secretes of growth and development of *Bombyx mori* (L) lies in the wealthy nutrition (Kanafi, *et al*., 2007) [12]. As per the observation of (Alagumalai, *et al*., 1991) [1], fortification of mulberry leaves with the flour of black gram and red gram to improves the larval growth and cocoon characteristics in *Bombyx mori* (L).

It was noticed by Rajashekhargauda, *et al*. (1997) [22], the growth promoting effect of the water and ether extracts of the plants such as *Tribulus terrestris* (L) and *Psoralea corylifolia* (L). Subburathian and Krishnan (1998) [26] noticed Soya bean meal to accelerate the larval growth significantly at certain

level when supplemented along with food to the silk *Bombyx mori* (L). According to Sundararaj, *et al*. (2000) [27] silkworm reared on the leaf supplemented with soybean flour to record significantly higher larval weight on the account of the additional protein supplemented.

The silkworm larvae fed on mulberry leaves treated with *Coffea arabica* leaf extracts at 1:25 concentration recorded significantly higher shell weight (0.296g) than control (Jeyapaul *et al*., 2003) [11]. 3 % suspension of wheat and Tapioca flours along with mulberry leaves showed greater shell weight respectively by 28% and 15% (Eswaran and Sevarkodiyyone, 2004) [7]. Rajeswari and Isaiarasu (2004) suggested that leaf extracts of *Moringa oleifera* showed high larval growth (1974±53 mg/larva). Patil *et al*. (2005) [20] reported that *Parthenium* root extract induced silkworms to feed more, resulting in higher larval, cocoon and pupal weight. *P. corylifolia* extract improved the economic characters of silkworm (Gouda, 1991) [8]. Murugesh and Mahalingam (2005) reported that *T. terrestris* leaf extract improved the cocoon characters of *B. mori*. The silkworm larvae fed with *Coffea arabica* leaf extracts treated mulberry leaves, recorded higher shell weight (Jayapaul *et al*., 2003) [10]. According to Chavan *et al*. (2013) [5] *Clerodendrum multiflorum* plant extract can be used to increase the economic characteristics of *B. mori.*

The improvement noticed in the overall rearing performance of the final instar larvae of *B. mori* in response to the dietary supplementation of *Ganoderma* and Noni extract in the present study indicate the possibility of using it to realize the ultimate applied objective of qualitative and quantitative improvements of silk yield in sericulture research.

**Table 1:** Effect of *Ganoderma lucidum* on the economic parameters of the silkworm, *Bombyx mori.*

| Parameters | Concentration% | | | | | |
|---|---|---|---|---|---|---|
| | Control | 0.1% | 0.2% | 0.3% | 0.4% | 0.5% |
| Cocoon Weight (mg) | 1650±63.14 | 1825±57.44** | 1901±35.07** | 1835±57.33** | 1785±46.90** | 1758±46.98* |
| Pupal Weight (mg) | 1391±61.50 | 1528±55.04** | 1590±21.96** | 1540±48.39** | 1500±28.80** | 1480±35.95* |
| Shell Weight (mg) | 258±25.64 | 296±22.19* | 309±28.37* | 294±21.96* | 284±18.50 | 278±14.31 |
| Shell ratio (%) | 15.63±0.86 | 16.21±1.17 | 16.25±1.25 | 16.02±0.58 | 15.91±0.62 | 15.81±0.52 |
| Filament length (m) | 831.55±43.37 | 894.45±32.94* | 918.72±31.45** | 902.28±22.61* | 865.46±27.92 | 843.52±14.42 |
| Fibroin (%) | 76.30±1.26 | 80.40±1.15** | 83.50±1.28** | 81.70±2.22** | 78.40±1.00* | 76.80±1.13 |
| Sericin (%) | 23.70±1.25 | 19.60±1.15** | 16.50±1.28** | 18.30±2.22** | 21.60±1.00* | 23.20±1.13 |
| Denier | 2.50±0.07 | 2.90±0.09** | 3.10±0.06** | 3.00±0.07** | 2.80±0.06** | 3.00±0.07** |

Mean±S.D, *Significant **Highly Significant at $P \leq 0.05$, All other deviations are not significant.

**Table 2:** Effect of *Morinda citrifolia* (Noni) on the economic parameters of the silkworm, *Bombyx mori*.

| Parameters | Concentration% | | | | | |
|---|---|---|---|---|---|---|
| | Control | 0.1% | 0.2% | 0.3% | 0.4% | 0.5% |
| Cocoon Weight(mg) | 1650±63.14 | 1712±42.66 | 1763±53.10* | 1786±60.76** | 1780±53.26** | 1747±33.09* |
| Pupal Weight (mg) | 1391±61.50 | 1439±41.44 | 1480±34.89* | 1496±52.51* | 1495±38.24* | 1458±22.52 |
| Shell Weight (mg) | 258±25.64 | 273±14.40 | 282±18.23 | 289±16.73 | 285±18.02 | 294±12.94* |
| Shell Ratio (%) | 15.63±0.86 | 15.94±0.84 | 15.99±0.55 | 16.18±0.74 | 16.01±0.63 | 16.82±0.48** |
| Filament length (m) | 831.55±43.37 | 834.38±20.81 | 862.58±24.38 | 886.35±35.36 | 870.34±32.18 | 900.30±22.13* |
| Fibroin (%) | 76.30±1.26 | 76.65±1.44 | 79.00±1.25** | 79.60±1.08** | 80.40±1.36** | 80.85±1.26** |
| Sericin (%) | 23.70±1.26 | 23.35±1.44 | 21.00±1.25** | 20.40±1.08** | 19.60±1.36** | 19.15±1.26** |
| Denier | 2.50±0.07 | 2.45±0.05 | 2.92±0.07** | 3.28±0.06** | 3.15±0.05** | 3.22±0.07** |

Mean±S.D, *Significant **Highly Significant at $P \leq 0.05$, All other deviations are not significant.

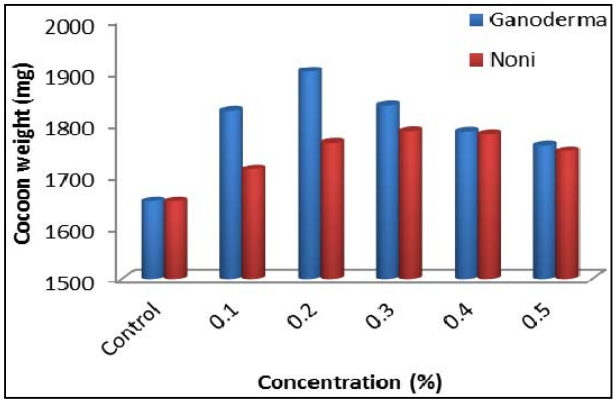


**Fig 1:** Effect of *Ganoderma lucidum* and *Morinda citrifolia* (Noni) extract on cocoon weight of *Bombyx mori*.

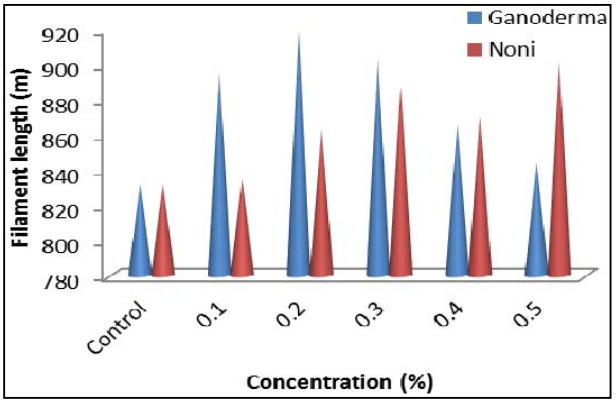


**Fig 2:** Effect of *Ganoderma lucidum* and *Morinda citrifolia* (Noni) extract on filament length of *Bombyx mori*.

## Conclusion

In conclusion, silkworm diet supplementation with *Ganoderma lucidum* and *Morinda citrifolia* (Noni) extract at certain levels may be effective to economic traits. The commercial characteristic of the silkworm such as cocoon characters (cocoon weight, pupal weight, shell weight, shell ratio, silk characters (filament length, fibroin, sericin and denier), were enhanced by extracts. The present study was only an attempt to assess the influence of *Ganoderma lucidum* and *Morinda citrifolia* (Noni), which is used as stimulant, nutritive and medicinal properties. *Ganoderma lucidum* and *Morinda citrifolia* should be screened for growth promoting activity in silk worm, *Bombyx mori* (L).

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