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Effect Of Coconut Milk Supplementation On Commercial Traits Of The Silkworm Bombyx Mori L

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Abstract
The mulberry silkworm is essential to the economy and the growth of the nation. Silkworms are extremely delicate insects with a monophagous feeding behaviour that only eats mulberry leaves. The provision of sufficient quantity and quality nutrition is one of the most important factors in the success of silkworm farming. One essential physiological component that affects silkworm growth, development, and silk output is nutrition. Since it has been shown that the nutritional value of mulberry leaves affects not only larval growth and survival but also cocoon parameters. Therefore, the silkworm's (Bombyx mori L.) diet plays a role in the sericulture industry. Thus, one way to boost the silkworms' growth rate and the commercial traits of the cocoons is to feed them mulberry leaves that have been supplemented with nutritional additives. Milk, honey, vitamins, probiotics, amino acids, and other dietary supplements can help maintain and enhance the silkworm's general health and growth so that it can produce high-quality cocoons that fetch a better price. As the additional nutritional supplements are expected to promote the silkworms' overall growth and development in addition to the cocoon's commercial attributes, the investigation has been carried out by supplementing the mulberry leaves with coconut milk in 5 concentrations, i.e., from 1% to 5%, and noticed positive results in enhancing the commercial characteristics of silk cocoons.
Keywords: *Silkworm; nutritional supplements; length of silk filament; non-breakable silk filament length.*

INTRODUCTION

Silk is a high-value product synthesized by the silkworm Bombyx mori. Bombyx mori L. is a silk-producing Lepidoptera insect that is crucial to the textile and garment industries. Silkworms are raised for their ability to spin silk; silk is a natural animal fiber. Sericulture is the process of growing mulberry trees, rearing silkworms, and making silk yarn. Sericulture creates jobs in rural and semi-urban regions, particularly for women and those from economically disadvantaged backgrounds, and has the potential to enhance people's socio-economic condition, particularly in rural areas. Nutrition is the most crucial and essential component for all living beings. Without nutrition or nutritious food, no living entity can survive and grow disease-free. Nutrition plays a crucial role in silkworm growth, development, and silk output. Silkworms are monophagous insects that rely solely on mulberry leaves for nutrition. These leaves contain carbohydrates, essential amino acids, proteins, vitamins, and minerals required for growth, development, and silk production. Silkworm biological and economic characteristics include reproduction, egg production, body weight, silk gland weight, cocoon weight, and so on, all of which are fully dependent on the nutritive values of the mulberry leaves. Silkworms are typically raised to produce the basic raw material, i.e., silk cocoons for the silk industry. Quality cocoon production is crucial for the production of high-quality silk. Nutritional supplements are crucial for silkworms as they enhance their health, growth, development, quality of cocoon and silk output.Nowadays, researchers are focusing on food additives for successful silkworm rearing to improve commercial production characteristics and sustain the sericulture sector. According to Sengupta et al. (1972), feeding mulberry genotypes with nutritive supplements such as sugars, amino acids, and fats can improve larval growth and the cocoon properties of different silkworm races. Etebari et al., (2005) observed an increase in cocoon weight and fertility in multivitamin-supplemented silkworms. Rahmathulla et al. (2007) observed the steady elevation of the weight of the silkworm and silk gland in the 5th instar silkworms administered with folic acid. Manjula et al. (2011) found that supplementing Vigna unguiculata with mulberry leaves at a concentration of 7.5% improved digestion and increased silk production. Brahma et al (2018) observed the increase in the body weight, silk gland weight and silk gland protein concentration in vitamin C supplemented silkworms compared with vitamin E supplemented worms. According to Anil Kumar and Jayaraju (2021), supplementing silkworms with several nutritional elements such as proteins, carbohydrates, amino acids, vitamins, minerals, salts, and so on can improve their growth and development as well as the quality of their cocoons. Mohamed and Helaly (2018), as well as Ruiz et al. (2023), discovered the elevation of cocoon parameters in silkworms supplemented with cow milk. Rania, S. Gad (2022) found that vitamin B9 treatment increased cocoon weight, shell weight, and silk percentage compared to the control. Chavan KK et al. (2024) reported that overall growth parameters have increased in silkworms treated with vitamin C + soya flour + vitamin B-complex + methionine in different ratios. There is a close link between nutrition and silkworm growth physiology; therefore, successful rearing is largely contingent on providing the silkworm's nutritional requirements. Worldwide research has shown that food additives such as minerals and vitamins improve the silkworm growth rate, the protein and mineral content of the hemolymph, the protein, DNA, and RNA content of the sericigen glands, and the cocoon quality parameters. To achieve the objective mentioned below, it is recommended to supplement with coconut milk, which has high quantities of saturated fat, vitamins, minerals, antioxidants, and antimicrobials. To examine the effect of coconut milk as a nutritional supplement on the growth and development of silkworms and the commercial characteristics of cocoons.

METHODOLOGY

Young age silkworms (chawki worms) of the bivoltine double hybrid (CSR 2 x CSR 27) x (CSR 6 x CSR 26) were acquired from the Chawki rearing center at Jakkadhanna, Vedurkuppam mandal, Chittoor district of Andhra Pradesh for the present study. By following the standard rearing methods recommended by Dandin et al. (2003), the silkworm stock was maintained. This was done by coordinating the essential requisites such as maintaining optimal ecological factors, a pathogen-free atmosphere in the silkworm culture laboratory, and suitable quality mulberry leaves. The laboratory and equipment used for silkworm culture were carefully cleaned and disinfected five days before the start of the culturing process. To provide a pathogen-free environment, a lime and bleaching mixture in a 95:5 ratio was sprinkled throughout the laboratory. Silkworm rearing beds were kept clean every day, fed three times a day, and spaced as optimally as possible to ensure healthy growth and development.

Preparation of Coconut Milk and Supplementation:

Fresh coconut milk was prepared by grinding fresh coconut pulp by using a mixer grinder into a soft paste, and by using muslin cloth, the coconut milk was filtered. To conduct the experiment, coconut milk was diluted to the necessary concentrations ranging from 1 to 5% that were used for the investigation.Immediately after passing the fourth moult, the silkworms were taken for the experiment. The mulberry leaves were drenched in coconut milk with selected concentrations, i.e., from 1 to 5% for ten minutes, and then the leaves were dried in the shade to remove excess water. Then the leaves were fed to the 5th instar silkworms every day as a first feed. Hundred silkworms were taken for each replication, and three replications were kept for the experiment. Mature silkworms were transferred to the plastic collapsible mountages at the completion of the fifth instar, and on the sixth day of mounting, the cocoons were collected from the mountages. Harvested cocoons were taken for evaluation, and the data was recorded and statistically examined. The following cocoon properties were evaluated using Sonwalkar's (1991) recommended methodologies.

Economical Traits of Cocoons

Weight of Silkworm
Weight of Cocoon
Weight of Shell
Shell percentage
Length of Silk Filament
Non-breakable Silk filament length
Denier

The silkworm Bombyx mori weaves a protective casing called a silk cocoon. In order to shield the sedentary, non-feeding stage of its life cycle from unfavorable weather conditions and natural adversaries. The nutritive quality of leaves fed to silkworms can affect the economic traits of cocoons. The following significant economic factors were examined using Sonwalkar's (1991) recommended methodologies.

Weight of Silkworm

Using an electronic balance, the mean weight of twenty five randomly chosen fully grown silkworms from each replication of the experiment and both the controls was determined and reported in grams.

Weight of Cocoon

The weight of a silk cocoon is a crucial economic trait, as the cocoon's weight is useful in determining the cocoon's price. Average cocoon weight was calculated for twenty-five cocoons and expressed in grams.

Weight of Shell

Randomly, twenty-five cocoon shells were taken and weighed from both the experimental and control batches and then noted. The average weight of 25 shells in grams was used to determine the weight of a single shell.

Shell percentage

The cocoon shell percentage was calculated using the same samples that were collected for the cocoon weight and shell weight. The weight of the cocoon shell divided by the weight of the entire cocoon is known as the cocoon shell ratio. The shell ratio was calculated using the formula provided below and expressed in percentage.

$$\text{Shell Percentage} = \frac{\text{Weight of the cocoon shell}}{\text{Weight of the entire cocoon}} \times 100$$

Length of Silk Filament

Ten cocoons were randomly selected from each set of experiments, which included treated coconut milk at 1% to 5% and both controls from all replications. An epprouvette, a tiny reeling machine with a circumference of 1.125 meters, was used to reel the silk filament from the cooked cocoons. The length of the filament was determined using the formula shown below.

Filament Length (m) = Number of rotations x Circumference of the wheel (χ)

$$\chi = 1.125\text{m}$$

Non-breakable Silk filament length

It is the average length of silk filament that can be unwound from the cocoons without a break. The non-breakable filament's length and number of breaks were calculated using Sonwalkar's (1991) formula

$$\text{Average Non-breakable filament Length} = \frac{\text{Total filament length}}{1 + \text{No.of breaks}}$$

Denier

The density of silk filament, or the weight of silk in grams per 9,000 meters of strand, indicates how fine the filament is. Using the provided formula, the silk filament thickness for the control and experimental cocoons was determined.

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

RESULTS

Precisely, the study focused on understanding the effect of coconut milk supplementation on the growth of silkworms and the commercial characteristics of silk cocoons in the popular hybrid (CSR 2 x CSR 27) x (CSR 6 x CSR 26). Elevation of commercial parameters of cocoons was noticed. The data collected during experimentation on economic parameters was statistically analyzed and shown in Table 1.Results in Table 1 show changes in the growth pattern of silkworms supplemented with coconut milk and economical parameters of cocoons. Significant enhancement of larval weight was noticed in the silkworms supplemented with coconut milk. Larval weights recorded in silkworms treated with coconut milk in different concentrations were 2.41±0.01, 2.43±0.23, 2.46±0.32, 2.47±0.08, and 2.48±0.23 grams, in 1% to 5%, respectively, and larval weights recorded in normal control and distilled water control were 2.38±0.36g and 2.34±0.41g, respectively. Gradual and significant elevation of cocoon weight was noticed in silkworms supplemented with coconut milk in different concentrations (1% - 1.803±0.01, 2% - 1.813±0.01, 3% - 1.865±0.03, 4% - 1.871±0.02, and 5% - 1.879±0.02 grams) compared with normal control (1.793±0.03g) and distilled water-treated control (1.776±0.04g). A similar trend was noticed in the shell weight of silkworms treated with different concentrations of coconut milk compared with both the controls (normal control 0.390±0.02 and distilled water control 0.384±0.01). The shell weights recorded in different concentrations were 0.397±0.03, 0.419±0.04, 0.428±0.04, 0.454±0.05, and 0.462±0.04 in 1%, 2%, 3%, 4%, and 5%, respectively. With regard to shell percentage, gradual elevation was noticed from 1% to 5% with reference to both the controls, i.e., normal control and treated with distilled water. The shell percentage recorded in different concentrations was 21.56±0.52%, 21.70±0.51%, 22.28±0.91%, 22.48±0.75%, and 22.77±0.98% in 1%, 2%, 3%, 4%, and 5%, respectively. The shell percentage recorded in normal control and distilled water control were 21.21±0.74% and 20.34±0.56% respectively. Gradual elevation of length of silk filament was noticed in silkworms treated with coconut milk in all the concentrations compared to the both the controls. The filament length recorded in different concentrations 1%, 2%, 3%, 4%, and 5%, was 1098±1.37 m, 1147±1.86m, 1198±1.09m, 1218±4.9 m, and 1227±2.8 m respectively. A steady elevation of non-breakable silk filament length was noticed in silkworms supplemented with coconut milk from 1% to 5% concentrations compared to both the controls.The non-breakable filament lengths recorded were 926.5±8.78, 937.3±8.28, 941.1±4.75, 956.3±4.54, and 966.5±5.31meters in 1%, 2%, 3%, 4%, and 5%, respectively, and in the normal control and distilled water control, the non-breakable filament lengths were 915.5±6.47m and 902.8±5.52m, respectively. Finer denier was noticed in coconut milk-supplemented silkworms. Deniers recorded in different concentrations, i.e., from 1%, 2%, 3%, 4%, and 5%, were 3.076±0.05, 2.966±0.05, 2.895±0.15, 2.813±0.14, and 2.786±0.12 denier, respectively, and in both the controls, the deniers recorded were 3.103±0.08d and 2.983±0.14d. Overall, coconut milk-supplemented silkworms showed enhancement of growth of silkworms and commercial traits of cocoons compared to both the control.

Table-1 Changes in economic traits of cocoons of silkworms supplemented with coconut milk in different concentrations (1% to 5%).

S. No		Name of the parameter		Control	Distilled water	Coconut milk concentrations					P value
						1%	2%	3%	4%	5%	
1		Weight of Silkworm (g)	Mean SD	2.38 ±0.36	2.34 ±0.41	2.41 ±0.01	2.43 ±0.23	2.46 ±0.32	2.47 ±0.08	2.48 ±0.23	0.000 *
2		Weight of Cocoon (g)	Mean SD	1.793± 0.03	1.776 ±0.04	1.803 ±0.01	1.813 ±0.01	1.865 ±0.03	1.871 ±0.02	1.879 ±0.02	0.000 *
3		Weight of Shell (g)	Mean SD	0.390 ±0.02	0.384 ±0.01	0.397 ±0.03	0.419 ±0.04	0.428 ±0.04	0.454 ±0.05	0.462 ±0.04	0.000 *
4		Shell percentage (%)	Mean SD	21.21± 0.74	20.34 ±0.56	21.56 ±0.52	21.70 ±0.51	22.28 ±0.91	22.48 ±0.75	22.77 ±0.98	0.000 *
5		Length of Silk Filament (meters)	Mean SD	1016 ±3.55	998 ±0.86	1098 ±1.37	1147 ±1.86	1198 ±1.09	1218 ±4.9	1227 ±2.8	0.000 *
6		Non–breakable filament length(meters)	Mean SD	915.5± 6.47	902.8 ±5.52	926.5 ±8.78	937.3 ±8.28	941.1 ±4.75	956.3 ±4.54	966.5 ±5.31	0.000 *
7		Denier (d)	Mean SD	3.103± 0.08	2.983 ±0.14	3.076 ±0.05	2.966 ±0.05	2.895 ±0.15	2.813 ± 0.14	2.786 ±0.12	0.000 *

* - Values are significant over control at P<0.05.

DISCUSSION

The study very clearly indicated that enhancement of larval growth and cocoon traits in coconut milk supplementation, as coconut milk is a versatile ingredient that is high in calories, a source of several vitamins, and minerals, such as manganese and copper. Coconut milk includes phenols, which are antioxidants. Antioxidants can help the body fight or eliminate free radicals, thereby protecting it from disease. Coconut milk includes lauric acid, a lipid known to have antibacterial properties. Etebari et al., (2005) studied impact of supplementation of multi-vitamins on biological and commercial traits cocoons and noticed elevation of weight of the silkworm and cocoon. Rahmathulla et al. (2007) evaluated the influence of folic acid on silkworm growth patterns, the development of silk glands, and cocoon parameters. The researchers observed gradual enhancement of silkworm growth, weight of the silk gland, and cocoon. Kalyankar et al. (2015) opined that different nutrients supplementation increase the economic traits of cocoons. The silk threads treated with valine and threonine showed very slight morphological changes, according to Nicodemo et al. (2014). The threonine-treated silkworms showed a significant increase in the tensile strength and toughness of the silk filament. Dudcheewan et al. (2017) stated that supplementation with coconut water was effective for an increase in economic characters of cocoons. Mohamed and Helaly (2018) opined that the presence of high protein and lipids content in milk may be the reason for the healthy and robust growth of silkworms. Abdel-Rahman (2018) studied the effect of whey protein as a supplement to silkworms and noticed an elevation of the weight of silkworms and cocoon weight. Usha Rani Brahma et al. (2018) observed elevation of body weight, weight of silk glands and silkworms and silk gland protein concentration of the silk gland supplemented with vitamin. Ruiz et al. (2023) also stated that cow's milk is a protein supplement that may be the reason for the expression of high cocoon yield parameters. Muzamil et al. (2023) stated that food additives can improve the metabolism and biological functions of silkworms in turn the economic traits of cocoons. Nivetha (2024) studied the effect of coconut water as a feed additive on the cocoon parameters of the silkworm Bombyx mori and found that improvement in the economic traits of cocoons, such as cocoon weight, pupa weight, and shell weight, compared to the control.

CONCLUSION

Nutrition is the basic unit of silkworm for growth and development. Dietary efficiency of silkworm is a crucial factor in converting the feed ingested to produce silk of commercial importance. Fortification of mulberry leaves is a constructive technique to increase the nutritional value of the food making it more useful which improves silkworm health, cocoon and silk quality. The study focused on the importance of dietary supplement with coconut milk in different concentrations through mulberry leaves. Perusal of the study revealed a significant elevation of beneficial economical traits of silkworms in all the concentrations (1-5%), especially the highest commercial characteristics were recorded with 5% coconut milk-supplemented silkworms. Since the nutritional supplements improved the growth and commercial traits of silkworm, fortification of natural food supplements may be suggested for regular use during culturing of silkworms for better rearing performance and economic productivity. Since the biological growth of silkworms is linked to their commercial cocoon characteristics, it is clear from the study that the addition of coconut milk impressed both the silkworms' growth and the cocoons' commercial traits. This can be used to increase the yield parameters of cocoon crops. Supplementing with coconut milk can be a fresh and environmentally friendly way to enhance the diet and general health of silkworms. Coconut milk supplementation has the potential to elevate the commercial properties as well as productivity when supplemented appropriately. However, additional research is needed to be carried out to determine the precise reason for the improvement in silkworm weight and cocoon parameters.

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