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Research Article

Seri Biotechnological Perspectives on Microclimate-Mediated Variation in Post-Cocoon Traits of Tasar Silkworm, Antheraea mylitta Drury

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ABSTRACT

Tasar silkworm, *Antheraea mylitta* Drury (Daba BV), is a semi-domesticated, silk-producing insect of high economic significance, supporting the livelihoods of tribal populations in India. Its rearing performance is strongly influenced by environmental variables, making it a critical model for Seri biotechnological interventions aimed at stabilizing productivity. In the present study, disease-free layings of *A. mylitta* were reared on *Terminalia arjuna* across three distinct sites in Telangana: Kakatiya University campus (Warangal), Chennur, and Mahadevpur. These sites provided varying microclimatic windows of temperature, relative humidity, and altitude to assess phenotypic responses. Post-cocoon parameters, including cocoon weight, shell weight, shell ratio, filament length, and denier, were recorded using standard procedures. Results indicated that cocoons produced at Kakatiya University under winter conditions (27°C, 78% RH) exhibited superior biomass conversion and fiber quality, characterized by higher shell weights and lower denier values, compared to forest sites. Conversely, Mahadevpur (30°C, 87% RH) yielded lighter cocoons but higher reelability, attributed to pupal desiccation from microclimatic stress during the rainy season. Chennur exhibited intermediate values for most traits. The site-specific variation in these quantitative traits underscores the extreme sensitivity of *A. mylitta* to microclimatic fluctuations. This study provides a baseline for breeding microclimate-tolerant strains, optimizing host-plant management, and developing environmental decision-support tools. Such biotechnological approaches are essential for ensuring stable silk yields and enhancing livelihood security for tribal rearers amidst changing environmental scenarios.

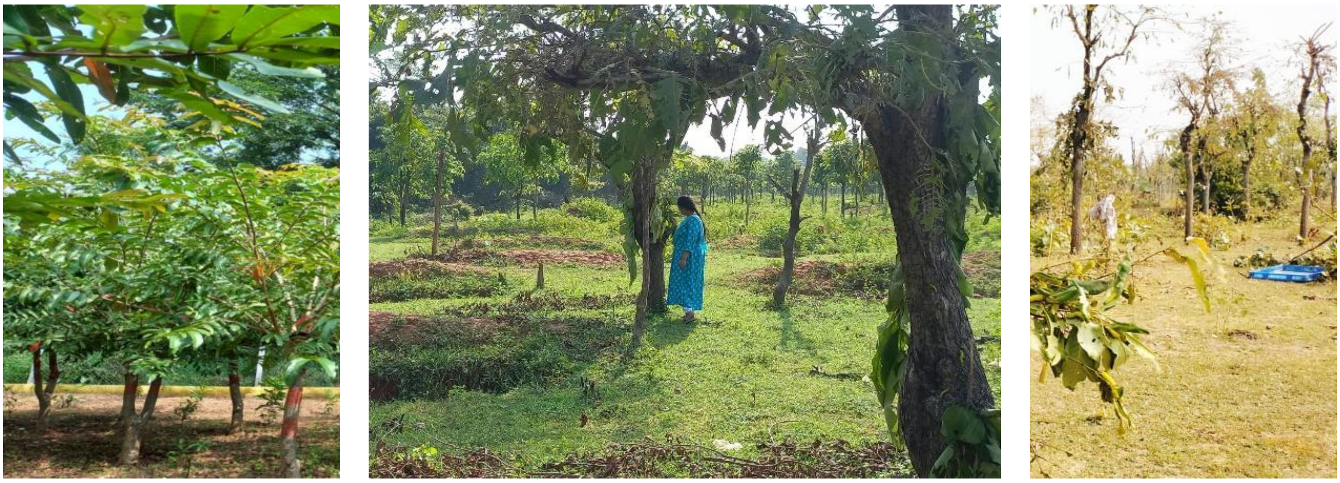
Keywords: Seri-biotechnology; Tasar silk; *Antheraea mylitta*; microclimate; post-cocoon parameters; *Terminalia arjuna*; tribal livelihoods.

1. Introduction

Tasar silk, produced by the semi-domesticated *Antheraea mylitta* Drury, serves as a vital ecological and economic resource that supports the livelihoods of tribal communities through forest-based sericulture [1]. Unlike the controlled environment of mulberry sericulture, tasar cultivation is highly susceptible to climatic fluctuations, where microclimatic factors—specifically temperature, humidity, and seasonal transitions—directly dictate the productivity and quality of the fiber [2] .

Consequently, understanding the impact of these environmental variables on post-cocoon traits is essential for developing targeted biotechnological interventions that can stabilize silk yields, conserve biodiversity, and ensure the economic resilience of rural rearers under variable field conditions [3].

Microclimatic factors such as temperature, relative humidity, seasonal fluctuations, and host plant quality play a crucial role in determining the growth, development, and productivity of silkworms [4][2]. Even minor variations in these factors can significantly affect cocoon quality and post-cocoon parameters. This study investigates the influence of microclimate on post-cocoon parameters of *A. mylitta* reared on *Terminalia arjuna* across three distinct sites in Telangana State, India. The objective is to elucidate phenotypic responses to site-specific environmental conditions and identify opportunities for Seri biotechnology to enhance tasar silk production.



(A) (B) (C)

Figure-2. Controlled plantation conditions. (A) KU Warangal; (B) Mahadevapur; (C) Chennur

Post-cocoon traits such as cocoon weight, shell weight, shell ratio, filament length, and denier are critical indicators of silk quality and economic value [5][6]. Understanding how these traits respond to microclimatic variations is essential for improving productivity and ensuring sustainable sericulture practices [7]. The present study focuses on analysing the influence of microclimatic conditions on post-cocoon traits of *Antheraea mylitta* across different rearing environments in Telangana State.

2. Materials and Methods

2.1. Study Sites

Three sites with distinct microclimatic profiles were selected: Kakatiya University campus, Warangal (managed plantation, winter season, 27°C, 78% RH), Chennur (natural forest, intermediate conditions), and Mahadevpur (natural forest, rainy season, 30°C, 87% RH). These sites represent a gradient of temperature, humidity, altitude, and seasonal variation, allowing assessment of environmental impacts on silkworm performance. The study was conducted at three different locations in Telangana State: Kakatiya University campus, Warangal (Figure-1), Chennur (forest area) and Mahadevpur (forest area). These locations differ in temperature, humidity, altitude, and seasonal conditions.

Figure-1. Cocoons of Kakatiya University, Mahadevpur, Chennur

2.2. Silkworm Rearing

Disease-free layings (DFLs) of *Antheraea mylitta* (Daba BV) were procured from Mahadevpur and reared on *Terminalia arjuna* leaves. Standardized rearing protocols were followed to minimize confounding factors other than microclimate. Cocoon harvest timings were adjusted based on developmental cues at each site. Controlled plantation conditions at Warangal and Natural Forest conditions at Chennur and Mahadevpur were monitored.

2.3. Measurement of Post-Cocoon Traits

Post-cocoon parameters assessed included cocoon weight, pupa weight, shell weight, shell ratio (shell weight/cocoon weight), filament length, cocoon length and width, reelability (percentage of usable silk filament), and denier (fiber thickness). Measurements were performed following established sericultural standards.

2.4. Data Analysis:

Post-cocoon traits were measured using standard reeling and gravimetric procedures. Shell Ratio (SR%) was calculated as: SR% = (Shell Weight / Cocoon Weight) x 100

2.5. Correlations Between Microclimate and Cocoon Traits

Temperature and relative humidity showed significant correlations with cocoon weight, shell weight, and reelability, indicating microclimate as a key determinant of silk quality and quantity.

2.6. Microclimatic Conditions

The experimental sites exhibited distinct microclimatic variations that influenced cocoon development. In Warangal during the winter season, the average temperature was approximately 27°C with a relative humidity of about 78%, creating moderately cool and humid conditions. In contrast, Mahadevpur during the rainy season recorded higher humidity levels, around 87%, with a mean temperature of 30°C, reflecting a warm and moist environment. The site at Chennur presented intermediate conditions, balancing temperature and humidity between the extremes observed at Warangal and Mahadevpur. These variations provided a diverse set of ecological conditions for evaluating cocoon characteristics.

2.7. Post-Cocoon Parameters Studied

To assess the quality and commercial value of the cocoons, several post-cocoon parameters were systematically studied. These included cocoon weight, pupal weight, and shell weight, which together indicate the biological efficiency of the silkworm. The shell ratio was calculated to determine the proportion of silk shell relative to the whole cocoon. Further, filament length, cocoon length and width, and reelability were measured to evaluate the spinning potential. The denier, representing the thickness of the silk filament, was also recorded. All measurements were carried out following standard procedures to ensure accuracy and reproducibility.

3. Results

3.1. Comparative Analysis of Post-Cocoon Traits

The experimental data reveals a significant decline in cocoon weight as the microclimate shifts from the stable winter of Warangal to the humid rainy season of Mahadevpur. The study revealed clear microclimate-dependent variation in post-cocoon traits of *Antheraea mylitta*.

The data presented in Table 1 reveal distinct regional differences in silk trait expression among cocoons reared at Kakatiya University, Chennur, and Mahadevpur. Cocoons from Kakatiya University exhibited the highest cocoon weight (13.2 g) and shell weight (1.7 g), indicating superior larval nutrition and optimal rearing conditions. The filament length reached 1000 m, suggesting excellent fibre formation and continuity. These results reflect the benefits of controlled microclimatic conditions, which promote efficient silk gland activity and uniform cocoon development.

In comparison, cocoons from Chennur showed intermediate performance across most parameters. The cocoon and shell weights were slightly lower (10.88 g and 1.65 g, respectively), while filament length (985 m) remained close to that of Kakatiya University. Interestingly, Chennur cocoons exhibited a higher shell ratio (15.21%) and reelability (20.43%), implying a balanced trade-off between cocoon compactness and reeling efficiency. These findings suggest that the intermediate climatic conditions at Chennur favor moderate silk yield and quality, bridging the gap between controlled and humid environments. Mahadevpur cocoons, reared under high humidity, displayed the lowest cocoon weight (3.62 g) and shell weight (1.23 g), accompanied by a shorter filament length (736 m). However, they recorded the highest reelability (34.15%) and shell ratio (34.15%), indicating that although the cocoons were lighter, their silk could be unwound more easily. This pattern highlights the influence of excessive humidity on cocoon formation—reducing overall biomass but enhancing reeling performance. Collectively, the data emphasize how regional **microclimatic variation** significantly affects silk yield and quality, with controlled conditions producing heavier cocoons and humid environments favoring reelability.

The results presented in Table 2 highlight how regional **eco-zones** and seasonal conditions directly influence cocoon quality and silk yield. At Kakatiya University, cocoons were reared in a managed plantation during the winter season, where the average temperature was 27 °C and relative humidity stood at 78%. These controlled conditions favored optimal larval growth, resulting in the highest cocoon weight (13.2 g) and longest filament length (1000 m). The findings emphasize the importance of regulated microclimates in enhancing silk traits, as stable temperature and humidity levels ensure efficient silk gland activity and uniform fibre deposition.

In contrast, cocoons from Chennur, reared in natural forest conditions during winter, experienced slightly higher temperatures (28 °C) and lower humidity (75%). While cocoon weight (10.88 g) and filament length (985 m) were marginally lower than those observed at Kakatiya University, the values still reflect favorable outcomes under semi-natural conditions. This suggests that natural forest environments can sustain good cocoon development, though they may lack the precision of managed plantations. The intermediate performance of Chennur cocoons demonstrates how subtle climatic variations can influence silk yield without drastically compromising quality.

The most striking differences were observed in Mahadevpur, where cocoons were reared in natural forests during the rainy season. The average temperature was higher (30 °C) and relative humidity reached 87%, creating a warm and excessively moist environment. Under these conditions, cocoon weight dropped significantly to 3.62 g, and filament length was reduced to 736 m. These results underscore the negative impact of high humidity and elevated temperatures on cocoon development, as excessive moisture disrupts fibre formation and reduces overall silk yield. Collectively, the data demonstrate that microclimatic regulation is critical for maximizing cocoon quality, with managed winter conditions producing superior results compared to natural rainy environments.

Table-1. Quantitative variation in silk traits across Telangana regions

Trait	Kakatiya University (KU)	Chennur	Mahadevpur
Cocoon Weight (g)	13.2	10.88	3.62
Shell Weight (g)	1.7	1.65	1.23
Filament Length (m)	1000	985	736
Reelability (%)	19.09%	20.43%	34.15%
Denier	9.08	9.09	9.12
Shell Ratio (%)	12.87%	15.21%	34.15%*

*Note: The Mahadevpur shell ratio is skewed by pupal desiccation caused by a significant time lapse between harvest and measurement, rather than a higher silk content.

Cocoons reared under controlled conditions at Warangal demonstrated superior developmental traits. They exhibited better cocoon formation, with enhanced shell deposition that contributed to stronger structural integrity. The fibre quality was also notably improved, as indicated by a lower denier, reflecting finer and more uniform silk threads suitable for high-quality textile production. In contrast, cocoons obtained from Mahadevpur during the rainy season, characterized by high humidity, showed reduced cocoon weight. However, these samples displayed relatively higher reelability, suggesting that despite lower mass, the silk could be unwound more efficiently, which is advantageous for certain reeling processes.

The samples collected from Chennur presented intermediate characteristics, balancing the traits observed in Warangal and Mahadevpur. Their performance highlighted the influence of

Table-2. Regional Microclimate vs. Quality

Site	Eco-Zone	Season	Avg Temp (°C)	Avg RH (%)	Cocoon Weight (g)	Filament Length (m)
Kakatiya University	Managed Plantation	Winter	27	78	13.2	1000
Chennur	Natural Forest	Winter	28	75	10.88	985
Mahadevpur	Natural Forest	Rainy	30	87	3.62	736

microclimatic variations on cocoon quality, with Chennur conditions producing results that were neither extreme nor deficient, but moderate across most parameters.

4. Discussion

The findings confirm that microclimatic conditions profoundly affect the post-cocoon traits of *A. mylitta*. Cooler, moderate humidity conditions at Kakatiya University favoured biomass accumulation and fiber quality, while higher temperature and humidity at Mahadevpur negatively impacted cocoon weight but enhanced reelability through pupal drying effects. These results highlight the importance of microclimate management and timing of cocoon harvest in optimizing silk yield.

Seri biotechnological approaches can leverage this information to develop microclimate-resilient silkworm strains, optimize host-plant selection and management, and refine rearing calendars tailored to local environmental conditions. Additionally, integrating environmental monitoring with simple decision-support tools can enable predictive management of cocoon quality, enhancing productivity and economic returns for tribal rearers.

Figure-3. Harvested Cacoons

The findings of the present study demonstrate that microclimate plays a crucial role in determining post-cocoon characteristics of *Antheraea mylitta*. Optimal temperature and moderate humidity conditions observed at Warangal contributed to better cocoon development and silk quality.

Higher humidity and temperature at Mahadevpur, especially during the rainy season, negatively affected cocoon weight but improved reelability due to drying effects associated with delayed harvesting. This indicates a complex interaction between environmental conditions and post-cocoon handling. The intermediate performance at Chennur further supports the idea that even slight variations in environmental factors can influence silkworm productivity.

These observations highlight the importance of controlled rearing conditions and the need for developing microclimate-based management strategies in tasar sericulture. These findings emphasize the importance of Microclimate management, Controlled rearing practices and Site-specific sericulture strategies.

Additionally, integrating environmental monitoring with simple decision-support tools can enable predictive management of cocoon quality, thereby enhancing productivity and economic returns for tribal rearers. These tools can incorporate real-time data on temperature, humidity, and other relevant microclimatic factors to provide actionable recommendations on optimal harvest times, pest management, and host plant care. Such integration not only aids in minimizing losses due to unfavourable environmental conditions but also supports adaptive management practices that respond dynamically to seasonal and climatic variability. Moreover, the development of user-friendly interfaces and mobile applications tailored for tribal communities can facilitate widespread adoption of these decision-support systems, empowering rearers with timely information to make informed decisions that improve cocoon quality and yield stability. The biotechnological perspective of this variation suggests that the metabolic rate of silk gland development is inhibited by high humidity (>85%) and high temperature (>30C).

Warangal (KU): The moderate temperature (27C) allows for a longer larval period, resulting in higher biomass and a massive 1000m filament.

Mahadevpur: The high humidity and rainy season environment likely increased the incidence of micro-pathogens or metabolic heat stress, leading to smaller cocoons. However, the high reelability here is a "handling artifact" caused by the drying of the pupa, which eases the cooking and reeling process

5. Conclusion

The study establishes that microclimate variation is a primary determinant of post-cocoon traits in *Antheraea mylitta*, directly impacting silk yield and fiber quality. Findings reveal that cooler, moderately humid conditions favor superior biomass accumulation, while higher temperatures and humidity though detrimental to cocoon weight can paradoxically enhance reelability through pupal desiccation. These results underscore the urgent need for Seri-biotechnological interventions, including the development of microclimate-resilient silkworm strains and the optimization of *Terminalia arjuna* management. By aligning rearing calendars with local climatic patterns and integrating environmental monitoring with predictive decision-support tools, sericulture can transition toward more stable and adaptive production models. Such site-specific management frameworks are essential for mitigating the risks of climate variability, ultimately ensuring higher quality silk yields, consistent income streams, and sustainable socio-economic upliftment for tribal communities reliant on tasar sericulture. This research provides a robust foundation for future breeding programs and strategic policy interventions in ecologically sensitive landscapes.

Competing interests:

The authors declare that they have no competing interests

Consent for Publication: Not applicable.

Availability of Data and Materials:

The datasets analyzed during the current study are available from the corresponding author upon reasonable request, subject toinstitutional and ethical regulations.

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