https://doi.org/10.17576/serangga-2025-3003-17

ASSESSMENT OF SILKWORM, *Bombyx mori* (LINNAEUS, 1758) EGG AND COCOON QUALITY AT THE SULAWESI SOCIAL FORESTRY AND ENVIRONMENTAL PARTNERSHIP CENTER, INDONESIA

Andi Sadapotto*, Sitti Nuraeni, Hasriani Hafit & Andi Prastiyo
Department of Forestry, Faculty of Forestry,
Universitas Hasanuddin,
90245 Makassar, Indonesia
*Corresponding author: *sadapotto@unhas.ac.id*

Received: 1 October 2024; Accepted: 13 November 2025; Published: 15 December 2025

ABSTRACT

The silkworm broodstock at the production center, strongly influences the quality of silk thread. Therefore, this research aims to determine the productivity and quality of cocoons in five silkworm races (*Bombyx mori* L.) at the Sulawesi Social Forestry and Environmental Partnership Center. Five treatments, based on silkworm type, were arranged using a Randomized Block Design (RBD) with three replications per treatment. Data were analysed using Analysis of Variance (ANOVA) and Principal Component Analysis (PCA). The results showed that the best productivity was found in the BN6 type of silkworm for egg hatchability with a percentage of 90.91±2.53%, AJ12 for young silkworm resistance with a rate of 97.98±0.44%, and BN16 for mature silkworm resistance with percentage 38.86±7.12%. Meanwhile, the best cocoon quality is found in the BC117 silkworm type, with the lowest defective cocoon at 3.12±2.21% and the highest cocoon shell at 18.87±0.83%, which is included in the class C cocoon quality range based on SNI 7635:2011 cocoon quality requirements. This research can serve as a basis for management to select the best types of broodstock as superior seeds, which can be developed to enhance the production and quality of silk thread in Indonesia.

Keywords: *Bombyx mori*; silkworm strains; cocoon quality; sericulture; superior broodstock

ABTRAK

Induk ulat sutera di pusat pengeluaran, secara dramatik mempengaruhi kualiti benang sutera. Oleh itu, kajian ini bertujuan untuk menentukan produktiviti dan kualiti kokon dalam lima jenis ulat sutera (*Bombyx mori* L.) di Pusat Perhutanan Sosial dan Perkongsian Alam Sekitar Sulawesi. Lima rawatan, berdasarkan jenis ulat sutera disusun menggunakan Reka Bentuk Sekat Rawak (RBD), dengan setiap rawatan mempunyai tiga ulangan. Analisis data menggunakan Analisis Varians (ANOVA) dan Analisis Komponen Utama (PCA). Hasil kajian menunjukkan produktiviti terbaik didapati pada ulat sutera jenis BN6 untuk kadar penetasan telur sebanyak 90.91±2.53%, AJ12 bagi rintangan ulat sutera muda dengan kadar 97.98±0.44%, dan BN16 bagi rintangan ulat sutera matang dengan peratusan 38.86. ±7.12%. Sementara itu, kualiti kokon terbaik terdapat pada jenis ulat sutera BC117, dengan kadar kokon rosak terendah sebanyak 3.12±2.21% dan nisbah selubung kokon tertinggi sebanyak 18.87±0.83%, yang diklasifikasikan sebagai kualiti kokon kelas C mengikut piawaian SNI 7635 (2011). Kajian ini boleh menjadi asas kepada pihak pengurusan untuk mendapatkan jenis induk yang terbaik sebagai benih unggul yang boleh dikembangkan untuk meningkatkan pengeluaran dan kualiti benang sutera di Indonesia.

Kata kunci: *Bombyx mori*; strain ulat sutera; kualiti kokon; serikultur; stok pembiakan unggul

INTRODUCTION

Silkworms are one of the non-timber forest products that have been produced on an industrial scale. Silkworms are insects that produce silk thread, which is renowed for its softness and beauty (Blamires 2022). Silk fiber is light, durable, has a beautiful luster, and is hygroscopic, allowing it to absorb moisture efficiently (Xing et al. 2023). Silkworms are insects from the Bombycidae group, namely butterflies whose cocoons are covered or wrapped with cocoons. Silkworm cocoons will then be further processed into raw material for silk thread.

In Southeast Asia, Indonesia has the potential to develop natural silk. The growth and development of silkworms and mulberry plants as food can grow well (Nath et al. 2023). South Sulawesi, particularly Soppeng and Gowa Regencies, is among Indonesia's main natural silk production. Until now, South Sulawesi is Indonesia's largest silk production area, but almost the entire natural silk trading system is still managed traditionally and on a small scale (Andadari et al. 2022). One institution providing silkworm seeds in South Sulawesi is the Sulawesi Social Forestry and Environmental Partnership Center, which monitors the production, distribution, and maintenance of silkworm eggs and mother seeds.

Sericulture have been taken seriously in Indonesia since 1950 to improve the welfare of communities around forests. Natural silk farming is labor intensive and includes agronomic, production, and industrial activities (Czaplicki et al. 2021). Agronomic activities include cultivating mulberries as feed for silkworms, production activities include providing silkworm seeds to harvest cocoons, and industrial activities include processing cocoons into the thread to weaving thread into silk cloth (Karthik & Rathinamoorthy 2017).

The economic value of sericulture originates from the use of silkworm cocoons as a source of silk fiber (Manjunath et al. 2020). Sericulture has strong economic potential due to high value and demand for silk fabric. However, this potential has not been matched by production levels. Indonesia can only meet the domestic supply of silk thread by 5% of the total demand of 900 tons/year, while 95% is imported from China (Widiarti et al. 2021).

Silkworm productivity refers to the ability of silkworms to produce silk thread of optimal quantity and quality under given cultivation conditions. This productivity is measured in various ways, including rearing quality, silkworm growth, environmental factors, life cycle time, and food availability. The productivity of reared silkworms is very dependent on the temperature and humidity of the environment (Sarkar 2018).

Efforts to improve silkworm productivity should focus on enhancing cocoon quality and survival rate. The biophysical conditions of the location also influence silkworm cultivation, especially temperature, humidity, air quality, airflow, and light (Zambrano-Gonzalez et al. 2023). Adequate food supply remains a crucial factor for successful rearing. The climate in Indonesia is ideal for efforts to develop and manage silkworm cultivation, this condition can increase productivity, and the quality of cocoons is good and on target. Apart from climate factors, land availability can support these development efforts. The level of success in cultivating silkworms is also inseparable from their food, namely mulberry plants (Singh & Ahmed 2017). If all influencing factors can be met, silkworm productivity will be significantly influenced (Giora et al. 2022).

Based on this, research was carried out on pure races with different characteristics, such as brood stock for cross breeding material for seeds for silk farmers. To increase cocoon production and quality, silkworm seeds are needed to produce high, suitable quality cocoons and adapt to conditions optimal for the growth and production of silkworms. Good management can increase productivity to support a sustainable silk industry (Fambayun et al. 2022; Trisuji et al. 2024). This research aims to determine the durability of silkworms and the quality of the cocoons of the silkworm, namely the race types BN6, BN16, BC117, AC29, and AJ12 at the Social Forestry and Environmental Partnership Center (BPSKL), Bili-Bili Village, Gowa Regency. This study seeks to guide the improvement of crossbreeding materials for higher-quality cocoons and silk fibers.

MATERIALS AND METHODS

Site Location and Study Design

This research was conducted at the Social Forestry and Environmental Partnership Center, Gowa Regency, South Sulawesi, Indonesia. The study involved five silkworm races, namely BN6, BN16, were evaluated to determine their productivity and cocoon quality. The best performing type can be used as a recommendation for silk farmers for alternative superior seeds. The experiment was arranged using the Randomized Block Design (RBD), with each treatment replicated three times.

Silkworm Rearing

Eggs are placed in folded paraffin paper in a 15x25 cm container. The container is stored in a maintenance area at room temperature and protected from the sun. The eggs that hatch were counted by marking the eggs. The eggs that have hatched into instar 1st silkworms were transferred to young silkworm rearing containers measuring 15x25 cm, which had been lined with paraffin paper and sprinkled with disinfectant (a mixture of lime and chlorine in a ratio of 95:5%). After being sprinkled with disinfectant, the instar 1st silkworms were fed with young mulberry leaves that had been finely chopped to a width of ±0.5 cm.

Silkworms were given food four times a day until instar 5th. For instar 2nd silkworms, the food provided is chopped mulberry leaves were chopped at the size of ±1.5 cm, while for instar 3rd silkworms, the mulberry leaves given were roughly chopped with a width of ±3 cm. In instar 4th, the silkworms were transferred to a sizeable silkworm rearing container measuring 50x50 cm coated with paraffin paper and then sprinkled with disinfectant. The number of 4th silkworms was calculated after being sprinkled with disinfectant at a dose of one gram for instar 1st, two grams for instar 2nd, and three grams for instar 3rd per 0.1 m^2.

Silkworm Cocooning

The silkworms were to the cocooning place for each treatment and count the number of silkworms that will cocoon were counted after ±5 days of cocooning, the cocoons were ready to be harvested. Normal and healthy cocoons were randomly selected from 10 cocoons for each treatment to calculate the weight of fresh cocoons, the weight of cocoons without pupae, the percentage of cocoon shells, and the percentage of cocoons.

Silkworm Productivity

Productivity is describes based on the hatchability, silkworm survival, and cocoon production. Factors such as the microclimate of a location can influence silkworm productivity (Ibragimov & Tokhirjonova 2023). Calculations related to silkworm productivity were as follows egg hatchability (1), endurance of young silkworm (2), and endurance of mature silkworm (3):

$$DS = \frac{NS}{NB} \ x\ 100\% \quad (1)$$

Where DS is hatchability/fertility (%), NS is number of eggs hatched, and NB is number of fertilized eggs.

$$DK = \frac{N3}{Ns} \ x\ 100\% \quad (2)$$

Where DK is the resistance of young silkworms or instar $1^{st} – 3^{rd}$ silkworms (%), N3 is number of instar 3^{rd} silkworms, and NS is number of eggs hatched.

$$DB = \frac{Nm}{N5} \ x\ 100\% \quad (3)$$

Where DB is the endurance of mature silkworms or instar 4^{th} – 5^{th} silkworms (%), Nm is number of cocoon silkworms, and N5 is number of early instar 5^{th} silkworms.

Cocoon Quality

The quality of cocoons is divided into classes A, B, C, and D based on the parameters tested, namely cocoon weight (g), percentage of cocoon shells (%), and defective cocoons (%) (Hafit 2024). The quality of the cocoon determines the thread fiber that will be produced as raw material in making silk cloth (Sadapotto et al. 2024). Calculation of the percentage of cocoon shells and defective cocoons can be done as follows deformed cocoons (4), and cocoon shell (5):

$$KC = \frac{Nc}{Nm} \ x\ 100\% \quad (4)$$

Where KC is defective cocoon (%), Nc is number of defective cocoons, and Nm is the number of cocoon silkworms.

$$KK = \frac{Wtp}{Ws} \ x\ 100\% \quad (5)$$

Where KK is the cocoon shell (%), Wtp is the weight of cocoons without pupae, and Ws is the weight of fresh cocoons.

Data Analysis

The research data would be tabulated in Microsoft Excel 2016 and then analyzed using Analysis of Variance (ANOVA). The research results would be analyzed using Principal Component Analysis (PCA) with XLSTAT to see the relationship between each variable. Standards for cocoon quality have been set in Indonesia. Cocoon quality class A is the best compared to D, which is not so good. Requirements for cocoon quality classification based on SNI 7635 (2011) standards.

RESULTS

Productivity of the Silkworm

For more details, the productivity of the silkworm can be seen in Table 1. Under optimal conditions, the hatchability of silkworm eggs can reach a high level of success, often reaching 80-90% or even higher. The research results on the hatchability of eggs in all the species studied showed that these five breeds were successful in hatching. ANOVA results indicated that egg hatchability was highest in the BN6 type (90.91±2.53%) and lowest in the BC117 type (42.95±19.40%) ($P<0.05$).

Table 1. Productivity of five silkworm types

Productivity	Types of Silkworm (%)				
	BN6	BN16	BC117	AJ12	AC29
Egg hatchability*	90.91 ± 2.53^{c}	61.05 ± 20.36^{ab}	42.95 ± 19.40^{a}	68.41 ± 5.65^{abc}	58.16 ± 2.20^{ab}
The endurance of young silkworms	97.60±0.51	97.78±1.63	64.88±3.79	97.98±0.44	64.49±1.01
The endurance of mature silkworm*	29.83 ± 14.42^{a}	38.86 ± 7.12^{a}	32.17 ± 12.70^{ab}	20.77 ± 5.25^{a}	34.75 ± 50.64^{ab}

Note: The (*) on each line indicates a significant effect at the P value <0.05. numbers followed by the same letter on the same line indicate no significant difference.

The results showed that the percentage of resistance of young silkworms from instars 1^{st} – 3^{rd} of the AJ12 race had the strongest resistance with a percentage of 97.98±0.44%, and the resistance of young silkworms was the lowest in the AC29 race with a percentage of 64.49±1 .01%. Meanwhile, the resistance of mature silkworms from instars 4th – 5th was highest in the BN16 type with a percentage of 38.86±7.12%, and the lowest was in the AJ12 type with a percentage of 20. 77±5.25%.

Cocoon Quality

The quality of the cocoons can be seen in Table 2, where the quality of the cocoons would be classified based on SNI 7635 (2011). The analysis of variance showed that the lowest percentage of defective cocoons was found in the BC117 type with a percentage of 3.12±2.21%. The size cocoon weight is the AJ12 type with a weight of 0.96±0.03 g. Meanwhile, the highest percentage of cocoon skin was found in the BC117 type with a percentage of 18.87±0.83%. The best cocoon quality from the research results is the BC117 type, which is in class C, followed by the BN6 type in class C, too and the rest are in class D cocoon quality.

Table 2. Cocoon quality in five types of silkworms

Silkworm	Deformed Cocoon (%)	Cocoon Weight (g)	Cocoon Shell (%)	Class
BN6	6.95±2.78	0.76±0.03	17.8±0.87	C
BN16	9.32±3.60	0.80±0.15	15.89±0.84	D
BC117	3.12±2.21	0.74±0.06	18.87±0.83	C
AJ12	8.94±1.23	0.96±0.03	17.15±1.04	D
AC29	8.92±3.49	0.77±0.05	15.58±0.84	D

The quality of cocoons in all breeds still needs to be improved to obtain superior cocoon quality. The observation results regarding the cocoon shell variable showed that the average percentage of cocoon shells was highest to lowest, starting from types BC117, BN6, AJ12, BN16, and AC29. The quality the weight of the cocoon shell produced, the higher the silk fiber produced (Banale 2017). Lower quality cocoons produce less silk fiber (Cheng et al. 2018).

Based on the productivity of silkworms and the quality of the cocoons produced by the five races of silkworms, each type can be grouped with the closeness between the AJ12 and BN16 types, followed by BN6. Then, in different groups, there are AC29 and BC117 in the same group. The relationship between the five types of silkworms studied based on productivity and cocoon quality can be seen in more detail in Figure 1. Mulberry leaves with good nutrition will increase the resistance of silkworms to disease attacks and increase the production of more cocoons (Mahadeva 2018).

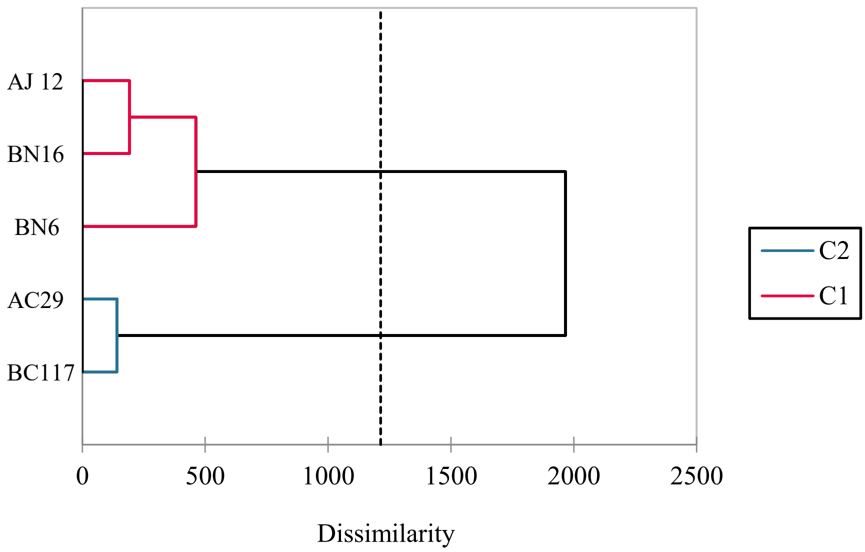

Figure 1. Dendrogram of five types of silkworms

In the analysis of PCA, the results showed that the silkworm types BC117 and BN16 are close to the resistance of mature silkworms. The types AC29, AJ12, and BN6 are closely related to egg hatchability. This can, of course, be influenced by environmental and human factors. The biophysical conditions of the location also influence silkworm cultivation, especially air temperature and humidity (Ram et al. 2016). Cleaning of silkworm areas and preventing pests and diseases must be done regularly (Tayal & Chauhan 2017).

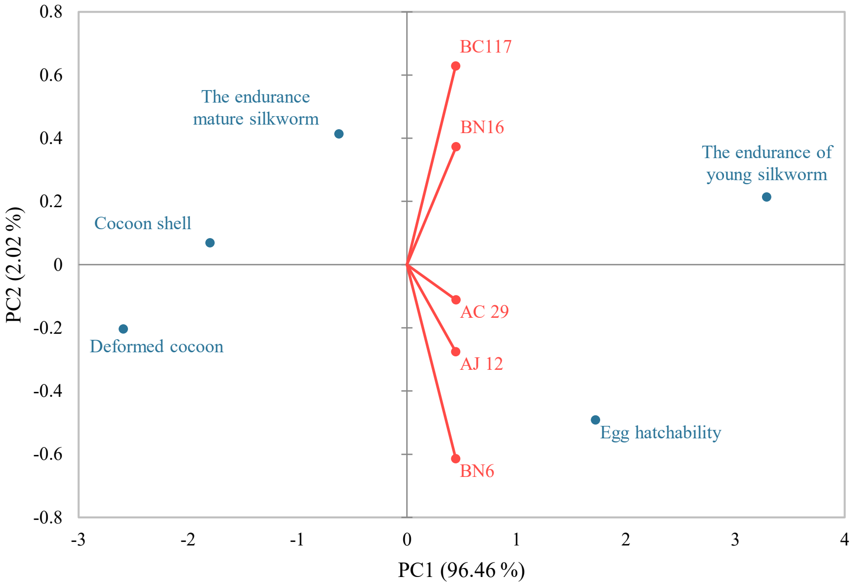

Figure 2. PCA analysis of the correlation between productivity and cocoon quality

DISCUSSION

This study demonstrated significant differences in productivity and cocoon quality among five silkworm races, with BC117 and BN6 showing superior cocoon characteristics. The silkworm rearing room's temperature and humidity greatly influence silkworm development (Gupta & Dubey 2021). Apart from the conditions of the rearing room, mulberry food sources are very much needed in the rearing process. In this context, hybrid mulberry cultivars with high leaf yield (Samami et al. 2019) may enhance feed availability, thereby improving cocoon yield and silkworm survival as observed in the BN6 and BC117 types. Young silkworms have more vulnerable resistance (Hu et al. 2023). The high hatchability of silkworms greatly influenced by the optimal temperature and humidity for embryo development which can affect the hatchability of silkworm eggs (Islam 2021). The quality of silkworms is related to the quality of silkworm egg seeds because they have the same parameters, namely the hatching percentage (Andadari et al. 2023). A high hatching percentage is significant and is a benchmark in determining the quality of silkworm egg seeds (Nuraeni et al. 2021). The success of silkworm rearing is influenced by many factors, including the quality and quantity of mulberry leaves, type of seed, and maintenance techniques (Tayal & Chauhan 2017).

The results of the research showed that the highest percentage of survival of mature silkworms was in the BN16 type with a percentage of 38.86±7.12% and the lowest was in the AJ12 type with 20.77±5.25% (Table 1). According to Borah & Boro (2020), mature silkworms require more food than younger silkworms due to higher metabolic demands associated with rapid growth and silk gland development, which impacts their survival rate. In our study, we observed that insufficient feeding or suboptimal conditions led to lower survival in mature silkworms compared to younger ones. Environmental conditions and treatment for mature silkworms are different from those for young silkworms. A suitable room temperature was 24-26° C with a humidity of 85-90% (Doloi et al. 2019).

The notably low defective cocoon rate in BC117 indicates its genetic potential for superior cocoon uniformity, while BN16's higher defect rate suggests environmental or handling stress during cocooning. The quality of cocoons is divided into classes A, B, C, and D based on the weight of the cocoon. By observing the percentage of defective cocoons (Table 1), which are included in class C, namely cocoons of types BC117 and BN6, while in class D they are types BN16, AC29 and AJ12. This is because, during the cocooning period, there are larvae that die during the cocooning process due to intolerance to the temperature and humidity in the rearing environment, so the cocooning process is not good. Only cocoons meeting minimum quality standards are suitable for reeling into silk thread (Babu 2018), highlighting the importance of seed selection for industrial viability. The quality of the cocoons is very influential on the silk thread produced (Sobirov et al. 2021).

The results of the weighing test of fresh cocoon weight samples obtained from each silkworm, the silkworm types (BN6, BN16, BC117, AC29, and AJ12) of these five types were successful in cocooning. Among all types, AJ12 cocoons exhibited the highest mean weight, whereas BC117 produced lighter but structurally superior cocoons. Several factors that influence the failure to form cocoons include genetic factors, namely the ability to withstand rearing environmental conditions and technical rearing management factors that significantly affect the weight of fresh cocoons produced. Temperature and humidity that are not within the silkworm's tolerance range will cause the silkworm to lack appetite, and lack of food will cause the silkworm to be susceptible to disease (Mallikarjuna & Balasaraswathi 2023).

CONCLUSION

Among the five silkworm races evaluated, AJ12 showed the highest endurance, with a young silkworm survival rate of 97.98 ± 0.44% during the 1st–3rd instars, while BN16 had the lowest (38.86±7.12%). Conversely, BN16 showed stronger endurance during later instars, indicating race-specific physiological adaptability. The lowest percentage of deformed cocoons was type BC117 (3.12±2.21%) in class B, the highest cocoon weight was in type AJ12 (0.96±0.03 g) in class D, and the highest percentage of cocoon skin was type BC117 (18.87±0.83%) in class C. The type of seed that farmers should keep is the best of the five seeds, namely the BC117 type.

ACKNOWLEDGMENT

Thanks to the Forest Protection and Insect Laboratory. Thank you also to the Bili-Bili Social Forestry and Environmental Partnership Center, Gowa Regency, South Sulawesi, Indonesia.

AUTHOR DECLARATION

Funding Statement
This research did not receive any form of funding.

Conflict of Interest
The authors declare no conflict of interest.

Data Availability Statement
The data supporting this study are available from the corresponding author upon reasonable request.

Authors' Contributions
The experiment was conducted by AS and HH. The data analysis was performed by AP. The initial draft was performed by HH, SN, and AP. AS, SN, and AS reviewed and finalized the manuscript. All of the authors read and approved the final version of the manuscript.

REFERENCES

Andadari, L., Heryati, Y., Agustarini, R., Sari, H. & Mulyati, E. 2023. Comparison of the Eggs and Cocoons Quality of Some Mulberry Silkworm Hybrid Bombyx mori L. *Jurnal Sylva Lestari* 11(2): 236-246.

Andadari, L., Yuniati, D., Supriyanto, B., Suharti, S., Widarti, A., Steven, E., et al. 2022. Lens on tropical sericulture development in Indonesia: recent status and future directions for industry and social forestry. *Insects* 13(10): 1-25.

Babu, K.M. 2018. *Silk: Processing, Properties and Applications*. Cambridge: Woodhead Publishing.

Banale, A.K. 2017. Investigation of properties of silk fiber produced in Ethiopia. *Journal of Materials* 2017(1): 1-5.

Blamires, S. 2022. *Silk: Exploring Nature's Superfibre*. Indiana: Xlibris Corporation.

Borah, S.D. & Boro, P. 2020. A review of nutrition and its impact on silkworm. *Journal of Entomology and Zoology Studies* 8(3): 1921-1925.

Cheng, L., Tong, X., Li, Z., Liu, Z., Huang, H., Zhao, H. & Dai, F. 2018. Natural silkworm cocoon composites with high strength and stiffness constructed in confined cocooning space. *Polymers* 10(11): 1-13.

Czaplicki, Z., Gliścińska, E. & Machnowski, W. 2021. Natural Silk-an Unusual Fibre: Origin, Processing and World Production. *Fibres & Textiles in Eastern Europe* 29(149): 1-28.

Doloi, A., Barkataki, N., Saikia, M. & Saikia, D. 2019. Development of a wireless sensor network based smart multiple ambient conditions sensing system for the rearing process of eri silkworm. *International Journal of Advanced Technology and Engineering Exploration* 6(52): 50-60.

Fambayun, R.A., Agustarini, R. & Andadari, L. 2022. Cultivation and breeding techniques for increase silk productivity in Indonesia. *IOP Conference Series: Earth and Environmental Science* 995(1): 1-8.

Giora, D., Marchetti, G., Cappellozza, S., Assirelli, A., Saviane, A., Sartori, L. & Marinello, F. 2022. Bibliometric analysis of trends in mulberry and silkworm research on the production of silk and its by-products. *Insects* 13(7): 1-19.

Gupta, S. K. & Dubey, R. K. 2021. Environmental factors and rearing techniques affecting the rearing of silkworm and cocoon production of *Bombyx mori* Linn. *Acta Entomology and Zoology* 2(2): 62-67.

Hafit, H. 2024. Perbandingan produktivitas sepuluh ras ulat sutera (*Bombyx mori* Linnaeus) di Balai Perhutanan Sosial dan Kemitraan Lingkungan (BPSKL) Bili-Bili Kabupaten Gowa. Thesis, Universitas Hasanuddin, Makassar.

Hu, Z., Zhu, F. & Chen, K. 2023. The mechanisms of silkworm resistance to the baculovirus and antiviral breeding. *Annual Review of Entomology* 68(1): 381-399.

Ibragimov, A. & Tokhirjonova, M. 2023. The impact of microclimate factors on silk thickness uniformity and optimal control through a mechatronic system. *The American Journal of Applied Sciences* 5(6): 17-22.

Islam, M.S. 2021. Temperature and relative humidity-mediated immature development and adult emergence in the mulberry silkworm *Bombyx mori* L. *Available at SSRN* 118: 50852-50856.

Karthik, T. & Rathinamoorthy, R. 2017. Sustainable silk production. In. Subramanian, S.M. (ed.). *Sustainable Fibres and Textiles*, pp. 135-170. Coimbatore, India: Woodhead Publishing.

Mahadeva, A. 2018. Insect pest infestation, an obstacle in quality mulberry leaves production. *Asian Journal of Biological and Life Sciences* 11: 41-52.

Mallikarjuna, G. & Balasaraswathi, S. 2023. Mulberry silk insect. In. Omkar (ed.). *Commercial Insects*, pp. 17-48. United States: CRC Press.

Manjunath, R.N., Kumar, A. & Kumar, A.K.P. 2020. Utilisation of sericulture waste by employing possible approaches. *Contaminants in Agriculture: Sources, Impacts and Management* 1: 385-398.

Nath, I., Dutta, P.J.L., Gadge, A.S. & Narzary, P.R. 2023. Role of plant extracts on growth and development of mulberry and non-mulberry silkworms. *Sci World* 3(4): 494-501.

Nuraeni, S., Latif, N., Prastiyo, A., Nurfausiah & Armidha, N. 2021. A mixture of red kidney beans (*Phaseolus vulgaris* L.) and bee bread of honey bees (*Wallacetrigona incise*) as artificial feed for silkworm (*Bombyx mori* L.). *IOP Conference Series: Earth and Environmental Science* 886(1): 1-8.

Ram, R.L., Maji, C. & Bindroo, B.B. 2016. Impact of climate change on sustainable sericultural development in India. *International Journal of Agriculture Innovations and Research* 4(6): 1110-1118.

Sadapotto, A., Prastiyo, A., Nuraeni, S. & Irfan, M. 2024. Effect of cleaning frequency of silkworm rearing sites on silkworm durability and cocoon quality. *International Journal of Agriculture & Biology* 32: 633–638.

Samami, R., Seidavi, A., Eila, N., Moarefi, M., Ziaja, D.J., Lis, J.A., et al. 2019. Production performance and economic traits of silkworms (*Bombyx mori* L., 1758) fed with mulberry tree leaves (Morus alba, var. Ichinose) significantly differ according to hybrid lines. *Livestock Science* 226: 133-137.

Sarkar, K. 2018. Management of nutritional and climatic factors for silkworm rearing in West Bengal: A review. *International Journal of Agriculture, Environment and Biotechnology* 11(5): 769-780.

SNI 7635:2011. 2011. *Kokon Segar Jenis Bombyx mori* L. Jakarta: Badan Standarisasi Nasional. [Indonesian].

Singh, B.K. & Ahmed, S.A. 2017. Sericulture. *Industrial Entomology* 1: 345-370.

Sobirov, Q.E., Mardonov, B.M., Akhmedov, J.A., Ermatov, S.Q. & Umurzakova, K.K. 2021. Investigation of the process of removing the thread from the surface of the cocoon in an aquatic environment. *Journal of Physics: Conference Series* 1889(4): 1-9.

Tayal, M.K. & Chauhan, T.P.S. 2017. Silkworm diseases and pests. *Industrial entomology* 1: 265-289.

Trisuji, R.M., Atmowidi, T., Priawandiputra, W. & Endrawati, Y.C. 2024. Evaluation of growth and silk quality produced by *Samia cynthia ricini* (Lepidoptera: Saturniidae) fed different leaves. *Serangga* 29(1): 95-107.

Widiarti, A., Andadari, L., Suharti, S., Heryati, Y., Yuniati, D. & Agustarini, R. 2021. Partnership model for sericulture development to improve farmer's welfare (A case study at Bina Mandiri Farmer Group at Sukabumi Regency). *IOP Conference Series: Earth and Environmental Science* 917(1): 1-13.

Xing, T., He, A., Huang, Z., Luo, Y., Zhang, Y., Wang, M., et al. 2023. Silk-based flexible electronics and smart wearable Textiles: Progress and beyond. *Chemical Engineering Journal* 474: 1-27.

Zambrano-González, G., Almanza, M., Velez, M. & Ruiz-Erazo, X. 2023. Effect of environmental conditions on the changes of voltinism in three lines of *Bombyx mori*. *Anais da Academia Brasileira de Ciências* 95(1): 1-15.