e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

Conditions of Sericulture Climate Typology in Soppeng District, South Sulawesi, Indonesia

Lutfi Halide[1], Sitti Nurani Sirajuddin[2], Eymal B. Demmalinno[3], Andi Sadapotto[4♥], and Nurul Magfirah Ashar[3]

[1]Students of the Environmental Science Doctoral Program, Graduate School, Hasanuddin University, Makassar, Indonesia
[2]Animal husbandry study program, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia
[3]Agribusiness study program, Faculty of Agriculture, Hasanuddin University, Makassar, Indonesia
[4]Forestry study program, Faculty of Forestry, Hasanuddin University, Makassar, Indonesia

♥Corresponding author email: sadapotto@unhas.ac.id

Article history: submitted: February 3, 2025; accepted: July 1, 2025; available online: July 30, 2025

Abstract. Sericulture requires a special typology, and it is important to pay attention to it because certain climatic conditions are considered. This research focuses on the climate typology of mulberry cultivation and silkworm cultivation in Soppeng Regency, which can support the sustainability of local sericulture. The research was conducted in the Soppeng Regency between October and December 2023. The data used was primary data originating from in-depth interviews with informants and also secondary data in the form of rainfall, temperature, humidity, etc. obtained from Portal National Aeronautics and Space Administration (NASA) which can be accessed through the site https://power.larc.nasa.gov/data-access-viewer/, Meteorology, Climatology and Geophysics Agency (BMKG) accessed via the page https://www.bmkg.go.id/ And World Meteorological Organization (WMO) through the site https://library.wmo.int/idurl/4/69061 and processed using descriptive techniques. The research results showed that the land area of Soppeng Regency is ± 700 km^2, at an average height of ± 60 meters above sea level, and temperature conditions range from 20.5-34.6 degrees Celsius, with air pressure between 1,003.6-1,014.3 millibars, while maximum rainfall is 982.1 mm. In addition to the condition of human resources, silk farmers have in-depth experience with silk cultivation. Thus, this typology supports the sustainability and success of the development of sericulture in the Soppeng Regency.

Keywords: climate; ecology; mulberries; silkworms

INTRODUCTION

Sericulture, the cultivation of silkworms for silk production, is significantly influenced by the climate typology. Rainfall is one of the limiting factors that determine soil quality because soil contains important elements as a land resource that must be maintained due to its role in supporting agricultural activities. Low rainfall is the cause of poor soil quality in the agricultural production process (Sumarniasih et al., 2023). Therefore, soil conservation measures are urgently needed to improve the affected land, prevent erosion, and increase soil productivity. The main option is vegetative soil conservation, where plants are used as a tool to reduce erosion and protect the soil from the kinetic energy of rainwater (Sidabutar et al., 2023).

Several studies have identified a relationship between climatic factors and silkworm productivity, including cocoon quality and silk yield (Bhat et al., 2024; Ram et al., 2016). Some studies have also attempted to classify cultivation areas based on agroclimatic suitability using zoning or spatial modeling approaches. However, most of these studies remain limited to macroclimatic approaches, without considering local climate typologies (microclimates) and long-term climate change, which may affect the adaptability of specific silkworm strains. Moreover, in Indonesia, there is a lack of research specifically examining the ideal climate typologies for sericulture development based on integrated climatological and ecological data. Therefore, there is a research gap in

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

mapping microclimatic typologies suitable for sericulture, particularly in providing a scientific basis for long-term decision-making and adaptation strategies in response to climate change. This research is crucial for strengthening evidence-based planning for the sustainable development of sericulture centers.

Silkworm (*Bombyx mori L.*) can be classified based on the area of origin, the number of generations each year, the number of molts during the larval stage and based on the color of the cocoon (Hartati, 2015). Hartati (2015) explains that the potential need for silk cocoons in Indonesia as raw material for making silk thread is very high, this is proven by the use of silk thread in the weaving industry, which still depends on imports from China, which are intended to produce silk thread as raw material for textiles (silk fabrics).

The silk fabric agricultural industry has become one of the most important home industries in a number of countries such as China, Japan, India, Korea, Russia, Italy and France. Today, China and India are the two main producers, together producing more than sixty percent (60%) of the world's total production annually. The silk road started from Xian in China's Shanxi Province to the Mediterranean Coast, namely the meeting point of the European and African continents, covering a distance of around 7,000 km. It is known as the Silk Road because it is the main luxury trade item that is always available, in addition to gold, gems, and spices. Indonesia knows silk through maritime silk route trade (Chen RuiTing et al., 2019). IASBABA (2023) states that the main factors that make China a major producer are:

a. Local climatic and industrial conditions. Temperate and tropical climate conditions with high rainfall are very suitable for the growth of univoltine, bivoltine and polyvoltine silkworm varieties
b. Technology. Chinese scientists have succeeded in developing a variety of hybrid varieties derived from crossing European and Japanese silkworm races which make it possible to maintain them seven times a year.
c. Labor. China was the first country to have a sufficient abundance of natural resources.
d. Innovative practice. China has begun integrating sericulture with fish farming (silk worm rearing waste becomes fish food).
e. Government support. Chinese sericulture developed through cooperatives (*commune silk*) so that production is guaranteed to be efficient and meets standards compared to the individual farmer system, including the rearing of small caterpillars. The Chinese government also provides incentives such as training, project priorities, land acquisition policies, energy subsidies, tax breaks, and so on.
f. Better export promotion policies with return on investment and quality protection have kept confidence in Chinese silk high.

Mulberry has different growth rates in various regions of Indonesia. Mulberry growth in West Java was the best compared to that of mulberry in Bali and Kalimantan (Sasmita et al., 2019). In the scale of silk product trade in Indonesia, the demand for silk agricultural products (sericulture), especially silk fabrics, tends to increase, with an average increase in demand per year of ten point five percent (10.5%). South Sulawesi Province has an average production of 25.59 kg of cocoons/boxes of silkworm seeds, or the equivalent of 3.66 kg of silk thread (Sadapotto et al., 2021). The fact that the progress and development of the sericulture textile industry in Indonesia can be felt in real life is one of the main reasons why innovation and research play an important role in supporting and even sharpening the progress of the silk fabric product industry.

This study focuses on the sustainability of the development of silk commodities. Apart from the fact that this commodity is currently one of the main programs of the

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

South Sulawesi Provincial Government, the development of silk commodities has a long value chain involving multiple sectors and has comprehensive benefits. This is beneficial not only for the continued economic development of the community but also for environmental sustainability. Typological conditions that support the success of sericulture are based on ecological conditions, namely temperature, humidity, air quality, air flow, and light.

METHODS

This research was conducted in Soppeng Regency between October and December 2023. The location was chosen deliberately (*purposive*) based on the consideration that the Soppeng district is a center for mulberry cultivation and rearing of silk worms that produce silk thread. Primary and secondary data were used in this research. Primary data included all data collected from the original sources obtained through informant interviews. Meanwhile, secondary data is in the form of rainfall, temperature, humidity, and so on obtained from *Portal National Aeronautics and Space Administration* (NASA), which can be accessed through the site https://power.larc.nasa.gov/data-access-viewer/, Meteorology, Climatology and Geophysics Agency (BMKG) accessed via the page https://www.bmkg.go.id/ and *World Meteorological Organization (*WMO) through the site https://library.wmo.int/idurl/4/69061. In addition, other supporting data are used in the form of journals, articles, books, research reports, and other sources.

The participants in this study were mulberry and silkworm farmers. There were 15 participants in the study. The informants were selected using a deterministic approach in the form of purposive sampling, considering they were the main actors in mulberry and silkworm production and had in-depth experience and knowledge regarding sericulture in Soppeng Regency. The data collection method used in this research consisted of: Observation (*participant observation*). This type of participant observation aims to obtain straightforward and clear data regarding the ecological typology of sericulture in the form of mulberry and silkworm cultivation in Soppeng Regency. Interview (*in-depth interview*) and documentation (*documentation*) to view and archive the ecological conditions of mulberries and silkworms in Soppeng Regency. Both primary and secondary data were processed using descriptive techniques. To ensure data validity, we consulted two subject matter experts, conducting in-depth interviews and obtaining a thorough survey review. The reliability of the survey questions was confirmed through Cronbach's alpha test, and the results surpassed the recommended standards, demonstrating the high reliability of our measures.

RESULTS AND DISCUSSION

Climatic Conditions of Mulberry Plants

Temperatures in Soppeng Regency range from 20.5-34.6 degrees Celsius with air pressure between 1,003.6-1,014.3 millibars. Meanwhile, the maximum rainfall was 982.1 mm in December 2022 with the highest number of rainy days being 30 days (BPS Soppeng Regency, 2023).

Mulberry is an adaptable plant that grows in tropical and subtropical regions. Mulberry plants grow well in the highlands and lowlands and require sufficient sunlight. Mulberry plants are widespread throughout the world and can survive in various climatic conditions, such as tropical, subtropical, and temperate climates. Therefore, the mulberry tree can be considered a universal plant because it can grow anywhere in all different climatic conditions. (Datta et al., 2016; Singhal et al., 2010).

Mulberry plants can grow well in various soil types, with an altitude of 300-800 m above sea level, good aeration and drainage, and a minimum soil solum of 50 cm. Mulberry plants require full sunlight from morning to evening. Rainfall between 635-2500 mm/year, temperature 230 °C - 300 °C, air humidity 65-68% (Duke, 2001)

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

Mulberries thrive in various climatic conditions, ranging from temperate to tropical, located north of the equator, between latitudes 28° N and 55° N. The ideal temperature range is 24–28°C. Mulberry grows well in places with annual rainfall ranging from 600 to 2,500 mm. In areas with low rainfall, growth is stunted owing to moisture stress, resulting in low yields. On average, mulberry requires 340m 3 /ha of water every ten days on clay soils and 15 days on loamy soils. Atmospheric humidity in the range of 65-80 percent is ideal for mulberry growth. Sunlight is an important factor in controlling leaf growth and quality. In tropical areas, mulberries grow in a range of nine–13 h of sunlight per day. Mulberries can be cultivated from sea level to a height of 1,000 m. Mulberries thrive in flat, deep, fertile, well-drained, loamy to loamy, and porous soils with good moisture-holding capacity. The ideal soil pH range was 6.2 to 6.8, and the optimal pH range was 6.5 to 6.8. Soil amendments can be used to improve the soil to obtain the required pH. Mulberries thrive in flat, deep, fertile, well-drained, loamy to loamy, and porous soils with good moisture-holding capacity. The ideal soil pH range was 6.2 to 6.8. Mulberries can be grown in saline, alkaline, or acidic soils after appropriate soil amendments.

This crop can be cultivated in various land forms, for example, mountains, plains, and valleys, under rain-fed and irrigated conditions (Srivastava et al., 2015) and also under harsh conditions in humid and semi-arid lands, with varied cultivation modes (shrub, dwarf, and tree). It has the highest impact in environmental protection through ecorestoration of degraded land, bioremediation of polluted sites, air purification through carbon sequestration and soil and water conservation through a network of deep-rooted root systems (Jian et al., 2012; Wang & Huang, 2024).

The mulberry plant with its characteristic perennial and woody nature with a root system that spreads deep and wide (Vijayan & Chatterjee, 2003) and high biomass production is more suitable and adopted for planting in environments contaminated with various soil pollutants including heavy metals. such as lead, cadmium and copper (PV et al., 2019; Zhou et al., 2015). Mulberry plants planted as trees are more suitable for water and soil conservation (Du et al., 2008). This plant species is also very suitable for removing gaseous carbon pollutants from the atmosphere through a high level of carbon absorption process (Lu et al., 2015).

Mulberry also grows well in land disturbed by waterlogging conditions, under drought stress, and salinity conditions (Han et al., 2017; Vijayan & Chatterjee, 2003), This is mainly due to its deeper and wider root system and its ability to wider adaptation in arid and semi-arid areas with varying soil pH conditions (Dai et al., 2009). Mulberries have the ability to grow even in barren soil with less nutrients (Han et al., 2017) and in poor environmental conditions with cold temperatures of −30 °C to high temperatures above 40 °C (Zhao et al., 2009). Mulberries thrive under climatic conditions ranging from temperate to tropical, located north of the equator between latitudes 28° N and 55° N. The ideal temperature range is 24–28° C.

The growth conditions of mulberries in Soppeng Regency are strongly supported by the ecological conditions of the Soppeng Regency. Soppeng Regency is one of the districts in South Sulawesi Province whose capital is Watansoppeng with a district area of 1,500 km^2. The geographical location of Soppeng Regency is at coordinates 40 06' 00" - 40 32' 00" South Latitude and 1190 47' 18" - 1200 06' 13" East Longitude. The Soppeng Regency area is located on the depreciation of the Walanae River which consists of land and hills. The land area is ± 700 km^2 and is at an average height of ± 60 meters above sea level. Hills covering an area of ±800 km^2 are at an average altitude of ± 200 meters above sea level. Meanwhile, the capital city of Watansoppeng is at an altitude of ± 120 meters above sea level. These topographic conditions have the potential for a number of community economic activities such as

 e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

agriculture, fisheries, plantations, residential land use and other socio-economic infrastructure.

The current area of mulberry land in the two mulberry production centers of South Sulawesi is 65.2 Ha, with 80.6 percent of it in Soppeng Regency (Ashar et al., 2024). With this total area of mulberry land, the potential for mulberry production in Soppeng Regency is of great value. This could also provide the potential for increased silk production because the silkworm's food needs are met. Mulberry growth conditions at the research location can be seen in Figure 1.

Figure 1. Condition of mulberry plants at the research location

Ecological Conditions of Silkworms

For the success of cultivating sericulture, several main factors need to be considered from the start. There are 3 (three) main components in the maintenance plan, namely the number of mulberry leaves, labor and maintenance facilities. The number of caterpillars to be reared is determined based on the total number of leaves that can be harvested. Good caterpillar maintenance requires the following: 1) Selected hybrid eggs; 2) Regulate environmental conditions so that caterpillars can grow comfortably; 3) Good foliar feeding; and 4) Avoiding disease by disinfecting the caterpillar room and equipment (Sadapotto et al., 2021).

For silkworm maintenance, the growth of silkworms is greatly influenced by the climatic conditions at the maintenance location, namely temperature, humidity, air quality, air flow, light, and so on. Silkworms can grow optimally at an environmental temperature of 23-28 ºC and humidity of 80-90%. Mulberry silkworm (*Bombyx mori L.*) is very delicate, very sensitive to environmental fluctuations, and unable to withstand extreme natural fluctuations in temperature and humidity due to its long domestication since 5000 years. Thus, the adaptability of silkworms to environmental conditions is very different from that of wild silkworms and other insects. Temperature, humidity, air circulation, gas, light, and so on, show significant interaction effects on silkworm physiology depending on the combination of factors and developmental stages that influence growth, development, productivity, and silk quality.

Temperature plays an important role in the growth of silkworms. Because silkworms are cold-blooded animals, temperature will have a direct effect on various physiological activities. In general, early instar larvae are resistant to high temperatures, which helps increase cocoon survival and character. Temperature has a direct correlation with silkworm growth; Wide temperature fluctuations are dangerous for the development of silkworms. An increase in temperature will increase various physiological functions, and if the temperature decreases, physiological activity will decrease. Increasing temperature during silkworm rearing, especially in the final

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

instar, accelerates larval growth and shortens the larval period. On the other hand, at low temperatures, growth is slow and the larval period is long. The optimum temperature for normal growth of silkworms is between 20°C and 28°C and the desired temperature for maximum productivity ranges from 23°C to 28°C. Temperatures above 30°C directly affect the health of worms. If the temperature is below 20°C all physiological activities are inhibited, especially in early instars; As a result, the worms become too weak and are easily attacked by various diseases

Silkworms are photosensitive and tend to crawl towards dim light. They don't like bright light or complete darkness. Keeping silkworms in continuous light conditions will slow down their growth. Furthermore, this causes pentamoulter and reduces the weight of larvae and pupae. Silkworms prefer dim light of 15 to 20 lux and avoid bright light and darkness. Older worms can survive better in periods of 16 hours of light and 8 hours of darkness. However, young worms prefer a dark period of 16 hours and a light period of 8 hours. Silkworm larvae do not like bright light or complete darkness but usually the light phase, in contrast to the dark phase, activates the larvae. Rearing in complete darkness or in bright light causes irregular growth and molting. The light phase usually makes the larvae last longer than the dark phase.

Silkworms can grow optimally at an environmental temperature of 23-25 ºC and humidity of 80-90%. If kept in a hotter temperature environment, productivity will decrease because silkworms are cold-blooded animals (*poikilotherm*). Silkworms are cold-blooded animals (*poikilotherm*), namely animals whose body temperature changes according to the temperature of their environment. The productivity of reared silkworms is very dependent on the temperature and humidity of the environment. In general, a good temperature for normal growth of silkworms is 20-28°C with humidity of 70-85%.

In general, a good temperature for normal growth of silkworms is 20-28°C with humidity of 70-85%. The optimum temperature and humidity required for rearing silkworms from instar I-III are in instar I, the temperature is 27-28°C and humidity 90%, in instar II the temperature is 27-28°C and humidity 85-90%, and in instar III the required temperature is 26-28°C and humidity 80%. For instars IV-V, the temperature and humidity required are lower (Andadari & Samsijah, 1992).

The optimum temperature and humidity required for rearing silkworms from instars I-III are in instar I; temperature 27-28°C and humidity 90%, in instar II; temperature 27-28°C and humidity 85-90%, and in instar III; the required temperature is 26°C and humidity 80%. For instars IV-V, the temperature and humidity required are lower. The temperature and humidity required for rearing silkworms in instar IV is 25-24° C with humidity 70-75% and in instar V, the temperature required is 23° C with humidity 70%. The average daily temperature in the morning is 24-26°, in the afternoon 26-30°C and in the afternoon 24-28°C with humidity of 81-84%, 75-83% and 74-83% respectively.

In Soppeng Regency, the success and increase in production of silkworm cultivation can be supported by environmental ecological conditions and also the community's ability to carry out cultivation. Silk farmers in Soppeng Regency are silk farmers who have been cultivating it for generations, so farmers understand the treatment of silk worms. The conditions for cultivating silkworms at the research location can be seen in Figure 2.

Silkworm Rearing Process

Based on previous research belonging to (Andadari & Samsijah, 1992) which states that in the larval phase there are several stages, namely instar I, instar II, instar III, instar IV and instar V. The duration of each instar is not the same, in general the shortest period is second, then first, third, fourth and fifth instar. The rest period is approximately one day but not the same for each instar. The shortest rest period is during the second

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

instar, then the first instar, third and fourth instar. The transition from one instar to another is called sleep and skin changes occur. The maintenance of silkworms is divided into two parts, namely the maintenance period for small caterpillars and the period for the maintenance of large caterpillars.

Figure 2. Silkworm cultivation conditions at the research location

In Soppeng Regency, silk farmers start cultivating when the caterpillars enter Instar II, namely when the small silkworms that have just emerged from the eggs are taken care of until the first feeding and can be called "hakitate," and this is the initial stage of the entire series of silkworm rearing. Raising small caterpillars is an essential aspect in the silk industry to produce healthy and strong caterpillars so that they can avoid disease attacks on large caterpillars and obtain a successful harvest. Success depends on optimum environmental conditions, well-maintained mulberry gardens, and skilled personnel. Ecological factors, especially temperature, humidity, light, and surrounding air circulation, influence growth, development, and physiological activities (Ashar et al., 2024).

Based on the research results, 2 ¾ boxes of silkworms were handed over after the second instar to the silk group, so one box was kept for the group leader and 1 ¾ box was divided between 2 group members. Farmers who raise silkworms still use straightforward cultivation methods. While silkworm rearing generally takes place under the house, only around 21 percent of farmers in Soppeng Regency keep caterpillars in special buildings, and 78 percent do so under the house. Various noises and smells that caterpillars don't like will affect their growth. The process of handing over silkworms to farmers at the research location can be seen in Figure 3.

Figure 3. Handing over silkworm seeds to farmers

In the last instar, namely instar V, the body of the mature silkworm (ready to cocoon) looks translucent, and the silkworm will stop eating. Caterpillars like this start to emit lots of silk fibers from their mouths. The pupal period is approximately 11 days. The 9th segment of the male pupa has a dot mark, while the 8th segment of the female pupa has

 e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

a dot mark ((Andadari & Samsijah, 1992).

After instar V lasts 1 week, the caterpillar will reduce its appetite and only eat a little. The caterpillar's body will become transparent and shrink. Caterpillars that are ready to make cocoons are usually called mature caterpillars. The body becomes transparent as the volume of the silk glands increases to fill most of the body. The time it takes from cocooning to pupation depends on the temperature and the caterpillar variety. Generally, caterpillars finish making cocoons in 2 days and then take two days to turn themselves into pupae.

The pupa is initially whitish and soft. 2 days later, it will turn dark brown and hard. Cocoons were harvested on the 6th and 7th days after cocooning. In this phase, caterpillars were taken one by one and placed on a rack made of bamboo and wood. This rack makes it easier for silkworm farmers to harvest and obtain clean cocoons. If this is not done, the cocoons formed will not be clean because they will be mixed with the remains of mulberry leaves in the rearing area. The V-instar stage is shown in Figure 4.

Figure 4. Last instar process (encapsulation)

Indonesia has the potential to develop sericulture in terms of land suitability, cultural, social, and economic aspects of society, human resource capacity, market potential, and technology (Agustarini et al., 2020; Andadari, 2016; Fambayun et al., 2022; Widiarti et al., 2021; Yuniarti & Wahyuddin Nur, 2024). However, there are several challenges in developing the national sericulture industry, such as high competition with other countries, low government support for the national sericulture industry, lagging technology, and slow handling of pests and diseases (Hartati, 2015; Nuraeni, 2017; Yuniati & Wahyuddin Nur, 2024). Apart from that, there are problems with the low availability and quality of national silkworm seeds (Andadari & Kuntadi, 2014; Yuniarti & Wahyuddin Nur, 2024) as well as low production per unit area (Andadari, 2016).

The availability of silkworm seeds in sufficient quantities with good quality needs attention in efforts to maintain the continuity of sericulture activities (Sarkar et al., 2012). The quality of seeds depends on several things, including caterpillar rearing techniques, quality and quantity of caterpillar food and disease prevention. Apart from these things, the quality of these seeds is also influenced by the combination of pure breeds used in crossing (Estetika & Endrawati, 2018).

Crossing is intended to manipulate the genes in the population in order to improve the silk content and quality and isolate lines that have commercial capabilities. Improving the quality of silkworms still needs to be done in Indonesia because the seeds used now are seeds from sub-tropical areas which are usually used in optimum conditions. Conditions are declared optimal if the results of rearing produce high quality cocoons with live pupae, and this is greatly influenced by rearing ability and environmental conditions

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

when rearing caterpillars (Hemmatabadi et al., 2016). In tropical conditions, where the agro-climate fluctuates, the quality of the leaves is low, and the abilities of caterpillar keepers are limited, thus requiring stronger types of caterpillars. One effort that can be done is through crossing pure lines from the collection of silkworm races that are owned (Andadari & Sunarti, 2015). Hybrid crosses are adapted to tropical environments and generally show different and more stable crossing patterns than their parents (Gowda et al., 2013).

CONCLUSION

The production of mulberries as a food source for silkworms affects the production of silk cocoons. The typological conditions of the Soppeng Regency are very helpful in increasing silk production. Based on ecological typology, namely, temperature, air humidity, and intensity of sunlight, geographical conditions in the form of soil type, altitude, land fertility, mulberry land area, and the condition of human resources experienced by silk farmers. The interrelationship between all typological conditions helps the sustainability and success of sericulture in the Soppeng Regency. For the government, the suitability of sericulture might require a program to increase silkworm rearing. For further research, we suggest that the interrelationship between the production of cocoons and climate change in Soppeng Regency can be studied.

REFERENCES

Agustarini, R., Andadari, L., Minarningsih, & Dewi, R. (2020). Conservation and breeding of sericultureworm (Bombyx mori L.) in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *533*(1). https://doi.org/10.1088/1755-1315/533/1/012004

Andadari, L. (2016). Pemilihan Jenis Hibrid Ulat Sutera Yang Optimal Untuk Dikembangkan Di Dataran Tinggi Dan/Atau Dataran Rendah. *Jurnal Penelitian Hutan Tanaman*, *13*(1), 13–21. https://surl.li/ctxwgr

Andadari, L., & Kuntadi, K. (2014). Perbandingan Hibrid Ulat Sutera (Bombyx Mori L.) Asal Cina Dengan Hibrid Lokal Di Sulawesi Selatan. *Jurnal Penelitian Hutan Tanaman*, *11*(3), 173–183. https://doi.org/10.20886/jpht.2014.11.3.173-183

Andadari, L., & Samsijah, S. (1992). Effects of cocooning frames on cocoon quality. *Buletin Penelitian Hutan*, *8*(552). https://www.cabidigitallibrary.org/doi/full/10.5555/19950609537

Andadari, L., & Sunarti, S. (2015). Kualitas kokon hasil persilangan antara ulat sutera (Bombyx mory L.) ras Cina dan ras Jepang. *Jurnal Pemuliaan Tanaman Hutan*, *9*(1), 43–51. https://doi.org/10.20886/jpth.2015.9.1.43-51

Ashar, N. M., Nurmalina, R., & Muflikh, Y. N. (2024). Sericulture Agribusiness Development Strategy in South Sulawesi Province, Indonesia. *Agro Bali: Agricultural Journal*, *7*(3), 810–823. https://doi.org/10.37637/ab.v7i3.1915

Bhat, M.R., Radha, P., Faruk, A.A., Vas, M., Brahma, D., Bora, N.R., Bharathi, K.M., Garai, I. (2024). Climate Change and Its Impact On Sericulture. *International Journal of Zoology and Applied Biosciences*, 9(4), 13-25. https://doi.org/10.55126/ijzab.2024.v09.i04.004

BPS Soppeng Regency. (2023). *Soppeng Regency in Number*. BPS Soppeng Regency

Chen RuiTing, C. R., Xiao Ying, X. Y., Liu Zhen, L. Z., Li LeiLei, L. L., Lu Yan, L. Y., Jiao Peng, J. P., & Miao YunGen, M. Y. (2019). Three vital RNA functions and interactions in the process of silk gland apoptosis in silkworm Bombyx mori. *Archives of Insect Biochemistry and Physiology*, *100*.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

https://doi.org/10.1002/arch.21511

Dai, J. L., Zhang, M., Hu, Q. H., Huang, Y. Z., Wang, R. Q., & Zhu, Y. G. (2009). Adsorption and desorption of iodine by various Chinese soils: II. Iodide and iodate. *Geoderma*, *153*(1–2), 130–135. https://doi.org/10.1016/j.chemosphere.2015.01.031

Datta, D., Pohlentz, G., Schulte, M., Kaiser, M., Goycoolea, F. M., Müthing, J., Mormann, M., & Swamy, M. J. (2016). Physico-chemical characteristics and primary structure of an affinity-purified α-D-galactose-specific, jacalin-related lectin from the latex of mulberry (Morus indica). *Archives of Biochemistry and Biophysics*, *609*, 59–68. https://doi.org/10.1016/j.abb.2016.09.009

Du, Q.-Z., Zheng, J., & Xu, Y. (2008). Composition of anthocyanins in mulberry and their antioxidant activity. *Journal of Food Composition and Analysis*, *21*(5), 390–395. https://doi.org/10.1016/j.jfca.2008.02.007

Duke, J. A. (2001). Morus alba (L.). *Handbook of Energy Crops. Available Online: https://www.scirp.org/reference/referencespapers?referenceid=1357256*

Estetika, Y., & Endrawati, Y. C. (2018). Produktivitas ulat sutera (Bombyx mori L.) ras BS-09 di daerah tropis. *Jurnal Ilmu Produksi Dan Teknologi Hasil Peternakan*, *6*(3), 104–112. https://journal.ipb.ac.id/index.php/ipthp/article/view/26189/16979

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). https://doi.org/10.1088/1755-1315/995/1/012055

Gowda M, Zhao Y, Maurer HP, Weissmann EA, Würschum T, Reif JC. (2013). Best linear unbiased prediction of triticale hybrid performance. *Euphytica* 191: 223-230. DOI: 10.1007/s10681-012-0784-z

Han, Q., Gao, H., Chen, H., Fang, X., & Wu, W. (2017). Precooling and ozone treatments affects postharvest quality of black mulberry (Morus nigra) fruits. *Food Chemistry*, *221*, 1947–1953. https://doi.org/10.1016/j.foodchem.2016.11.152

Hartati. (2015). *Analisis Fenotip Ulat Sutera (Bombyx mori L) Hasil Persilangan Ras Jepang, China, dan Rumania* (1st ed.). Global RCl. https://eprints.unm.ac.id/14685/11/Buku%20%20Referensi.pdf

Hemmatabadi, R. N., Seidavi, A., & Gharahveysi, S. (2016). A review on correlation, heritability and selection in silkworm breeding. *Journal of Applied Animal Research*, *44*(1), 9–23. https://doi.org/10.1080/09712119.2014.987289

IASBABA. (2023). *Do Not Open This Test Booklet Until You Are Told To Do So*. *1*(iii).

Jian, Q., Ningjia, H., Yong, W., & Zhonghuai, X. (2012). Ecological issues of mulberry and sustainable development. *Journal of Resources and Ecology*, *3*(4), 330–339. https://doi.org/10.5814/j.issn.1674-764x.2012.04.006

Lu, Q.Y., Wu, Z.J., Xia, Z.S., & Xie, L.H. (2015). A new nepovirus identified in mulberry (Morus alba L.) in China. *Archives of Virology*, *160*, 851–855. https://doi.org/10.1007/s00705-014-2330-x

Nuraeni, S. (2017). Gaps in the thread: Disease, production, and opportunity in the failing silk industry of south sulawesi. *Forest and Society*, *1*(2), 110–120. https://doi.org/10.24259/fs.v1i2.1861

PV, K., P, J., & Umapathy, G. (2019). Characterization of waste water for cultivation of mulberry. *Journal of Pharmacognosy and Phytochemistry*,

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

8(3), 141–144. http://www.eschooltoday.com/wastewater/what-is-wastewater.html/

Ram, R.L., Maji, C., Bindro, 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., Lusia, P., Riwu, M., Sahide, M. A. K., Sirimorok, N., Parenreng, S. M., Salindeho, Y. M., Yahya, A. F., Mulyani, A., Said, R. D., Suryani, S., Rauf, Y., & Pratama, Y. F. (2021). *Laporan Kajian Rantai Nilai Komoditas Sutra Sulawesi Selatan*. Bappelitbangda Provinsi Sulawesi Selatan.

Sarkar, N., Ghosh, S. K., Bannerjee, S., & Aikat, K. (2012). Bioethanol production from agricultural wastes: an overview. *Renewable Energy*, *37*(1), 19–27. https://doi.org/10.1016/j.renene.2011.06.045

Sasmita, N., Purba, J. H., & Yuniti, I. G. A. D. (2019). Adaptation of Morus alba and Morus cathayana plants in a different climate and environment conditions in Indonesia. *Biodiversitas Journal of Biological Diversity*, *20*(2), 544–554. https://eprints.unmas.ac.id/id/eprint/127/

Sidabutar, F., Trigunasih, N. M., & Sumarniasih, M. S. (2023). Evaluasi Kesesuaian Lahan untuk Pengembangan Tanaman Konservasi dan Perkebunan di DAS Unda, Provinsi Bali, Indonesia. *Agro Bali : Agricultural Journal*, *6*(3), 852–859. https://doi.org/10.37637/ab.v6i3.1277

Singhal, B. K., Khan, M. A., Dhar, A., Baqual, F. M., & Bindoroo, B. B. (2010). Approaches to Industrial Exploitation of Mulberry (Mulberry sp.) Fruits. *Journal of Fruit and Ornamental Plant Research*, *18*(1), 83–99. https://www.cabidigitallibrary.org/doi/full/10.5555/20103259939

Srivastava, C. M., Purwar, R., Kannaujia, R., & Sharma, D. (2015). Flexible silk fibroin films for wound dressing. *Fibers and Polymers*, *16*, 1020–1030. https://doi.org/10.1007/s12221-015-1020-y

Sumarniasih, M. S., Kembaren, D. A., Narka, I. W., & Karnata, I. N. (2023). Evaluasi Kualitas Tanah dan Pengelolaan Lahan Kering di Kecamatan Gerokgak dan Kubutambahan Kabupaten Buleleng, Provinsi Bali, Indonesia. *Agro Bali : Agricultural Journal*, *6*(3), 659–669. https://doi.org/10.37637/ab.v6i3.1517

Vijayan, K., & Chatterjee, S. N. (2003). ISSR profiling of Indian cultivars of mulberry (Morus spp.) and its relevance to breeding programs. *Euphytica*, *131*(1), 53–63. https://doi.org/https://doi.org/10.1023/A:1023098908110

Wang, H., & Huang, G. (2024). Extraction, purification, structural modification, activities and application of polysaccharides from different parts of mulberry. *Food & Function*, *15*(8), 3939–3958. https://doi.org/10.1039/D3FO05747J

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). https://doi.org/10.1088/1755-1315/917/1/012009

Yuniarti, A., & Wahyuddin Nur, A. (2024). Transformasi Tenun Sutera Melalui Kolaborasi dengan Perguruan Tinggi dalam Era Digital. *Journal of Human And Education*, *4*(2), 160–166. https://doi.org/10.31004/jh.v4i2.739

Zhao, W., Fang, R., Pan, Y., Yang, Y., Chung, J.-W., Chung, I.-M., & Park, Y.-J. (2009). Analysis of genetic relationships of mulberry (Morus L.) germplasm using sequence-related amplified polymorphism (SRAP) markers. *African Journal of*

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i2.2258

Biotechnology, *8*(11). http://www.academicjournals.org/AJB

Zhou, L., Zhao, Y., Wang, S., Han, S., & Liu, J. (2015). Lead in the soil–mulberry (Morus alba L.)–silkworm (Bombyx mori) food chain: translocation and detoxification. *Chemosphere*, *128*, 171–177. https://doi.org/10.1016/j.chemosphere.2015.01.031