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The adaptability of the commercial seeds of silkworm (Bombyx Mori L) on different altitude preservation

The adaptability of the commercial seeds of silkworm (Bombyx Mori L) on different altitude preservation

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Abstract. The selection of silkworm seeds is critical when we are going to start a sericulture business that must be by the environmental conditions, especially the climate. This research aims to look at the response of silkworm seeds which are preserved on two different altitudes from the seed sources in South Sulawesi and Central Java. The seeds preservation, started from hatching eggs to become cocoons, is done at an altitude of 120 meters above sea level (Soppeng Regency) and 700 meters above sea level (Enrekang Regency). Preservation procedures are carried out by the standard operating procedures for maintaining silkworms. The preservation procedure is carried out based on the standard operating procedure for preserving silkworms. The results show that the duration of local C301 PPS seeds is 1.5 - 2 days longer than CRT and C301 CRT BS09 at two different altitude locations. Adaptation of the three seeds based on the hatchability of eggs and the durability of larvae meet the standard commercial seed at different altitude preservation results. The C301 PPS seeds have better solid quality than the other two seeds at two different altitude locations. The cocoons characteristics (shape, color, and texture) and larvae (larvae color and pattern) and relatively the same at two different altitude locations.

1. Introduction

Silkworm (*Bombyx mori* L) is one type of insects from the Order of Lepidoptera which has undergone an evolution of domestication [1–3]. These insects have very high economic value for humans because after passing through the larval phase they will produce silk fibers to form the cocoons. These silk fibers are the raw materials for the textile industry, surgical threads, parachutes, and various other purposes. Until now, the specialty of silk fiber is still undefeatable by artificial silk fiber. Silkworms can be preserved in various regions at different latitude and altitude according to race, voltmeter, moltivism or the result of a cross among those various characters.

South Sulawesi is the largest area for preserving silkworms in Indonesia. This sericulture business is carried out by farmers in the three main regencies: Enrekang, Soppeng, and Wajo, in the form of a people's silk business. The area of sericulture center in the Soppeng Regency and Wajo tends to be almost the same as the agro-climate conditions which are located at altitudes below 250 meters above sea level, while in the Enrekang Regency the altitude is more than 400 meters above sea level.

Since 1980, about 90 % silkworm seeds have been produced by KSPA (Kesatuan Pengusaha Sutera Alam/Natural Silk Concession Unit) Perhutani Public Company in Donri-donri District, Soppeng Regency, and the rest are from Perhutani Public Company in Candiroto District (Central Java). The

development of the quality of these seeds undergoes up and down in either the aspects of the caterpillar's biology or the quality of the cocoon and its fibers. This research tests the response of seeds growth maintained in two different altitude areas.

2. Material and Method

The used commercial silkworm seeds are the C301 strain produced by the KPSA Perhutani Public Company (C301 PPS) in the Soppeng Regency, South Sulawesi; BS09 CRT and C301 CRT strain are produced by PSA (Natural Silk Concession) District of Candiroto, Temanggung Regency, Central Java. Each seed strain is preserved on a preservation shelf of 300 eggs divided into three replications. Preservation is carried out at different altitude/altitude areas: Village of Donri-Donri, District of Donri-Donri, Soppeng Regency (120 meters above sea level), and Village of Mata Allo in the District of Alla, Enrekang Regency (700 m above sea level) (Figure 1). Variables observed are the caterpillar's characteristics, cocoons, duration of preservation and seeds productivity (egg weight, egg hatchability, survival of young larval (instar I-III), survival of grown larval (instar IV-V)). Technical preservation and toning the silkworms are carried out based on the standards of silkworms preservation [4,5].

3. Results and discussion

The preservation duration of commercial silkworms described at each stage included the duration of the meal (feeding stage), molting, and transforming each tested seed into a cocoon (Table 1). C301 PPS Strain shows the same time for two preservation areas with different altitudes. Meanwhile, the preservation of silkworm strains originally from Candiroto, the duration of preservation tends to be longer than 1.5 to 2 days at elevation areas in Enrekang Regency, rather than the preservation in low-lying areas in Soppeng Regency.

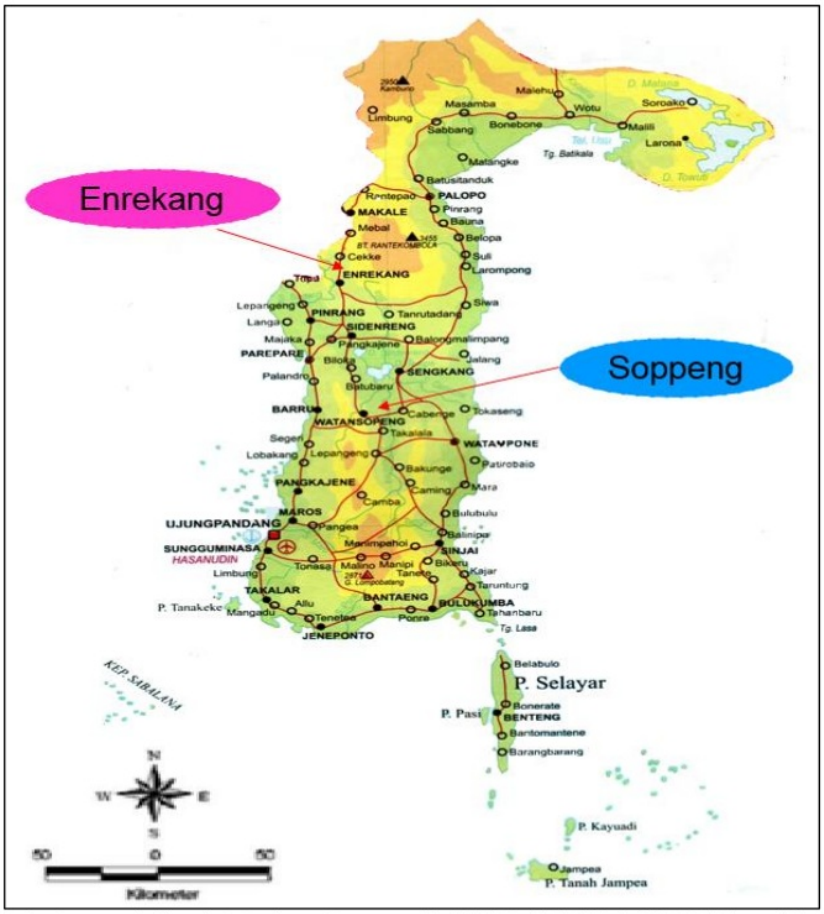

Figure 1. Research Sites in Enrekang Regency (3 ° 20'58.1 "S 119 ° 48'15.8" E) and Soppeng Regency (4 ° 13'04.0 "S 119 ° 56'23.8" E).

Table 1. The duration of the larval period at the altitudes different

1. Lowland

Instars	C301 PPS			BS09 CRT			C301 CRT		
	Eating Stadia (days)	Molting (days)	larval duration (days)	Eating Stadia (days)	Molting (days)	larval duration (days)	Eating Stadia (days)	Molting (days)	larval duration (days)
I	2.5	0.5	3.0	2.5	0.5	3.0	2.5	0.5	3.0
II	3.0	1.0	4.0	2.5	1.0	3.5	2.5	1.0	3.5
III	3.0	1.0	4.0	2.5	1.0	3.5	2.5	1.0	3.5
IV	3.0	1.5	4.5	3.0	1.5	4.5	3.0	1.5	4.5
V	7.5	-	7.5	6.5	-	6.5	6.5	-	6.5

	Total		23.0			21.0			21.0
Highland									
I	3.5	1.0	4.5	3.0	1.0	4.0	2.5	1.0	3.5
II	2.5	1.0	3.5	2.5	1.0	3.5	2.5	1.0	3.5
III	3.0	1.0	4.0	3.0	1.0	4.0	3.0	1.0	4.0
IV	4.0	1.0	5.0	4.0	1.0	5.0	4.0	1.0	5.0
V	6.0	-	6.0	6.5	-	6.5	6.5	-	6.5
	Total		23.0			23.0			22.5

The duration of the larval period preserved in the lowlands or the highlands for the South Sulawesi region is still shorter when compared to some other sericulture countries such as India. According to [6], the duration of silkworm larvae in India ranged from 636.40-653.88 hours or in other words, 26.5 to 27.25 days.

Differences in the duration of the feeding phase and the molting phase cause differences too in the duration of preservation of the tested seed. This is influenced by environmental factors around such as the height of the place directly related to temperature and humidity. The air temperature in preserving silkworms in the lowland such as in District of Soppeng, averagely 28.5 ºC with 78 % humidity during the preservation of small caterpillars, and averagely 27.9 ºC with 78.6 % humidity in preserving the large caterpillars.

The difference in duration of preservation occurs because of the physiological response of the seeds used toward temperature and humidity. The suitable temperature for the conservation of small caterpillars (instar I - III) is average of 25-28-28 ºC with humidity of 80-90 %, while for large caterpillars (instar IV-V) is 24-24-24 ºC and with 70-75 % [7-9].

Table 2. Egg weight, egg hatching and survival of larval at different altitudes

Breeds	Eggs Weight (mg)	Lowland			Highland		
		Eggs hatchability (%)	Survival of young larval (%)	Survival of grown larval (%)	Egg hatchability (%)	Survival of young larval (%)	Survival of grown larval (%)
C301 PPS	0.5	100.00a	100.0	96.14 a	92.33	95.75	99.33
BS09 CRT	0.4	96.70b	100.0	96.02 ab	90.83	95.49	99.52
C301 CRT	0.6	96.70b	100.0	94.96 b	92.50	95.58	99.62

**Means in each column followed by the same letters are not significantly different at $p < 0.05$*

Egg weight, hatchability, the durability of young larval and grown larval in two locations are presented in Table 2. The egg weights of the three hybrids tested seeds are relatively the same, i.e., an average of 0.5 ± 0.1 mg. According to [9], the weight of silkworm eggs is 0.5 mg. The hatchability of the eggs from the three test hybrid seeds shows higher C301 PPS egg hatchability than BS09 CRT and C301 CRT. Statistical analysis of eggs hatchability indicates that there are differences that are not significant with a percentage of more than 90 %, so it has met as commercial hybrid seeds. The same results reported by [6], the hatchability of eggs obtained in hybrids ranged from 90.05 - 97.65 %. Hatchability of eggs in the tested hybrid seeds ranged from 93.87 - 95.88 % [10]. The hatchability of various hybrid seeds from various countries producing world seeds ranges from 77.5 to 98.5 % [11].

The larval phase consists of five instars, the first instar to the 3rd instar is called young larvae, the 4th and 5th instars are called grown larvae. Young and grown larvae have different quality and quantity needs and environmental needs [12]. Thus the observation of the durability of larvae is distinguished by

the differences in those characters. The Table 2 shows the durability of young larval is the same in a result which is up to 100 % in the lowlands and above 90 % in the altitude area, which means it still meets the requirements of commercial seeds [8]. As for the grown larval endurance test show significantly different results between C301 PPS and C301 CRT, but the BS09 CRT is relatively the same. Similarly, the survival of grown larval, BS09 CRT against C301 CRT, is relatively the same. The percentage of larvae forming pupae or larval resistance of commercial seeds during preservation ranged from 72.86 to 96.91 % [11].

The survival of the test seeds shows good results because all the technical stages of preservation have met FAO or JICA standards such as caterpillar sanitation with the use of larval nets after molting larvae which are continued by the use of disinfectant materials with appropriate doses and adequate feeding. The use of lime mixed chlorine disinfectant (5:95) at a dose of 1 g per 0.1 m^2 for the 1st instar, 2 g for the second and 3 g instars for the 3rd instar. While the large larvae use (10:90) at a dose of 50 g / m^2. They are feeding with the age of young leaves, which is about one month old. The instar I am given young mulberry leaves fr the upper stalks, while for instar II and III caterpillars are given leaves from the lower stem. Feeding is done three to four times a day, which are morning, afternoon, evening, and night.

The body characteristics of the larvae observed are the color, pattern, and length starting from the head to the abdominal horn tip, as shown in Table 3. The characteristics of the color and pattern of the larvae among the three seeds are the same, namely crescents clearly on the second segment dorsal abdomen and eye spots on the second segment of the thorax. Larval length is significantly different, that C301 PPS is longer (7.7 cm) than the other two seeds (6.8 cm) in the lowlands. Whereas in the plateau, the length of the larvae are relatively same. The length of the larvae can reach the maximum length preserved in the plateau. This result is consistent with the results reported by [12], the maximum larval length of a silkworm can reach 7.43 cm on the 7th day of the 5th instar. Furthermore, it is explained that the maximum larval length is related to the amount of food that can be consumed by the larvae.

Table 3. Characteristics of larvae.

1. Breeds	larval length (cm)		Colour and Larval marking
	Lowland	Highland	
C301 PPS	7.70 a	7.41	White, marked (crescents and eye spot)
BS09 CRT	6.80b	7.63	
C301 CRT	6.80 b	7.47	

**Means in each column followed by the same letters are not significantly different at $p < 0.05$*

Typical signs or caterpillar body patterns are a sign or characteristic of Japanese race silkworms. According to [13], the crossing of silkworm elders from plain larval races with freckle parents will produce speckled larval pattern because the allele (+ p) is more dominant than plain (p). [14] explained that the color and pattern of silkworm larvae was determined by other than genetic factors also because of the distribution of pigments in hypodermal and epicuticular cells. According to [15], the diversity of the phenotype among the silkworm genotypes is very important for parent selection which is suitable for the successful development of superior varieties or silkworm hybrids that have potential which adapt to environmental fluctuations. The classification and characterization of silkworm breeds is important in sericulture to support the development of new hybrids [10].

The cocoon characteristics in Table 4 show the cocoon weight, cocoon shell weight and C301 PPS seed cocoon skin ratio, in the lowlands are higher than those from outside the BS09 CRT and C301 CRT. Whereas in the highlands there is a tendency for C301 PPS seeds to match the quality of the cocoons with the CRT BS09. The ratio of cocoon peel that meets the standard is from the C301 PPS seeds which are preserved at two different altitudes (23.23 - 23.61 %). According to [16], that the ratio

of cocoon skin is one of the benchmarks for determining the selling price of cocoons which ranges from 22-25 %.

The characteristics of the cocoon in Table 5 show that the three test seeds have the same color and texture of the cocoon, namely white and coarse. The shape of the cocoon, the C301 PPS shows an oval shape compared to the BS09 CRT and C301 CRT oval shape with a slightly curved in the middle (like peanuts) that is closer to the Japanese race. The length of the cocoons for the three seeds are relatively the same while the width of the cocoons in the lowlands is significantly different and reversed on the highlands.

Table 4. The quality of cocoon

Breeds	Lowland			Highland		
	Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell ratio (%)	Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell ratio (%)
C301 PPS	1.99 a	0.46 a	23.23 a	1.73 ab	0.42 a	23.61 a
BS09 CRT	1.66 b	0.34 b	20.71 b	1.91 a	0.41 a	21.72 b
C301 CRT	1.62 b	0.32 b	19.91 b	1.68 b	0.35 b	20.40 b

**Means in each column followed by the same letters are not significantly different at p < 0.05*

Table 5. Characteristics of cocoon

Breeds	Cocoon colour	Cocoon texture	Cocoon shaped	Lowland		Highland	
				Cocoon length (cm)	Cocoon wide (cm)	Cocoon length (cm)	Cocoon wide (cm)
C301 PPS	White	bearish	Ellipsodal	3.55	2.17 a	3.56	2.13
BS09 CRT			Peanut	3.30	1.89 b	3.55	2.08
C301 CRT			Peanut	3.40	1.99 b	3.51	1.92

**Means in each column followed by the same letters are not significantly different at p < 0.05*.

4. Conclusion

The duration of preservation of the C301 PPS local seed larval period is 1.5 - 2 days longer than the BS09 CRT and C301 CRT at two different altitude locations. Adaptation of the three seeds based on the hatchability of the eggs and their survival of larva has met the commercial standards of seeds at different altitude preservation results. Larval characteristics (larval color and pattern) and cocoons (color, wrinkles and cocoon hardness) are relatively similar at two different altitude locations.

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