Research Article

PHYSIOLOGYCAL STUDIES ON SILK GLAND OF SAMIA RICINI (DONOVAN) UNDER THERMAL STRESS CONDITION

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ABSTRACT

Among non-mulberry silks, only eri silk production is in increasing trend and India stands second in eri silk production. Eri silkworm, *Samia ricini* is domesticated and polyphagous in nature. In India most of the sericulture belt prevails in the tropical region where temperature goes 32–40 °C during the summer when compared to interior parts. Eri silkworm is poikilothermic insect, temperature will have direct effect on physiological growth and development of the silk gland. The silk gland accumulates proteins during the silkworm development and its growth is importance for the synthesis of silk proteins. The temperature required for eri silkworm is 24-28 ºC and above this temperature is harmful to the growth and development of silkworm. Insects have adopted different biological and physiological strategies to overcome changes in their surrounding environment but lack of tolerance in domesticated eri silkworm may affect growth and development of silk gland and eventually silk production. Therefore, the present study was conducted under thermal stress condition (31.2 ± 1°C) to assess some important physiological parameters such as larval weight (g), silk gland weight (g),silk gland somatic index (%) and silk conversion index (%) of different ecoraces Viz. Borduar, Titabar and Mendipathar. The results show that Mendipathar eco race performed better than Borduar and Titabar ecoraces in all the parameter studied.

INTRODUCTION

The temperature and humidity is the main factor which affect the physiology of the insects (Couret *et al.,* 2014). Insects can adapt daily altering environmental temperature (Damos and Soultani, 2011; Chen *et al.,* 2015). Fluctuation in environmental condition is maintained by the internal temperature and water content, but insectshave limit of tolerance (Singh *et al.,* 2009). Temperature has a direct correlation with the growth of silkworm. The wide temperature fluctuations are harmful to the development of the larvae and silk gland. The rise in temperature will affect the physiological development and decrease in temperature cause decrease in physiological activity in silkworm (Rahmathulla *et al.,* 2004). Eri silk worm *Samia ricini* (Donovan) is a domesticated, polyphagous and multi voltine in nature (Sarkar, 1980; Devaiah and Dayashankar, 1982; Gogoi and Yadav, 1995; Biswas and Das, 2001; Chowdhury, 2006; Chakravorty and Neog, 2006; Sarmah *et al*., 2013). Being a domesticated insect *S. ricini*is very sensitive to environmental changes andcannot grow and develop under extreme temperature fluctuations. The variation of temperature and humidity during different stages of larval development found to be more favourable for growth and development of larvae than constant temperature (Lemoine *et al.,* 2014). Increasing temperature during early instar accelerate growth and shorten the period of larvae in late instar period. The growth and development of silk gland is an important to the sericulture industry as it is responsible for the synthesis of silk proteins, the basic raw material of the silk cocoon (Sutherland *et al.,* 2010). Prominently, the silk gland grows during the fourth and fifth larval instars and the growth of silk gland is modulated by abiotic environmental factors (Shimizu, 2000). The temperature plays a great role in the development of silk gland and synthesis of silk. Keeping in view of these aspects the study was conducted under thermal stress environmental condition in different eco races of *Samia ricini*.

MATERIALS AND METHODS

Borduar, Titabar and Mendipathar ecoraces of eri silkworm were procured from the Central MugaEri Research & Training Institute, Assam. The experiment was conducted in the Department of Ecology and Environmental Sciences, Pondicherry University, Puducherry. The standard rearing

method was adopted as recommended by (Sarkar, 1980; Sarmah *et al.*, 2013)

Silkworm rearing

Tray rearing method was adopted and fresh tapioca leaves were harvested and fed 4-5 times. Bed cleaning was done during all the instars. The larvae at moult were kept undisturbed. The optimum temperature of (25-26°C) and relative humidity of (75-76%) were maintained for control group.

Temperature treatment of V^{th} instar larvae

V^{th} instar larvae from each ecoraces (experimental group) were maintained at a temperature of 31.2 ± 1°C and RH of 76 ± .71% every day for 5 hours until fully mature and after treatment transferred into optimum temperature.

Extraction of silk gland

Ten randomly selected individual larvae were used in dissection of silk gland. The dissected silk gland was allowed for 5-7 mins in the saline and removed excess moisture by blotting paper and immediately weights of silk gland was recorded and mean value was calculated.

Ten mature larvae and cocoon shell were weighed individually and mean data were recorded.

Silk gland somatic index (%) and silk conversion index (%) was calculated followed by the formula:

$$SSI = \frac{\text{Silk gland weight (g)}}{\text{Mature larval weight(g)}} \times 100$$

$$SCI = \frac{\text{Shell weight (g)}}{\text{Silk gland weight (g)}} \times 100$$

Finally, data were analysed statistically by t-test at 5% level of significance, using spss software version 16.

RESULTS AND DISCUSSION

Borduar

The mean value of larval weight of control was 5.18 ± 0.13g and thermal treated was 3.39 ± 0.19g. The silk gland weight of control was 1.12 ± .03g and thermal treated was 0.71 ± .03g. The silk gland somatic index was 21.70 ± 0.99% and thermal treated was 20.91 ± 3.03% and silk conversion index was 37.11 ± 0.47% and thermal treated was 28.73 ± 1.36%. The larval weight ($t = 35.66$, $P < 0.05$), silkgland weight ($t = 12.59$, $P < 0.05$) and silk conversion index ($t = 18.33$, $P < 0.05$) showed statistically significant difference in between the control and thermal treatedbut no significant difference was observed in silkgland somatic index ($t = 0.78$, $P > 0.05$) table 1.

Table 1. Performance of Borduar eco race under control & treated temperature.

Parameters	Control 25.6 ± 2°C	Treated 31.2 ± 1°C	t–value	P-value
Larval wt. (g)	5.18 ± 0.13	3.39 ± 0.19	35.66	0.00*
Silkgland wt.(g)	1.12 ± 0.03	0.71 ± 0.03	12.59	0.00*
Silkgland somatic index (%)	21.70 ± 0.99	20.91 ± 3.03	0.78	0.22**
Silk conversion index (%)	37.11 ± 0.47	28.73 ± 1.36	18.33	0.00*

Each data is the mean of ten larvae.
*Significant $P < 0.05$
** Non-significant $P > 0.05$

Titabar

The mean value of larval weight of control was 5.17± 0.14g and thermal treated was 3.37± 0.10g. The silk gland weight of control was 1.12 ± .04g and thermal treated was 0.70 ± .08g. The silk gland somatic index was 21.62 ± 0.66% and thermal treated was 20.73 ± 2.80% and silk conversion index was 36.52 ± 0.78% and thermal treated was 28.34 ± 18.07%. The larval weight ($t = 33.38$, $P < 0.05$), silkgland weight ($t = 14.55$, $P < 0.05$) and silk conversion index ($t = 18.07$, $P < 0.05$) showed statistically significant difference in between the control and thermal treatedbut no significant difference was observed in silkgland somatic index ($t = 0.98$, $P > 0.05$) table 2.

Table 2. Performance of Titabar eco race under control & treated temperature.

Parameters	Control 25.6 ± 2°C	Treated 31.2 ± 1°C	t–value	P-value
larval wt. (g)	5.17 ± 0.14	3.37 ± 0.10	33.38	0.00*
Silkgland wt.(g)	1.12 ± 0.04	0.70 ± 0.08	14.55	0.00*
Silkglandsometic index (%)	21.62 ± 0.66	20.73 ± 2.80	0.98	0.17**
Silk conversion index (%)	36.52 ± 0.78	28.34 ± 1.20	18.07	0.00*

Each data is the mean of ten larvae.
*Significant $P < 0.05$
** Non-significant $P > 0.0$

Mendipathar

The mean value of larval weight of control was 5.17± 0.14g and thermal treated was 3.37± 0.10g. The silk gland weight of control was 1.12 ± .04g and thermal treated was 0.70 ± .08g. The silk gland somatic index was 21.62 ± 0.66% and thermal treated was 20.73 ± 2.80% and silk conversion index was 36.52 ± 0.78% and thermal treated was 28.34 ± 18.07%. The larval weight ($t = 33.38$, $P < 0.05$), silkgland weight ($t = 14.55$, $P < 0.05$) and silk conversion index ($t = 18.07$, $P < 0.05$) showed statistically significant difference in between the control and thermal treatedbut no significant difference was observed in silkgland somatic index ($t = 0.98$, $P > 0.05$) table 3.

Among the ecoraces Mendpathar exhibited relatively higher weight of silk gland of 1.15 ± 0.06 g in control and 0.77 ± .10 g in treated followed by Borduar (1.12 ± .03 g control and 0.71 ± .03 g treated)and Titabar (control 1.12 ± 0.04 and treated 0.70 ± 0.08 g). Das (2015) have reported silk gland weight of 0.57±0.03 g. Our findings were also similar with the observations (Nangia *et al.,* 1998; Kumar and Elangovan, 2010).

Table 3. Performance of Mendipathar ecorace under control & treated temperature.

Parameters	Control 25.6 ± 2°C	Treated 31.2 ± 1°C	t–value	P-value
Larval wt. (g)	5.23 ± 0.21	3.41 ± 0.12	23.47	0.00*
Silk gland wt. (g)	1.15 ± 0.06	0.77 ± 0.10	9.92	0.00*
Silk gland somatic index (%)	21.98 ± 1.15	21.02 ± 2.32	1.16	0.13**
Silk conversion index (%)	37.35 ± 1.11	29.14 ± 2.68	8.95	2.68**

Each data is the mean of ten larvae.
*Significant $P < 0.05$
** non-significant $p > 0.05$

The silkgland somatic index (SSI) represents the biomass of the silkgland in relation to total body weight. It gives an idea of quantity of silk that can be spun by the larva. Silkgland somatic index was observed highest in Mendipathar (control 21.98 ± 1.15 % and 21.02 ± 2.32 % treated) followed by (21.70 ± 0.99% control and treated 20.91 ± 3.03 %) Borduarand Titabar (control 21.62 ± 0.66% and treated 20.73 ± 2.80%). The results showed that there was differential variation in silk gland somatic index among the ecoraces in both control and treated condition. Higher silkgland somatic index indicated the ability to produce good quantity of silk. The results of the present study are similar to the findings of (Chhatria1 *et al.,* 2016)who also reported silkgland somatic index (21.23-23.63%) in *P. ricini.* The silk conversion index value of Borduar ecorace was control (37.11 ± 0.47%) and treated (28.73 ± 1.36%), Titabar ecorace control (36.52 ± 0.78%) and treated (28.34 ± 1.20%) and Mendipathar ecorace control (37.35 ± 1.11%) and treated (29.14 ± 2.68%). There was differential variation in the silk conversion index among the ecoraces. Mendipathar performed better followed by Borduar and Titabar ecorace.

CONCLUSIONS

In the present study all the three ecoraces of eri silkworm performed good in all the aspects studied. Further larval weight, silk gland weight, silk gland somatic index and silk conversion index were recorded significantly higher in the Mendipathar ecorace. From the study it was clear that the temperature greatly influenced the growth and development of larvae and silk gland. However, much study is needed on silk gland with respect to temperature stress at the molecular level changes.

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