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Bio-Energetics in Selected Eco-Races of Eri Silkworm

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Abstract

Ericulture is mainly confined to North-Eastern region of India accounting nearly 98% of eri silk produced in the country. Eri silkworm is polyphagous in habit and acclimatized to hardy climatic zones of dry lands. The availability of food plants in various states of the country has opened new vistas for the development of ericulture. An attempt has been made to work out the bio-energetics of selected eco-races of eri silkworm in relation to castor varieties. Total food consumption and digestion differed significantly among the castor hybrid/ variety and eco-races of eri silkworm. Highest total food consumption was registered when Borduar eco-race of eri silkworm was reared on the leaf of DCH-177 hybrid both on fresh and dry weight basis. Further, significantly higher mean consumption index and approximate digestibility were observed when Borduar eco-race of eri silkworm was reared on the leaves of DCH-177 castor hybrid on fresh weight basis, while it was significantly more in DCH-177 × Khanapara on dry weight basis. Mean growth rate was differed statistically between the castor hybrid/ variety and eco-races of eri silkworm and significantly more growth with DCH-177 × Borduar on fresh weight basis and DCH-177 × Mendipathar on dry weight basis.

1. Introduction

Vanya silks represent the finest facets of India's richest culture and tradition. Among the commercially exploited non-mulberry silkworms, the eri silkworm, *Samia cynthia ricini* Boisduval is completely domesticated, well adopted and reared all through the year (Reddy *et al.*, 1999). Eri silkworm survives under wide range of climatic conditions ranging from 13-36 °C and is found to be more resistant to diseases (Thangavelu and Boraiah, 1986).

Castor leaf is principally utilized for feeding eri silkworm with its commercial exploitation for large scale rearing and production of eri cocoons (Jolly *et al.,* 1979; Devaiah *et al.,* 1985; Reddy *et al.,* 1989). Castor is rich in varietal composition and many local and high yielding varieties and hybrids are widely grown in India. Further, identification of castor genotype for rearing of eri silkworm is an important criterion for growth and development as well as enhancement of cocoon and egg production. It has also been stated that the silk ratio varies with the type of host and eri silkworm breed used for rearing (Dookia, 1980). The quality food greatly determines the performance of insect including growth, development and reproductive ability, which encompasses both the absolute and relative amount of water, carbohydrates, proteins, amino acids, lipids, fatty acids, vitamins, minerals, etc. The process of consumption, digestion and conversion efficiency of food in insects greatly determines the physiological, behavioural, ecological and evolutionary aspects (Slansky and Scriber, 1985).

Hence, the present study was carried out to determine the bio-energetics of selected eco-races of eri silkworm reared on castor hybrid/ variety.

2. Materials and Methods

The disease free layings (DFLs) of six eco-races of eri silkworm eggs *viz*., Borduar, Dhanubanga, Khanapara, Kokrajhar, Mendipathar and Titabar were procured from Central Sericultural Germplasm Resources Centre (CSGRC), Hosur, Tamil Nadu and Central Muga and Eri Research and Training Institute (CMERTI), Jorhat, Assam and reared on castor hybrid/ variety: DCH-177 and Local Pink. DCH-177 hybrid and Local Pink variety of castor were raised/ cultivated at a spacing of 90 cm × 60 cm by adopting Randomized Block Design. The recommended package of practices under irrigated condition was followed at each stage of crop growth (Anonymous, 2000). Eri silkworm rearing operations were conducted from the day of brushing to spinning as per the procedure outlined by Dayashankar (1982). The average temperature and relative

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humidity recorded during rearing was 28.20 °C and 72.00%, respectively. The selected eco-races of eri silkworms were reared in specially designed cages (Plate 3.2) to prevent the mixing of larvae and kept treatment and replication-wise as these worms are highly motile in later instars (fourth and fifth).

After two hours of egg hatching, the larvae of six eco-races were fed with tender leaves of respective castor hybrid and variety from brushing to spinning under each replication separately and transferred on to the rearing trays. One hundred larvae were maintained in each replication and four replicates were maintained throughout the rearing period by replacing the missing larvae with the fresh ones for determination of bio-energetic indices. Left over (uneaten) leaves and excreta were collected in each instar and dried in a hot air oven daily at about 100 °C until constant weight.

The following bio-energetic indices of eri silkworm were worked out both on fresh and dry weight basis by adopting the formulae developed by Waldbauer (1968) and Scriber and Feeny (1979).

2.1 Food Consumption (g)

The quantity of food intake indicates the preference of the food by the insect. The preference of food by an insect is governed by the biological and physico-chemical properties of the leaves. The food consumption was computed by adopting the following formula:

2.1.1 Fresh Weight Basis

Food consumption (g) = Weight of fresh food offered to larvae (g) – Weight of fresh remnants (g)
Where,
Weight of fresh remnants (g) = Weight of oven dried remnants (g) × Blank (g)

Where,

$$\text{Blank} = \frac{\text{Weight of fresh leaves in control (g)}}{\text{Weight of oven dry leaves in control (g)}}$$

2.1.2 Dry Weight Basis

$$\text{Food consumption (g)} = \frac{\text{Dry weight of leaf fed (g)} - \text{Dry weight of left over leaf (g)}}{\text{(Blank) (Remnants)}}$$

2.2 Food Digestion (g)

The amount of food digested indicates the amount of nutrients passed through the digestive system for utilization. The digestion is mainly governed by the physiology of insect, its nutritional requirement and nutritional value of the host. Food digestibility was calculated by using the following formula:
Food digestion (g) = Weight of food ingested (g) – Weight of excreta voided (g)

2.3 Consumption Index (CI)

CI is a better measure of consumption rather than the bulk food eaten, as it measures the rate at which the food enters the digestive system. CI was calculated by using the following formula:

$$CI = \frac{F}{T\,A}$$

Where,

F = Weight of food consumed (g)

T = Duration of feeding (days)

A = Mean weight of larva during the feeding period (g)

2.4 Approximate Digestibility (AD) (%)

The digestibility can be precisely measured by AD to evaluate the best host/eco race compared to the amount of food digested as it measures the digestible portion of the food that is ingested. The AD was calculated by using the formula:

$$AD\ (\%) = \frac{\text{Weight of food digested (g)}}{\text{Weight of food ingested (g)}} \times 100$$

2.5 Growth Rate (GR)

GR explains the weight gain per day per gram of mean body weight during the larval stage. It was calculated by using the following formula:

$$GR = \frac{G}{T\,A}$$

Where,

G = Increase in weight of the larva over the feeding period (g)

T = Duration of feeding (days)

A = Mean weight of the larva during the feeding period (g)

The data obtained in the current investigation was subjected to two-way analysis (Completely Randomized Design) of variance ($p \leq 0.05$ and $p \leq 0.01$) (Sundarraj *et al.*, 1972) through SPSS for Windows version 21.0.

3. Results and Discussion

3.1 Food Consumption (FC)

The consumption of food did vary between castor hybrid and variety when the leaves of which were offered as food to selected eco-races of eri silkworm. Significantly, higher FC being noticed in DCH-177 hybrid (28.84 g) over local pink variety (28.43 g) on fresh weight basis. While, Local pink (6.240 g) recorded more FC over DCH-177 (6.186 g) on dry weight basis. Among the eco-races of eri silkworm, Borduar recorded highest (28.75 g and 6.291 g) FC and it was lowest in Dhanubanga (28.54 g and 6.265 g) on both fresh and weight basis. Further, similar trend was recorded on dry weight basis. Food consumption was higher in the interaction of DCH-177 × Borduar (29.00 g). The consumption of food was lowest in Local pink × Khanapara. However, on dry weight basis, FC was maximum in DCH-177 × Borduar (6.335 g). Whereas, considerably minimum FC was found in Local pink × Mendipathar on dry weight basis. (Table 1 & 2)

Table 1: Bio-energetics in selected eco races of eri silkworms reared on castor hybrid/ variety on fresh weight basis

Eco-races of eri silkworm (E)	Food consumption (g/larva)			Food Digestion (g/larva)			Consumption index (Mean)		
	Castor hybrid/ variety (C)			Castor hybrid/ variety (C)			Castor hybrid/ variety (C)		
	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean
1. Borduar	29.00	28.50	28.75	19.13	18.25	18.69	3.471	2.843	3.157
2. Dhanubanga	28.69	28.40	28.54	18.74	18.12	18.43	3.372	2.955	3.163
3. Khanapara	28.84	28.41	28.62	18.93	18.13	18.53	3.396	3.058	3.227
4. Kokrajhar	28.86	28.43	28.65	18.94	18.17	18.55	3.247	2.895	3.071
5. Mendipathar	28.79	28.40	28.60	18.85	18.13	18.49	3.304	3.091	3.197
6. Titabar	28.84	28.43	28.63	18.92	18.17	18.54	3.440	3.031	3.235
Mean	28.84	28.43	28.63	18.92	18.16	18.54	3.372	2.979	3.175
F-value (2 way ANOVA)	C = 626.02** E = 11.68** C x E = 3.07*			C = 1335.70** E = 11.61** C x E = 3.00*			C = 3232.26** E = 50.48** C x E = 64.76**		

Table 1: Continue...

Eco-races of eri silkworm (E)	Approximate digestibility (Mean)			Growth rate (Mean)		
	Castor hybrid/ variety (C)			Castor hybrid/ variety (C)		
	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean
1. Borduar	83.80	82.25	83.02	0.354	0.337	0.346
2. Dhanubanga	83.41	82.03	82.72	0.349	0.335	0.342
3. Khanapara	83.01	81.94	82.48	0.349	0.326	0.337
4. Kokrajhar	83.41	82.10	82.76	0.354	0.337	0.346
5. Mendipathar	82.80	81.92	82.36	0.351	0.325	0.338
6. Titabar	83.17	81.99	82.58	0.348	0.334	0.341
Mean	83.27	82.04	82.65	0.351	0.332	0.342
F-value (2 way ANOVA)	C = 14114.10** E = 340.01** C x E = 86.02**			C = 18911.13** E = 109.61** C x E = 21.01**		

*Significant ($p \leq 0.05$); **Highly significant ($p \leq 0.01$)

The results on consumption of food are in close confirmation with those of Misra and Srivastava (1984) who recorded significant variation in intake of food among different castor varieties during later instars when compared to early instars of eri silkworm. Similarly Chandrashekhar (2007) too recorded higher food consumption when the leaves of DCH-32 castor hybrid were fed to the eri silkworm. Kedir (2011) also registered more food intake in Acc. 208624, Acc. 106584, Abaro and Acc. 203241 castor genotypes when compared to Bako genotype. Whereas, Lakshmi Narayanamma *et al.* (2014) registered higher food intake during later instars and total of all instars on the leaves of PCH-111 genotype, in addition JC-12 and GCH-4 genotypes recorded more food intake both on fresh and dry weight basis, respectively when compared to other castor cultivars.

3.2 Food Digestion (FD)

Total food digestion was more in DCH-177 hybrid as compared to Local pink variety of castor both on fresh and dry weight basis. Among the eco-races of eri silkworm, total food digestion was more in Borduar (18.69 g and 2.295 g) on fresh and dry weight basis respectively and less in worms of Dhanubanga eco-race (18.43 g) on fresh weight basis and Khanapara eco-race (2.038 g) on dry weight basis. The interaction between castor hybrid/variety and eco-races of eri silkworm exhibited highly significant variation with respect to food digestion with highest being in DCH-177 × Borduar and lowest in DCH-177 × Khanapara on fresh weight basis. Further, on dry weight basis, total food digestion was highest in DCH-177 × Borduar, whereas it was lowest in Local pink × Mendipathar. Basaiah (1988) registered higher food

Table 2: Bio-energetics in selected eco races of eri silkworms reared on castor hybrid/ variety on dry weight basis

Eco-races of eri silkworm (E)	Food consumption (g/larva)			Food Digestion (g/larva)			Consumption index (Mean)		
	Castor hybrid/ variety (C)			Castor hybrid/ variety (C)			Castor hybrid/ variety (C)		
	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean
1. Borduar	6.335	6.246	6.291	2.458	2.132	2.295	5.848	4.919	5.384
2. Dhanubanga	6.289	6.241	6.265	2.354	2.110	2.232	6.046	5.204	5.625
3. Khanapara	5.533	6.248	5.890	1.960	2.116	2.038	6.615	5.353	5.984
4. Kokrajhar	6.319	6.235	6.277	2.427	2.118	2.272	5.595	4.993	5.294
5. Mendipathar	6.321	6.234	6.277	2.409	2.108	2.258	6.558	5.504	6.031
6. Titabar	6.323	6.238	6.280	2.417	2.116	2.267	6.439	5.353	5.896
Mean	6.186	6.240	6.213	2.337	2.117	2.227	6.184	5.221	5.702
F-value (2 way ANOVA)		C = 0.54^{NS} E = 3.114* C x E = 3.26*			C = 33.96** E = 4.179** C x E =4.06**			C = 1813.392** E = 130.343** C x E = 16.869**	

Table 2: Continue...

Eco-races of eri silkworm (E)	Approximate digestibility (Mean)			Growth rate (Mean)		
	Castor hybrid/ variety (C)			Castor hybrid/ variety (C)		
	DCH-177	Local Pink	Mean	DCH-177	Local Pink	Mean
1. Borduar	61.56	54.61	58.09	0.337	0.316	0.326
2. Dhanubanga	60.59	53.78	57.19	0.338	0.311	0.325
3. Khanapara	59.63	53.68	56.66	0.340	0.302	0.321
4. Kokrajhar	60.62	54.09	57.35	0.342	0.316	0.329
5. Mendipathar	59.18	53.60	56.39	0.345	0.300	0.322
6. Titabar	60.17	53.75	56.96	0.341	0.311	0.326
Mean	60.29	53.92	57.11	0.341	0.309	0.325
F-value (2 way ANOVA)		C = 18911.13** E = 109.61** C x E = 21.01**			C = 3931.21** E = 21.14** C x E = 49.45**	

*Significant ($p \leq 0.05$); **Highly significant ($p \leq 0.01$)

digestion in Aruna castor variety both on fresh and dry weight basis. Further, Chandrashekhar (2007) reported higher food consumption with DCH-32 castor hybrid on dry weight basis. Sannappa *et al*. (2013) also reported higher food digestion in Local pink variety of castor both on fresh and dry weight basis. The study conducted by Lakshmi Narayanamma *et al.* (2014) revealed that the castor genotypes PCH-111, PCH-222, GCH-4 and Haritha registered higher total digestion of food. According to Gururaj *et al.* (2017), the total food digestion in eri silkworms differ with the castor cultivars when the leaves were offered for feeding and higher values were found in JC-12 castor cultivar (Table 1 & 2).

3.3 Consumption Index (CI)

Marked difference was found in respect of mean CI between castor hybrid and variety with highest value being noticed in DCH-177 hybrid over Local pink variety on fresh weight basis and dry weight basis. Among the eco-races of eri silkworm the mean CI recorded was more in Titabar (3.235) on fresh weight basis and in mendipathar (6.031) on dry weight basis. Whereas, it was minimum in Kokrajhar (3.071 and 5.294) on both fresh and dry weight basis respectively (Khalequzzaman, 1990).

The interaction between DCH-177 × Borduar recorded higher mean CI (3.471), and the same was less in Local pink × Borduar (2.843) on fresh weight basis. When CI scored on dry weight basis, it was higher in DCH-177 × Khanapara (6.615) and Local pink × Borduar (4.919). Khalequzzaman (1990) opined that CI decrease with the advancement in age of the larvae and the mean CI was better in DCS-9 and Local genotype on fresh and dry weight basis, respectively. According to Sannappa *et*

al. (2002), the mean CI was superior in DCH-32 genotype on fresh weight basis and the same pattern of CI was registered by Chandrashekhar (2007) on dry weight basis. Sannappa *et al.* (2013) recorded related results with higher mean CI in Local pink variety on fresh and dry weight basis. As per Lakshmi Narayanamma *et al.* (2014), mean CI was higher in castor hybrid PCH-111 during total larval period. Gururaj *et al.* (2017) found more CI in castor hybrid GAUCH-1 (Table 1 & 2).

3.4 Approximate Digestibility (AD)

The castor hybrid/ variety exhibited marked variation in respect of AD with significantly highest value being recorded in DCH-177 hybrid over Local pink variety on fresh weight and dry weight basis. Among the eco-races of eri silkworm, significantly maximum mean AD was noticed in Borduar on fresh (83.02%) and dry weight basis (58.09%). The AD was minimum in Mendipathar (82.36% and 56.39%) on fresh and dry weight basis. Further, the mean AD was highest in DCH-177 × Borduar and lowest in Local pink × Mendipathar on fresh and dry weight basis. Sannappa *et al.* (2002) recorded more AD in PCS-121 castor genotype and it was less in RC-8 when scored on fresh weight basis. The results of current investigations are in conformity with those of Chandrashekhar (2007) who registered higher mean AD in Local castor genotype. Kedir (2011) noticed relatively more AD in Acc.106584, Acc 208624 and Local genotype and it was less in Bako castor variety. Sannappa *et al.* (2013) registered considerably higher AD when eri silkworm was fed on the leaves of Local green and Local pink castor varieties.

3.5 Growth Rate (GR)

The mean GR of eri silkworms was significantly highest in DCH-177 hybrid (0.351 and 0.341) and less in Local pink variety (0.332 and 0.309) both on fresh and dry weight basis, respectively. Eco-races of eri silkworm did vary significantly with respect to GR and it was higher in Borduar eco-race (0.346) and lower in Khanapara (0.337) on fresh weight basis. However, on dry weight basis, the worms of ecoraces Kokrajhar recorded maximum GR and the same was minimum in Khanapara. Mean GR was significantly more in the interaction of DCH-177 × Borduar. While, it was less in Local pink × Mendipathar on both fresh and dry weight basis. But the interaction of DCH-177 × Mendipathar recorded higher GR on dry weight basis. Relevant results were noticed by Chandrashekhar (2007) who recorded higher mean GR in DCS-85 genotype than other castor genotypes on dry weight basis and Kedir (2011) recorded higher mean GR in Local genotype (control) and it was lesser in Arsel genotype. As per Gururaj *et al.* (2017), the GR was more in GAUCH-1 castor variety both on fresh and dry weight basis. Chumkijini Chhatria *et al.* (2017) also recorded variations in GR during different instars when the leaves of castor hybrid/ variety were fed to the eri silkworm with greater value being noticed in DCS-107 during first instar, Jyothi during second instar, Non-bloomy green during third instar, DCH-519 during fourth instar, Non-bloomy green and red during fifth instar. Nevertheless, Jyothi variety recorded higher mean GR over other varieties/ hybrids (Table 1 & 2).

4. Conclusion

The Borduar eco-race of eri silkworm reared on the leaf of Local pink variety of castor found better as evidenced by the bio-energetics, rearing, cocoon and grainage parameters followed by Kokrajhar and Titabar eco- races. Thus from the current investigation, it can be inferred that, Borduar eco-race of eri silkworm can be reared on the leaf of Local pink variety of castor to enhance the production and productivity of eri cocoons.

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