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Consumption and Conversion Efficiency of Food in New Elite Bivoltine Hybrid Silkworm, *Bombyx mori* L. under Restricted Feeding Levels

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Food consumption and conversion efficiency of new bivoltine hybrids (CSR2 × CSR4 and CSR2 × CSR5) were studied under restricted feeding levels (10, 20 and 30% less quantity of mulberry leaves). The data were compared with a control fed with standard quantum of feed as per the recommendation. The nutritional indices parameters *i. e.* ingesta, digesta, approximate digestibility (%) and reference ratio were recorded higher in control batches compared to less feed batches while nutritional efficiency parameters *i. e.*, ECI and ECD to cocoon and shell were recorded significantly higher in restricted feeding level batches. This increase is attributed due to the physiological adaptation under nutritional stress condition.

Key words: New bivoltine silkworm hybrid, Food consumption, Feed conversion, Restricted feeding levels

Introduction

The consumption of food influences insect growth, survival, biomass accumulation and reproductive performance (Slansky and Scriber, 1985). Differences in food consumption and utilization efficiencies have been noticed among silkworm races quite early (Yammamoto and Fujimaki, 1982; Ramadevi *et al.*, 1992; Magdum *et al.*, 1996b; Trivedi and Nair, 1999). The relation among food ingestion, digestion and body weight gain in silkworm under restricted feeding condition was reported by Sumioka *et al.* (1982a, b) and Ueda and Suzuki (1967). They also observed that feed conversion efficiency parameters were higher under restricted feeding levels. Ingestion pattern and food utilization efficiency of some Japanese silkworm strains under different feeding levels was studied (Singh and Ninagi, 1995; Meenal and Ninagi, 1995). Kuribayashi *et al.* (1990) reported that the amounts of food ingested and digested by the larvae of new bivoltine hybrid silkworm races are about 40% higher than old races. The difference of food ingestion, digestion and conversion among races or hybrids are well established. Recently new productive bivoltine hybrids suitable to rear during favorable seasons of Indian conditions were evolved and popularized in the field (Basavaraja *et al.*, 1995). So it is essential to evaluate the effect of less feeding condition on ingestion, digestion and conversion efficiencies of new bivoltine hybrid races because some times farmers are loosing crop due to shortage of leaves and wrong assessment of leaf production.

Materials and Methods

The rearing of the newly evolved and introduced bivoltine silkworm hybrid races (CSR2 × CSR4 and CSR2 × CSR5) were conducted by utilizing V1 mulberry leaves maintained under irrigated condition as per the procedure laid by Krishnaswami (1978). Feed utilization study was confined to 5th instar larvae as 80% of total leaves are consumed in this instar. Since resumption to 5th instar, 50 larvae each in three replications were separated from each hybrid. The separated silkworm larvae were fed with 10% (T1), 20% (T2) and 30% (T3) less than the recommended quantity of mulberry leaves. A separate batch was also maintained by providing standard feed as per the recommendation and was considered as control (T4). Weighed fresh mulberry leaves as per the recommendation was fed to the silkworm twice a day. Utmost care was taken to maintain the leaf moisture and also the environmental conditions during rearing. Additional larvae batches of

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each treatments were also maintained to determine the dry weight and for subsequent determination of daily increment in larval weight. The healthy larvae were counted daily in each replication and if any unequal or dead or missing larvae during rearing operation were removed and replaced with larvae from additional batches. The leftover leaf and excreta were collected, oven dried and weighed daily and observations on dry weight of larvae, cocoon and shell were also recorded. The nutritional indices parameters *i.e.*, ingesta, digesta, approximate digestibility (AD %), reference ratio (RR) and nutritional efficiency parameters *i.e.*, conversion of ingested food to cocoon and shell (ECI to cocoon and shell) and digested food to cocoon and shell (ECD to cocoon and shell) were calculated by using standard gravimetric method (Waldbauer, 1968). The methods of calculation of various parameters were as follows:

Ingesta = Dry weight of leaf fed - Dry weight of leftover leaf

Digesta = Dry weight of leaf ingested - Dry weight of litter

Approximate Digestibility (AD%) =

$$\frac{\text{Dry weight of leaf ingested} - \text{Dry weight of litter}}{\text{Dry weight of food ingested}} \times 100$$

$$\text{Reference ratio} = \frac{\text{Dry weight food ingested}}{\text{Dry weight of litter}}$$

$$\text{ECI to cocoon \%} = \frac{\text{Dry weight of cocoon}}{\text{Dry weight of ingesta}} \times 100$$

$$\text{ECD to cocoon \%} = \frac{\text{Dry weight of cocoon}}{\text{Dry weight of digesta}} \times 100$$

$$\text{ECI to shell \%} = \frac{\text{Dry weight of shell}}{\text{Dry weight of ingesta}} \times 100$$

$$\text{ECD to shell \%} = \frac{\text{Dry weight of shell}}{\text{Dry weight of digesta}} \times 100$$

The experiment was repeated thrice and the pooled data were tabulated, compiled and analysed by using analysis of variance (ANOVA).

Results and Discussion

The ingestion capacity of food was recorded significantly higher in control (T4) (Table 1) when compared with T2 and T3 in both the races while significant difference was not observed between T4 (control) and T1 (less 10% feed). Significantly higher digesta was recorded in control treatments (1.421 and 1.441 g for CSR2 × CSR4 and CSR2 × CSR5 respectively). Significant difference of ingesta was not observed between control and 10% less feed batches (T1) of both the races studied. However, 30% less feed (T3) batches recorded significantly lower digesta. At lower feed level, the amount of food ingested and digested were lower than the control, which is in agreement with the earlier reports of Singh and Ninagi (1995).

Approximate digestibility gradually reduces in 5th instar and digestibility is affected by nutrient deficiency (imbalanced diet), high content of crude fiber and deficiency of water in the food (Waldbauer, 1964). Comparatively higher AD % (Table 1) was recorded in control (32.95 and 32.01% for CSR2 × CSR4 and CSR2 × CSR5 respectively). However, significant difference of AD % between less feed batches and control was not observed except in CSR2 × CSR5.

Reference ratio (RR) expresses ingesta required per unit excreta production. High value of RR indicates high rate of digestion and absorption of food. It also expresses the retention efficiency of food. No significant difference was

Table 1. Nutritional indices of CSR hybrid silkworm (*B. mori*) reared under low feeding level

Race	Treatments	Ingesta (g)	Digesta (g)	Approximate digestibility (%)	Reference ratio
CSR2 × CSR4	T1 (less 10%)	4.47	1.421	32.88	1.45
	T2 (less 20%)	4.25	1.281	29.91	1.43
	T3 (less 30%)	4.11	1.141	27.79	1.38
	T4 (control)	4.49	1.481	32.95	1.49
CSR2 × CSR5	T1 (less 10%)	4.46	1.431	31.99	1.47
	T2 (less 20%)	4.31	1.371	31.86	1.46
	T3 (less 30%)	4.01	1.241	30.92	1.44
	T4 (control)	4.51	1.441	32.01	1.47
C.D. at 5%		0.1067**	0.0891**	1.789*	0.0551 NS

*, significant at 5%, **, significant at 1%, NS, non significant.

Table 2. Nutritional efficiency parameters of CSR hybrid silkworm (*B. mori*) reared under low feeding level

Race	Treatments	ECI to cocoon (%)	ECD to cocoon (%)	ECI to shell (%)	ECD to shell (%)
CSR2 × CSR4	T1 (less 10%)	16.11	53.23	8.51	27.34
	T2 (less 20%)	16.52	59.01	8.71	30.33
	T3 (less 30%)	16.85	62.27	8.91	31.48
	T4 (control)	16.36	51.34	8.71	27.02
CSR2 × CSR5	T1 (less 10%)	17.01	53.14	9.17	28.67
	T2 (less 20%)	17.44	56.74	9.31	29.19
	T3 (less 30%)	18.45	59.67	9.57	30.64
	T4 (control)	17.11	53.46	9.33	29.16
C. D. at 5%		0.1172**	0.0367**	0.1130**	0.1208**

*, significant at 5%, **, significant at 1%.
ECI: Efficiency of conversion of ingested food, ECD: Efficiency of conversion of digested food.

observed between different treatments and control. However, comparatively higher reference ratio (Table 1) was recorded in control batches. (1.49 for CSR2 × CSR4 and 1.47 for CSR2 × CSR5).

The feed conversion efficiency has been considered as an important economic index in sericulture (Junliang and Xiaoffeng, 1992; Trivedy and Nair, 1998). Larva which utilizes the food to the maximum extent for self-gain is considered to be more efficient (Ramadevi *et al.*, 1992). Magdum *et al.* (1996b) stresses the importance of evaluation of bioenergetics parameters in identifying more productive silkworm races. Significantly higher ECI to cocoon % (16.85 and 18.45% for CSR2 × CSR4 and CSR2 × CSR5 respectively) was recorded when larvae were fed with 30% less feed (T3). According to Hidashi *et al.* (1982) and Sumioka *et al.* (1982a, b), the amount of ingestion and digestion decreases when the worms were fed with less feed during 5th instar. However, the efficiency of conversion of ingested and digested food into body matter, cocoon shell and pupae is higher in less feed batches. Our results are in the conformity with the earlier findings and it is noticed that less fed batches recorded significantly higher feed efficiency parameters (Table 2). This may be due to the fact that choice of feed leads to some physiological adaption to overcome nutritional stress condition (Nath *et al.*, 1990; Tzenov, 1993). Muthukrishnan and Pandian (1987) also reported that insects have evolved a variety of strategies to acquire and accumulate energy from nutrient and water from the available food in the given condition.

Similarly significant difference of ECD to cocoon was observed between different treatments and control (Table 2). Higher ECD to cocoon % was recorded in T3 (62.27% for CSR2 × CSR4 and 59.67% for CSR2 × CSR5) and was found significant. Approximate digestibility was low in less fed batches but ECI and ECD were high, showing an inverse relationship between AD and ECD (Table 1 and 2)

Significantly higher ECI to shell % was recorded when larvae fed with 30% less feed (T3). Significant difference of ECI to shell was observed between all the treatments and control (Table 2). ECI to cocoon % and shell % were ultimate nutritional indices in terms of productivity to evaluate the production efficiency of breed or hybrid (Maachi and Katagiri, 1991). Similar trend was observed in the case of ECD to shell and significant and higher value was recorded in 30% less feed batches (31.58 and 30.64% for CSR 2 × CSR4 and CSR2 × CSR5, respectively).

It is concluded from the present investigation that feed stress in silkworm rearing affect the consumption of food and subsequently affects the digestibility of the food. However, the higher feed conversion efficiency values of the less feed batches shows that insect have some physiological adaptation to nutritional stress condition. The study indicated that ingestion, digestion and utilization of food are important factors for the silkworm growth and development and the quantity and quality of which depends upon the feeding levels and genotype of the hybrid.

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