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Food consumption and utilization pattern of fifth instar muga silkworm *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae) reared on twigs of SOM (*Persea bombycina* King)

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Abstract
The food consumption and utilization study conducted on semi-domesticated muga silkworm, *Antheraea assamensis* Helfer by rearing it on the leaves of *Persea bombycina* King twigs indoor, revealed variation in values for growth rate (GR), consumption index (CI), reference ratio (RR), efficiency of conversion of ingested food (ECI) etc. depending on season and different days of the fifth instar. Consumption index (CI) showed opposite pattern of change with efficiency of conversion of ingested food (ECI), reference ratio (RR), growth rate (GR) in indoor rearing on twigs.

Keywords: consumption and utilization, *Antheraea assamensis*, *Persea bombycina*, growth rate (GR)

Introduction
Nutritional ecology of insects is the pre-requisite for a better knowledge on their ethobiology and physiology [1]. Silkworm growth is composite result of various physiological activities of an organism, by which matter accumulates in the body as a result of balance between assimilation and dissimilation in which complicated phenomena are involved [2]. In sericulture, food is a factor of paramount importance that regulates growth, development, and silk yield. Food intake and silk production in silkworms are very closely related to nutritional factors [3, 4]. The rate of food consumption of silkworms depends upon the nutritional quality of leaf and that the rate of consumption varied in each instar in a cyclic way [5].
The muga silkworm, *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae) is a *vanya* silkworm endemic to north eastern region of India, outdoor reared throughout the larval periods mainly on *som* (*Persea bombycina* King) and *soalu* (*Litsea monopetala* (Roxb.) Pers). Therefore, it is difficult to compute the correct amount of food consumed by the larva.
Muga silkworm is multivoltine and there are 5-6 crops in a year with two commercial crops viz., *Jethua* (Spring) and *Katia* (Autumn). Many attempts have been done to rear muga silkworm in indoor condition, [6-9] but still it is confined in laboratory conditions only. Again, year round rearing of muga silkworm on fresh and quality leaves is not possible. As quality cocoon is influenced by the availability of the nutrient contents of the leaves, therefore, it is necessary to evaluate the nutritional parameters such as consumption, efficiency of conversion of ingested food and growth rate etc. Several workers have extensively studied the nutritional parameters of different silkworms *viz.*, Hamamura (1959), [10] Hiratsuka (1920) [11] on *Bombyx mori*; Joshi (1984, 1985), [12, 13] Poonia (1978) [14] on *Samia ricini*; Yadava *et al*. (1983) [15] on *Antheraea proylei* and Rath (2010) [16] on *Antheraea mylitta.* Systematic study on consumption and utilization of food in respect of muga silkworm is scanty. Therefore, an attempt has been made to rear the muga silkworm on twigs of *som* to compute the nutritional parameters.

Materials and Methods
At first 30-40 cm long '*Som*' twigs were collected from the *som* plantation of Sericulture Department, Assam Agricultural University, Jorhat. These twigs were detached from the plants at dawn, as higher sucrose content of the leaves was reported to be available at this time. Tied with an elastic to prevent from desiccation. Twigs were then kept on a rearing tray of 36 × 27 × 7 cm^3 size [17].

After that basal part of the twigs were wrapped by water soaked cotton and wrapped again by a polythene sheet and The disease free layings (dfls) were collected from the Central Muga Eri Research and Training Institute, Lahdoigarh, Jorhat. Disinfection of the rearing room and appliances were done thoroughly with 2 per cent formalin solution prior to brushings of worms. The eggs were collected and subjected to surface sterilization with 2 per cent formalin solution for about 5 minutes in order to destroy any trace of pebrine parasite. Then the eggs were washed with cleaned tap water and dried under shade. After drying the eggs were incubated inside BOD incubator at 26 °C till hatching. Newly hatched larvae (100 numbers) were transferred to the rearing tray with the help of a fine brush. The tray was then kept inside the rearing cage fitted with mosquito proofed wire netting. The twigs were changed three times in a day. During initial two instars, twigs containing tender and medium leaves and during late instars, twigs having medium and mature leaves were selected. The rearing place was away from direct sun light.

The mean value for the amount of excreta released/larva/48 hours interval was calculated. Fresh individual body weight of the larva was recorded at 48 hours interval. From these data the average fresh body weight of the larva/48 hours interval was recorded and the average body weight gain of the larva/48 hours interval were calculated out. The amount of ingesta/larva/48 hours interval was calculated by adding the value for fresh body weight gain/larva/48 hours interval to the corresponding value obtained for excreta/larva/48 hours interval and the mean value was calculated out later on [18] The above experiment was carried out in three difference seasons *viz.*, post-monsoon, pre-monsoon and monsoon season. The various indices of consumption and utilization of food were calculated on fresh weight basis adopting equations of Waldbauer (1968) [19].

i) Consumption Index (CI)

$$\text{Consumption Index (CI)} = \frac{F}{TA}$$

Where, F = Fresh weight of food eaten (g)
T = Duration of feeding period
A = Mean fresh or dry weight of larva during feeding period

ii) Growth rate (GR)

$$\text{Growth rate (GR)} = \frac{G}{TA}$$

Where, G = Fresh weight gain of larva during feeding period (g)

iii) Efficiency of conversion of ingested food (ECI) to body matter

$$ECI = \frac{\text{Weight gain (g)}}{\text{Weight of food ingested (g)}} \times 100$$

iv) Reference ratio (RR)

$$\text{Reference Ratio (RR)} = \frac{\text{Weight of food eaten (Fresh)(g)}}{\text{Weight of excreta (Fresh)(g)}}$$

The experiment errors found while observing the various effect was determined by calculating their respective P values following Panse and Sukhatme (1989). [20]

Results and Discussion

Examination of the CI, GR and ECI (%), RR revealed that the CI showed opposite pattern of change with GR, ECI (%); RR with lower value of CI just after moulting and then registered progressive increase. Examination of the GR revealed that the growth of the insect was higher just after moulting, there was a progressive decrease during the later part of the instar. The ECI and RR also showed almost similar pattern with that of GR (Table 1, 2, 3).

However, in the present investigation, RR was observed in post-monsoon season 1.1225 to 1.6850; in pre-monsoon season 1.0400 to 2.2225 and in monsoon season 1.0575 to 2.6275 on twigs of *P. bombycina*. Reference Ratio (RR) is an indirect expression of absorption and assimilation of food. Higher RR values mean high rate of digestion and absorption of the food. [21] Mathavan and Pandin (1974) [22] recorded 1.5 RR value for 5th instar larva of lepidopterans and Anantha Raman *et al*. (1993) [23] recorded 1.6 RR value for 5th instar larva of *B. mori*. Magadum *et al*. (1996) [24] reported that RR varied from 1.45 to 1.77 during 5th instar in nine bivoltine breeds of *B. mori*. Das *et al*. (2002) [18] recorded the RR value of *A. assamensis* in between 1.04 to 2.69 in pre-monsoon season and 1.06 to 4.31 in monsoon season.

In the present investigation, GR, CI, ECI were found to vary depending on the seasons and different days of the same instar. Hiratsuka (1920) [11] also reported that ECI and ECD varied from instar to instar, day to day of the same instar and breed to breed of the same silkworm. Trivedy and Nair (1999) [25] found variation in conversion efficiency depending on climatic condition. They reported that when CI increased, the rate of passage of food through the gut increased allowing less time for digestion and assimilation. On the contrary, when CI decreased the passage of food through gut became slow and facilitated increased digestion and assimilation. They observed that the ECI (larva) ranged from 14.175 per cent to 20.122 per cent during fifth instar of *B. mori*. Magadum *et al*. (1996)[23] studied the breed and seasonal differences in food consumption and utilization efficiencies in fifth instar of nine bivoltine breeds of *B. mori* and reported that CI ranged from 1.103 to 1.307. Raman *et al*. (1994) [26] recorded ECI for body, cocoon and shell of silkworm *B. mori* hybrid race (NB_4D_2 × KA) were 23.63, 9.496 and 46.65 per cent. However, Das *et al*. (2004) [27] recorded higher ECI (5.59 to 43.43) and RGR (0.02 to 0.30) in fifth instar *A. assamensis* larva.

In the present study, comparatively higher ECI and GR and lower CI upto middle of the fifth instar were recorded. It may be inferred that ingested food was utilized for body development. In late fifth instar, food was utilized as energy for organ development. However, in all the seasons, it was observed that the values for CI were lower up to early part of fifth instar, then there was sharp increase in the later part of the 5th instar. Lower values of ECI and GR from middle to late part of fifth instar also suggested that the ingested food was being metabolized for silk gland development rather than general body weight development. Ono (1951) [28], Legay (1958) [29] reported that fifth instar period of silkworm was the most important regarding development of silk gland and secretion of silk.

Table 1: Nutritional indices of *Antheraea assamensis* reared on twigs of *Persea bombycina* (post-monsoon season)

Age of 5th instar larva 2 days interval	CI	GR	ECI (%)	RR
1st Day	2.0600	0.1575	40.6175	1.6850
3rd Day	1.8500	0.1550	35.0500	1.5325
5th Day	2.4200	0.0930	20.8275	1.2750
7th Day	3.5475	0.0563	14.1750	1.1750
9th Day	5.3400	0.0328	9.9275	1.1225
S.Ed (±)	0.0216	0.0023	0.0248	0.0237
CD (P = 0.05)	0.0461	0.0048	0.0530	0.0505
CD (P = 0.01)	0.0638	0.0067	0.0732	0.0698

Data represent average of four replications

Table 2: Nutritional indices of *Antheraea assamensis* reared on twigs of *Persea bombycina* (pre-monsoon season)

Age of 5th instar larva 2 days interval	CI	GR	ECI (%)	RR
1st Day	2.0775	0.1680	48.5050	1.9500
3rd Day	2.0950	0.1790	54.5300	2.2225
5th Day	2.4125	0.0483	20.8300	1.2700
7th Day	4.7600	0.0320	10.5450	1.1300
9th Day	6.3200	0.0293	7.9325	1.1000
11th Day	10.0925	0.0233	4.9725	1.0600
13th Day	10.3100	0.0160	3.6500	1.0500
15th Day	13.7400	0.0110	2.7400	1.0400
S.Ed (±)	0.0190	0.0019	0.0408	0.0198
CD (P = 0.05)	0.0392	0.0040	0.0841	0.0409
CD (P = 0.01)	0.0532	0.0054	0.1140	0.0555

Table 3: Nutritional indices of *Antheraea assamensis* reared on twigs of *Persea bombycina* (monsoon season)

Age of 5th instar larva 2 days interval	CI	GR	ECI (%)	RR
1st Day	2.0300	0.1668	61.7900	2.6275
3rd Day	1.8800	0.1638	37.2800	1.5925
5th Day	3.0250	0.0785	16.5375	1.2075
7th Day	4.4675	0.0523	11.2175	1.1375
9th Day	5.0125	0.0468	9.9850	1.1150
11th Day	10.2975	0.0190	4.8675	1.0575
S.Ed (±)	0.0213	0.0020	0.0217	0.0228
CD (P = 0.05)	0.0448	0.0042	0.0456	0.0479
CD (P = 0.01)	0.0614	0.0058	0.0624	0.0655

Conclusion

Food utilization efficiency of muga silkworm depends on quantity and quality of food offered, age of the larvae, environmental condition and various other factors during the period of rearing. Present investigation revealed that growth rate (GR), consumption index (CI), reference ratio (RR), efficiency of conversion of ingested food (ECI) varies in different days of the same instar and in different seasons. It may be concluded that upto middle of fifth instar the consumed food was utilized for general growth and development and from this stage onward, the food was utilized for silk gland development.

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