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Change in Rate of Feeding and Assimilation in *Antheraea mylitta* Fed on Two Major Food Plants and its Effect on Silk Production and Reproduction

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Abstract: *Antheraea mylitta* is a polyphagous and autogenous insect. About 206.8 g wet leaves of *Terminalia tomentosa* or 188.7 g of *Terminalia arjuna* were consumed by *Antheraea mylitta* from hatching to gut purging of which 81% of leaves were eaten during V instar. Irrespective of food plant both rate of feeding and assimilation declined significantly with the development of the larvae. The Relative Growth Rate (RGR) was found highest during II instar and then declined. The metabolic efficiency of the larvae declined up to IV instar followed by an increase during V instar. Significantly higher consumption, assimilation, growth and respiration were measured in the larvae fed on *T. tomentosa*. While significantly higher feeding rate was observed in *T. arjuna* fed larvae during II and V instar over *T. tomentosa* fed ones but the assimilation rate remained at lower level. The silk production by the larvae fed with *T. tomentosa* and the reproductive fitness of the moths developed from it were found to be significantly higher than that of *T. arjuna* fed ones. Thus, *T. tomentosa* proves its comparative superiority over *T. arjuna*.

Key words: *Antheraea mylitta*, assimilation, feeding, food plant, silk production, reproduction

INTRODUCTION

Lepidopterans form one of the major groups of terrestrial insect primary consumers that eat almost 100% of its total food requirements during its larval stages and accumulate sufficient food energy to tide them over the non-feeding pupal and adult stages. The Indian tropical tasar silkworm *Antheraea mylitta* is wild and polyphagous in nature, completes two to three life cycles a year and is of high economic importance. The larva is a voracious feeder in non feeding adult insects and hence the growth rate, developmental time, final body weight, survival and reproduction are influenced to a great extent not only by the amount and rate of feeding but also equally by the food quality. Maximum potential fitness is only possible when the larva obtain adequate amount of necessary nutrients in a suitable relative balance[1]. A number of studies were undertaken in the past to find out the food utilisation efficiency in *A. mylitta*[2,3,4]. The earlier studies did not reveal any information on the rate of feeding and assimilation, its RGR (relative growth rate), adult characters, reproductive fitness, cocoon shell production and quantum of food ingested, assimilated and biomass produced during different instars of development of the insect which is the aim of the present study.

MATERIALS AND METHODS

Antheraea mylitta Drury (Lepidoptera: Saturniidae) of Daba bivoltine ecorace was taken as the experimental material because of its high exploitation potency. Primary food plants, *Terminalia tomentosa* and *T. arjuna* were selected because these plants support the insect with ideal growth, survivability and reproductive fitness and commercial rearing were under taken on these plants at a large scale.

Indoor rearing of the fresh and healthy newly hatched larvae were conducted as per the method described earlier[2]. During the rearing fresh leaves were provided to the larvae in sufficient quantity twice a day until the larvae attain maturity. Mature larvae then mounted on the respective food plants out door to spin the cocoons. Cocoon shell weights were recorded soon after pupation is over. The harvested cocoons were kept for observations on adult emergence, moth weight, fecundity and fertility. There were 5 replications each of 50 worms for each host plant. Buffer stocks for each host plant were maintained separately to compensate for mortality. Quantity of food ingested and assimilated, faecal matter excreted and gain in body weight were measured by standard gravimetric method of Waldbauer [5], while feeding rate (food intake per g of larva per day) and assimilation rate (food assimilated per g of larva per day) was measured following Delvi and Pandian [6]. The middle body weight of an individual (calculated by adding half the mean net growth to the initial mean body weight of the individual) was used for calculation of rate of feeding and assimilation. The results were analysed using ANOVA and student's t-test for significance. The present study was under taken during July-August in prevailing climatic conditions (temp. 26-34°C and 77-86% R.H.).

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Table 1: Rate of feeding and assimilation, metabolic efficiency and relative growth rate in *A. mylitta* fed on two different food plants

		Larval stadium						
Parameters	Food plant	I	II	III	IV	V	CD at 5%	Entire larval life
Food consumption (g)	Tt	0.488	1.993	7.436	30.033	166.859	2.337	206.809
	Ta	0.400 (p<0.05)	1.786 (p<0.02)	5.894 (p<0.001)	27.454 (p<0.001)	153.183 (p<0.001)	2.342	188.717 (p<0.001)
Food assimilation (g)	Tt	0.360	1.338	4.543	20.773	72.856	1.301	99.827
	Ta	0.277 (p<0.001)	1.098 (p<0.001)	3.198 (p<0.001)	17.195 (p<0.001)	61.971 (p<0.001)	1.367	84.020 (p<0.001)
Tissue growth (g)	Tt	0.081	0.497	1.985	9.907	28.857	0.713	41.328
	Ta	0.062 (p<0.001)	0.380 (p<0.001)	1.373 (p<0.001)	7.757 (p<0.001)	23.379 (p<0.001)	0.799	32.951 (p<0.001)
Respiration (g)	Tt	0.279	0.841	2.558	10.865	43.999	1.483	58.499
	Ta	0.214 (p<0.001)	0.719 (p<0.001)	1.826 (p<0.001)	9.438 (p<0.001)	38.592 (p<0.001)	1.068	51.071 (p<0.001)
Feeding rate	Tt	2.542	1.971	1.386	0.626	0.531	0.088	0.349
	Ta	2.509 (P, NS)	2.297 (p<0.01)	1.401 (P, NS)	0.633 (P, NS)	0.572 (p<0.01)	0.097	0.367 (p<0.05)
Assimilation rate	Tt	1.876	1.324	0.846	0.432	0.232	0.048	0.168
	Ta	1.733 (p<0.001)	1.414 (P, NS)	0.760 (p<0.001)	0.397 (p<0.001)	0.231 (P, NS)	0.072	0.163 (P, NS)
RGR	Tt	0.462	0.586	0.458	0.241	0.119	0.036	0.070
	Ta	0.433 (p<0.01)	0.565 (P, NS)	0.406 (p<0.01)	0.213 (P, NS)	0.113 (P, NS)	0.022	0.064 (p<0.01)
R/C	Tt	57.153	42.146	34.371	36.150	26.362	2.146	28.280
	Ta	53.588 (p<0.001)	40.153 (P, NS)	31.002 (p<0.01)	34.404 (p<0.05)	25.190 (P, NS)	2.055	27.044 (P, NS)
R/A	Tt	77.419	62.683	56.253	52.264	60.387	3.225	58.576
	Ta	77.559 (P, NS)	65.244 (P, NS)	57.068 (P, NS)	54.912 (p<0.01)	62.219 (P, NS)	2.371	60.558 (P, NS)

Tt-*Terminalia tomentosa*, Ta- *Terminalia arjuna*
Significance obtained from Student's t-test was cited inside the parentheses
RGR: Relative growth rate; R/C: Respiration/consumption; R/A: Respiration/assimilation

RESULTS AND DISCUSSION

From Table 1 it is clear that food consumption, assimilation, tissue growth, respiration and feeding and assimilation rate, RGR, metabolic efficiencies (respiration/consumption -R/C and respiration/assimilation- R/A) followed the same trend irrespective of the food plant on which the larvae were fed upon. The absolute values for food consumption, assimilation, tissue growth and respiration increase where as, the rate of feeding and assimilation decrease significantly with advancement in the larval age. The RGR is highest in the II and lowest in V instar. The decreased tendency of RGR with advancing age of the larvae may be due to either reduction in feeding rate with increase in body weight[6,7,8,9] or decline in utilization efficiency[10]. Reduction in growth rate with the advancement of larval stage was noticed in *Galleria mellonella*[11], *Spodoptera litura*[12] and in other insects[1]. But the metabolic efficiency (R/C and R/A) behaves differently. The R/C tends to decline up to III instar, rises in IV and again declined during V instar. The behaviour of R/C is quite similar to that of assimilation efficiencies as reported earlier [2]. It implies that R/C and assimilation efficiencies are interrelated. The R/A in the other hand, declined up to IV instar followed by a rise during V instar. From these results it is clear that first instar larvae are metabolically active and as the larvae ages R/C declines, but R/A increased during V instar. This might be due to the fact that higher metabolism of assimilated food is required at this stage to facilitate higher absolute growth and to store sufficient nutrients for the non-feeding stages. A trend of higher metabolism in the later stages of *A. mylitta* was also reported in *A. proylei*[13], but it is in contradiction to the findings of Mohanty and Mitra[14] in *A. mylitta*.

Absolute values for food consumption, assimilation, tissue growth and respiration were remained significantly at higher level in the larva fed with *T. tomentosa* over *T. arjuna* in all instars. Feeding rate in *T. arjuna* fed ones remained at higher levels during II to V instar and was significant only during II and V. But the assimilation rate remains significantly at the lower side in I, III and IV instar in *T. arjuna* fed larvae. The RGR was comparatively higher in the larvae fed with *T. tomentosa* over *T. arjuna* but the values were significant during I and III instar. The R/C in *T. tomentosa* fed were at higher side and were significant only during I, III and IV; in contrast, the R/A value show the reverse trend where, *T. arjuna*

Table 2: Percentage of ingestion, assimilation and biomass production during different instars of *A. mylitta* fed upon two primary host plants.

	Percentage of total during entire larval life					
	Ingestion		Assimilation		Biomass production	
Stages	*T. tomentosa*	*T. arjuna*	*T. tomentosa*	*T. arjuna*	*T. tomentosa*	*T. arjuna*
I	0.24	0.21	0.36	0.33	0.20	0.19
II	0.96	0.95	1.34	1.31	1.20	1.15
III	3.60	3.12	4.55	3.81	4.80	4.17
IV	14.52	14.55	20.81	20.46	23.97	23.54
V	80.68	81.17	72.98	73.76	69.82	70.95

Table 3: Feeding and assimilation level and weight exponents obtained from regression analysis.

	Feeding rate		Assimilation rate	
Food plant	Feeding level Y g	Weight exponent X g	Assimilation level Y g	Weight exponent X g
T. tomentosa	1.8186	0.0564	1.2601	0.0440
T. arjuna	1.9030	0.0740	1.2094	0.0532

Table 4: Effect of rate of feeding and assimilation on silk production and reproduction in *A. mylitta.*

Food plant	Shell weight (g)	Adult emergence%	Moth weight (g) Male	Female	Fecundity (nos.)	Fertility (%)
T. tomentosa	2.044	92.281	2.997	6.724	245	93.310
T. arjuna	1.711	88.087	2.252	6.410	211	87.236
P	<0.01	<0.02	<0.001	NS	<0.001	<0.001

fed have significantly higher values during IV instar. These differences are due to difference in food plants upon which the larvae fed as reported earlier[15].

When the entire larval life was considered all the parameters show significant higher values in *T. tomentosa* fed ones over *T. arjuna* excluding assimilation rate, R/C and R/A.

Table 2 shows proportional food intake, assimilation and biomass production in different instars of *A. mylitta.* The larvae ingest about 95.2 to 95.72% of the total intake during the last two instars, which is *at par* with other lepidopteran leaf feeders[5]. Similarly the bulk assimilated food available for utilisation during last two instars amounts to 93.8 to 94.2% and the absolute growth records 93.8 to 94.5%, which indicate the importance of the last two instars to support growth as reviewed by Wadbauer[5]. The regression equation Y= a+bX for feeding rate-weight relationship (Table 3) revealed that for a 1 g of increase in body weight the decrease in feeding rate was 0.0564 g g^{-1} per day in *T. tomentosa* and 0.0740 g g^{-1} per day in *T. arjuna.* The assimilation level was found to be higher in the larvae fed with *T. tomentosa* than those fed with *T. arjuna.* In contrast, in *B. mori* for 1 mg increase in body weight the decrease in feeding rate is 0.3452 mg g^{-1} per day. Not only grasshopper[6] but also *B. mori* showed a straight-line inverse relationship for feeding rate-body weight in the first four instars[16] which was also observed in *A. mylitta.* However, the rate of feeding in *A. mylitta* is 2.5 times more than that of *B. mori,* which shows the food consumption ability of the larva.

The silk production (in terms of shell content) was found to be significantly higher in *T. tomentosa* fed ones over *T. arjuna* (Table 4). This might be due to the fact that *T. tomentosa* is comparatively a choice food which *A. mylitta* can assimilate easily and acquire the required RGR and contribute substantial allocation for silk production. Earlier studies in the Sarihan and Sukinda ecorace of *A. mylitta* also revealed that the shell content in *T. tomentosa* fed ones were significantly higher over *T. arjuna* fed ones[17].

Adult emergence, adult weight, fecundity and fertility were also influenced due to the food type. Adult emergence was found significantly higher in the larvae fed with *T. tomentosa* (92.3%) over *T. arjuna* (88.1%). Adult male weight was found significantly higher in *T. tomentosa* fed larvae than that of *T. arjuna* fed ones, but female weight did not differ. Both fecundity and fertility were significantly higher in the moths developed from the larvae fed on *T. tomentosa* (245, 93.3%) than on *T. arjuna* (211, 87.2%) (Table 4).

The results revealed that food quality is responsible for attaining physiological potential, which corroborates the findings of Slansky and Scriber[1]. From the study it was revealed that due to change in food quality parameters on quantitative nutrition gets affected and further influence the adult characters and reproductive fitness which are in accordance with the earlier findings[5,10,18,19,20]. The higher nutritional qualities of *T. tomentosa* enable the larvae to attain the potential fitness in the above characters over *T. arjuna.* The physiological performance in the adults seems to be

guided by the nutritional factors present in food plant and have a negative effect when food plant is not nutritionally effective. The decline in adult emergence, adult weight, fecundity and fertility in the moths developed from the larvae fed with *T. arjuna* might be a reflection of food quality, which agrees with earlier findings of Scriber and Slansky[10] and Slansky and Scriber[19].

From the above study it further be concluded that *T. tomentosa* is comparatively a superior food plant in comparison to *T. arjuna* which support the earlier findings[2,21].

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