J. Biosains Vol 1. No. 1.: 5-7.(1995)

FOOD UTILIZATION PARAMETERS COULD BE USED TO INDICATE FOOD SUITABILITY IN THE SILKWORM, *BOMBYX MORI*

Intan Ahmad, Ameiria D. Lubis and Soelaksono Sastrodihardjo
(Department of Biology and Inter University Center for Life Sciences
Institut Teknologi Bandung)

ABSTRACT

*The determination of the most suitable kind of mulberry leaf for feeding the silkworm, **Bombyx mori**, was carried out by measuring the index of nutrition of the fourth-instar larvae **Bombyx mori**. Silkworm fed on **Morus nigra** and **Morus alba** had a higher efficiency of conversion of digested dry matter to body substance (ECD) and a higher efficiency of conversion of digested dry matter to body substance (ECI) compared to silkworm fed on **Morus cathayana** and **Morus multicaulis**. The relative growth rate (RGR) of the larvae fed on **Morus nigra** was higher compared to the larvae fed on **Morus alba**. Based on the values of ECI and ECD, we believe that **Morus nigra** is the most suitable kind of mulberry leaf for feeding silkworms. Silkworms fed on **Morus nigra**, which had the highest protein content, had a second highest value of RGR next to that of the larvae fed on **morus multicaulis**, which had the lowest protein content. The difference in carbohydrate content of the various kind of mulberry leaves seemed to have little effects on the growth of the larvae.*

Key Word Index : *Silkworm, **Bombyx mori,** Mulberry, Morus sp, growth, nutritional indices, food utilization.*

ABSTRAK

*Penentuan daun murbai yang paling cocok untuk santapan ulat sutra, Bombyx mori, dilakukan dengan pengukuran index nutrisi instar ke empat larva Bombyx mori. Ulat sutra yang disuguhi **Morus nigra** dan **Morus alba** mempunyai efisiensi konversi yang lebih tinggi terhadap substansi yang dicerna menjadi substansi tubuh (ECD) dan efisiensi konversi yang lebih tinggi terhadap substansi yang dicerna menjadi substansi tubuh (ECI) dibandingkan dengan ulat sutra yang disuguhi **Morus cathayana** dan **Morus multicaulis**. Kecepatan tumbuh relatif (RGR) dari larva yang disuguhi **Morus nigra** lebih tinggi dibandingkan larva yang disuguhi **Morus alba**. Berdasarkan nilai-nilai ECI dan ECD, kita percaya bahwa **Morus nigra** adalah daun murbai yang paling cocok untuk makanan ulat sutra. Ulat sutra yang disuguhi **Morus nigra**, yang mempunyai kandungan protein tertinggi, memiliki nilai RGR ke dua setelah larva yang disuguhi **Morus multicaulis**, yang mempunyai kandungan protein terendah. Perbedaan dalam kandungan karbohidrat dari berbagai daun murbai kelihatannya hanya sedikit mempengaruhi pertumbuhan larva.*

INTRODUCTION

In Indonesia, several mulberry varieties are grown and used as food sources for silkworm, *Bombyx mori*. Unfortunately, to the best of our knowledge there are no published paper showing the extent to which different mulberry varieties effect the growth and development of *Bombyx mori*, or in other word which mulberry leaf is actually the most suitable for the silkworm. Therefore, we conducted a series of studies to see the qualitative effects of four varieties of mulberry leaf on the growth, food consumption and the efficiency of food use.

Because plant tissue is generally much lower in nitrogen than animal tissue (Southwood, 1972), it is likely that in the natural food as well as artificial diet of phytophagous insects, nitrogen is a limiting factor (Mattson, 1980, Ahmad, 1992). Even though mulberry leaf generally contains all nutrients required by the silkworms. Nonetheless, the amount and proportion of nutrients can vary within and among mulberry species (Xu and Wu, 1992). Therefore, in order to see the effects of these two macronutrients against insect performance,

we measured the protein and carbohydrate contents of the mulberry leaf.

MATERIALS AND METHODS

Polyhibrid bivoltine silkworm larvae, *Bombyx mori*, were reared in accordance to the methods developed by Katsumata (1964). Four mulberry species were used as food sources in these experiments, i.e.,: *Morus alba, Morus cathayana, Morus multicaulis* and *Morus nigra*. 100 first instar newly hatched larvae were reared in one of the four mulberry species. All experiments began with newly molted, unfed, 4th-instar larvae, they were held individually in arenas containing one of the four mulberry species which had been weighed and changed every day. The experiments were ended when these larvae had become pharate 5th instars. The gravimetric method described by Waldbauer (1968) and Ahmad (1992) was used to determine food consumption and growth parameters of all experiments. The protein content of the mulberry leaf was determined by Kjeldahl analysis (Karowe and martin, 1989), and carbohydrate content with the method modified from Roe (1955).

RESULTS AND DISCUSSION

Table 1 shows the food consumption and utilization parameters of 4th-instar *Bombyx mori* larvae fed on different mulberry species. When larvae were fed *M. multicaulis*, which had the lowest protein content (Table 2), they ate significantly more food than when fed the other mulberry species. Apparently these larvae ate more in order to increase the intake of nutrient. As a result it is not surprising to see that by eating a lot more food as compared to larvae fed on M. nigra and *M. alba*, the relative growth rate (RGR) of the larvae fed on *M. multicaulis* was significantly higher then the others. Infact, we expected the same thing would happen in the larvae which fed on *M. cathayana* (they ate more as compared to the larvae which fed on *M. alba* and *M. nigra*), but the value of RGR did not support our expectation. Our results showed that the lowest RGR values were achieved by larvae fed on *M. alba* and *M cathayana*.

Interestingly, larvae which fed on *M. alba* and *M. nigra* had similar values of ECD and ECI, and these two indices were significantly higher than those larvae fed on *M. cathayana* and *M multicaulis*. The higher values of ECD and ECI indicated that by eating less, the larvae were able to obtain sufficient nutrient to support their growth, this is very good. For example, the larvae which fed on *M. nigra* ate only half to food eaten by the larvae that fed on *M. cathayana*. However, larvae which fed on *M. cathayana* had RGR significantly lower than of larvae which fed on M. nigra. The low values of ECI and ECD on *M. cathayana* and *M. multicaulis*, we believe as a consequence of increased consumption due to the lower protein content. These reduces ECD and ECI values may reflect higher metabolic feeding costs (karowe and Martin, 1989, Ahmad, 1992). Based on these two indices (ECD and ECI) we believe that *Morus nigra*, followed by *M. alba* are the most suitable food for 4th instar *Bombyx mori* larvae. Although it is apparent from our experiments that high protein contents, does support the best performance for larvae fed on *M. nigra* (had the highest protein content). This finding could be mis leading, since the situation is not the same as the larvae that fed on *M. cathayana, M. alba* and *M. multicaulis* (had the lowest protein content). Our results only suggest that it is important for the insects to be able and adequate and balanced intake of protein (amino acids) and not only the total protein contents from their food.

Approximate digestibility was significantly affected by the kind of mulberry eaten and protein content. The results indicated that all food were easily digested (AD ranging from 57 - 87 %) and the leaves became less digestible as protein content of the leaves decreased (see Table 1 and Table 2). The difference in carbohydrate contents of the various kind of mulberry leaves seemed to have little effect on the growth of the larvae. In fact 4th instar Manduca sexta larvae Ahmad (1992) and final instar *Heliothis zea* larvae (Waldbauer et.al. 1984) can survive

on a defined diet that contains only protein and lacks carbohydrate, indicating that they do not have an absolute requirement for dietary carbohydrate.

Table 1. Consumption, growth and utilization parameters of the 4th instar *Bombyx mori* larvae fed on the four mulberry species (*Morus alba, Morus Cathayana, Morus multicaulis and Morus nigra*). N = 25 per treatment. All values are means ± SE. Means within a column followed by the same letters are not significantly different (ANOVA followed by SNK test, $p < 0.05$).

Mulberry	RGR	RCR	AD (%)	ECD (%)	ECI (%)
M. alba	0,591± 0,009^{c}	6,001± 0,418^{c}	57,318± 2,226^{d}	18,574± 1,438^{a}	10,646± 0,488^{a}
M. cathayana	0,612± 0,009^{c}	14,313± 0,350^{b}	81,602± 0,820^{b}	5,240± 0,260^{b}	4,276± 0,160^{b}
M. multicaulis	0,655± 0,648^{a}	16,293± 0,350^{a}	87,208± 0,577^{a}	4,609± 0,248^{b}	4,020± 0, 18^{b}
M. nigra	0,639± 0,006^{b}	7,560± 0,385^{c}	68,956± 1,417^{c}	12,266± 0,796^{a}	8,459± 0,380^{a}

The indices are :

RGR : Relative Growth Rate
RCR : Relative Consumption Rate
AD : Approximate Digestibility
ECD : Efficiency of Conversion of Digested Food
ECI : Efficiency of Conversion of Ingested Food

Table 2. Amounts of total protein and carbohydrate in leaves fed *Bombyx mori* larvae in this study

Mulberry leaf	Protein (%)	Carbohydrate (%)
M. alba	6.914	5.913
M. nigra	9.020	3.175
M. cathayana	7.567	4.866
M. multicaulis	5.956	3.297

REFERENCES

Ahmad, I.M. 1992. *Dietary self-selection by the tobacco hornworm, **Manduca sexta**: self selection from defined diets and the role of the maxillae in this process.* Ph.D. Thesis University of Illionis at Urbana-Champaign.

Karowe, D.N. and M.M. Martin. 1989. *The effect of quantity and quality of diet nitrogen on the growth, efficiency of food utilization, nitrogen budget, and metabolic rate of fifthinstar **Spodoptera eridanie** larvae (Lepidoptera: Noctuidae).* J. Insect Physiol. Vol.35, no.9, pp 699-708.

Katsumata, Fujio. 1964. *Silsilah hidup ulat sutra. Tokyo.*

Mattson, W.J., Jr. 1980. *Herbivory in relation to plant nitrogen content.* Ann. Rev. Ecol. Syst. 11: 199-161.

Roe, J.H. 1955. *The determination of sugar in blood and spinal fluid with anthrone reagent.* J. Biol. Chem. 212: 335-343.

Southwood, T.R.E. 1972. *The insect/plant relationshipan evolutionary perspective.* pp. 3-3- In H.F. Van Emden (ed.), Insect/plant relationship. London: Blackwell.

Xu, J and X. Wu. 1992. *Studies on the leaf-conversion rate of the silkworm, **Bombyx mori**.* Paper presented at XIX International Congress of Entomology Beijing China.

Waldbauer, G.P., R.W. Cohen, and S. Friedman. 1984. *Self-selection of an optimal nutrient mix from defined diets by larvae of the corn earworm, **Heliothis zea** (Boddie).* Physiol. Zool. 57: 590-597.

Waldbauer, G.P. 1968. *The consumption and utilization of food by insects.* Advan. Insect Physiol. 5:229-288.