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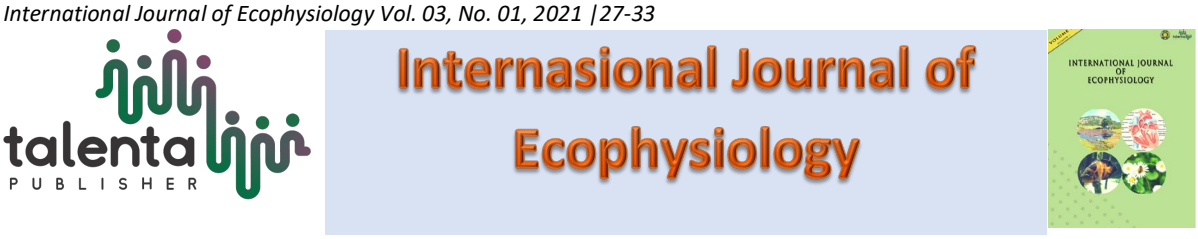

Efficiency of Feed Consumption and Rate of Silkworm Respiration *(Bombyx mori* L.) Mulberry Leaves (*Morus* sp.) Containing Vitamin B1 (Thiamine)

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Abstract. The effect of Mulberry (*Morus* sp.) leave that contain vitamin B1(Thiamine) on the efficiency of feed consumption and respiration rate of silkworm (*Bombyx mori* L.) had been carried out. This study was complete randomized designed (CRD) by 5 treatments and trireplicated. Each replication consisted of 10 silkworms. The treatmeants were vitamin B1 with concentration of 0; 0,1; 0,2; 0,3 and 0,4mg/100 ml. The results showed that the relative consumption rate increased to the concentration of 0,4mg/100 ml and respiration rate was 0,4mg/100ml ($p<0,05$). Vitamin B1 had no effect on the relative growth rate, efficiency of convertion of digested food, efficiency of convertion of ingested food and approximate digestibility.

Keyword: *Bombyx mori* L., *Morus* sp., Vitamine B1 (thiamine), efficiency of food, respiration rate

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1 Introduction

Indonesia is one of the tropical countries that develops natural engineering business, because it has natural conditions suitable for the growth of silkworms and mulberry plants as silkworm feed[1]. In tropical conditions, silkworms of different breeds have different nutritional needs for the growth and productivity of cocoons. Feed consumption has a direct impact on the weight of the larvae, the weight of the cocoon, the amount of silk produced and the number of eggs. The efficiency of the conversion of absorbed and digested feed in larvae is strongly influenced by mulberry varieties, seasons and nutritional quality[2]. According to [3] silkworm production can be affected by the quality and number of mulberry leaves and so is the limited respiration produced by silkworms. Respiration produced in the physiological body of animals occurs at the time of eating and resting activities that are utilized for energy in the body [4]. Silkworms consume mulberry leaves. Mulberry leaves contain amino acids, tannins and vitamins and one of

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them is vitamin B1. Vitamin B1 (thiamine) is required in the metabolism of all animal species by increasing the efficiency of the amount of feed. In animals, thiamine is obtained from its food [5].

2. Material and Methods

The study used a complete randomized design (RAL) with 5 treatments with 3 repeats consisting of 10 caterpillars i.e. a concentration of vitamin B1 0mg / 100ml; 0,1mg/100ml; 0.2mg/100ml; 0.3mg/100ml and 0.4mg/100ml. Silkworm eggs are obtained from candiroto silkworm breeding center, Central Java. The eggs are wrapped in white HVS paper and carbon paper is then arranged in a plastic basket until hatched. Silkworms that have hatched are fed mulberry leaves that have been dipped in vitamin B1 solution. Caterpillars are put in petri dishes that have previously been coated with wet wipes and pedestal paper. At the end of instar II the caterpillar that has stopped eating, placed separately until replacing cuticles (molting). After replacing the cuticle, the caterpillar enters the beginning of instar III and weighs its body weight. Mulberry leaf feed that has been dipped in vitamin B1 before given is weighed first. At the end of instar III which is characterized by caterpillars have stopped eating and changed cuticles (molting) where the maintenance of silkworms is cleaned, feces and the rest of the feed is collected. At the end of instar III the silkworm weighed its weight. The feces and rest of the feed produced by the caterpillars are then dried in the oven at a temperature of 60 ° C until the weight is constant. The same is done at the beginning and end of instar IV through V.

a. The nutritional index of [6] is: Growth rate (GR).

$$GR = \frac{g}{\boldsymbol{tw}} \left(\frac{mg}{day}\right) \quad (1)$$

Consumption Rate/*CR*

$$CR = \frac{f}{\boldsymbol{tw}} \left(\frac{mg}{day}\right) \quad (2)$$

Efficiency of Conversion of Digested Food/*ECD*

$$ECD = \frac{g}{(\boldsymbol{f-e})} x100 \quad (3)$$

Efficiency of Conversion of Ingested Food/*ECI*

$$ECI = \frac{g}{\boldsymbol{f}} x100 \quad (4)$$

Approximate Digesstibility/AD

$$ECI = \frac{(f-e)}{\boldsymbol{f}} x100 \quad (5)$$

Information:

G = Increase in larval weight during instar III-V,

E = The weight of fecal produced by larvae during instar III-V,

F = Weight of feed eaten by larvae during instar III-V,

T = Length of feeding period during instar III-V,

W = Average weight of larvae during instar III-V.

All of the above calculations are calculated in dry weight.

b. O_2 consumption in Instar III through V is calculated based on [7]

c. The amount of CO_2 expenditure on Instar III through V is calculated based [7}

The data obtained from each observation parameter (variable) is recorded and organized into table form. Quantitative data (dependent variables) obtained, tested its meaning on the influence of treatment groups (independent variables) with the help of computer statistics program, namely SPSS release program 22.The test sequence begins with a normality test, homogeneity test. If the test results show $p<0.05$ then the data is transformed and continued with a non-parametric test. To see the difference from 2 treatments continued Mann-Whitney test. If the test results show $p>0.05$ then continued the one-way fingerprint test (ANOVA) for the data with repeated observation (more than 2 times) or more than 2 treatments and if the difference is real ($p<0.05$) then continued with the Post Hoc analysis test – Bonferroni standard 5%.

3. Result and Discussion

a. Relative Growth Rate (RGR)

The relative growth rate of silkworms can be seen in Table 1.

Table 1 Average relative growth rate of Bombyx mori L. fed Morus sp. + vitamin B1 with different concentrations

Conceration (mg/100ml)	Relative Growth Rate (RGR) (g/days)		
	Instar III	Instar IV	Instar V
Control	1,86±0,05a	1,41±0,03a	1,03±0,02a
0,1	1,70±0,03a	1,27±0,02a	1,02±0,01a
0,2	1,73±0,03a	1,31±0,05a	0,96±0,03a
0,3	2,17±0,03a	1,55±0,03a	1,10±0,03a
0,4	1,68±0,03a	1,43±0,02a	1,08±0,01a

Information: numbers followed by the same letter in the same column are no different real ($p>0.05$)

From statistical tests the relative growth rate of silkworms in instar III, IV and V is no different from real ($p>0.05$) by control and inter-treatment. Because vitamin B1 in the control feed is estimated to have vitamin B1 so there is no need to add vitamin B1 to the treatment package. According to [8] in mulberry leaves contained vitamin B1 which can increase the growth rate of silkworms used as a source of energy and protein metabolic processes.

b. Relative Consumption Rate(RCR)

The relative rate of consumption (Table 2) can be seen that the relative consumption rate of silkworms indicates a noticeable difference ($p<0.05$) in instar III that decreases at a concentration of 0.4mg/100ml, while in instar IV and V there is no noticeable difference ($p>0.05$) between control and treatment.

Table 2 Average Relative Consumption Rate of *Bombyx mori* L. fed *Morus* sp. + vitamin B1 with different concentrations

Conceration	**Relative Consumption (RCR) (g/days)**		
(mg/100ml)	**Instar III**	**Instar IV**	**Instar V**
Control	4,88±0,16a	2,62±0,09a	1,91±0,06a
0,1	4,28±0,07a	2,97±0,03a	2,39±0,04a
0,2	4,25±0,09a	2,70±0,04a	2,05±0,06a
0,3	6,00±0,35 a	3,42±0,10a	2,67±0,05a
0,4	3,43±0,05 b	2,85±0,06a	1,94±0,06a

Information: numbers followed by the same letter in the same column are no different real ($p>0.05$)

c. Efficiency of Conversion of Digested Food/*ECD*

The efficiency of feed consumption digested by silkworms (Table 3) in statistical tests on instar III, IV and V did not differ markedly ($p>0.05$) between control and treatment.

Table 3 Average efficiency of feed consumption digested Bombyx mori L. fed morus sp leaves. + vitamin B1 with different concentrations

Conceration	**Efficiency of Conversion of Digested Food/ECD (%)**		
(mg/100ml)	**Instar III**	**Instar IV**	**Instar V**
Control	69,10±15,98a	39,00±12,97a	18,15±08,30a
0,1	51,60±19,44a	30,29±08,51a	18,29±08,13a
0,2	62,63±27,83a	38,66±19,88a	18,63±09,38a
0,3	69,75±19,46a	43,43±22,38a	24,69±16,08a
0,4	62,43±23,70a	42,49±23,67a	20,31±15,77a

Information: numbers followed by the same letter in the same column are no different real ($p>0.05$)

d. Efficiency of Conversion of Ingested Food/ECI

The efficiency of feed consumption eaten by silkworms (Table 4) in instar III, IV and V was statistically no real difference ($p>0.05$) between the control and treatment group.

Table 4 Average feed consumption efficiency of *Bombyx mori* L. fed leaves *Morus* sp. + vitamin B1 with different concentrations

Conceration	**Efficiency of Conversion of Ingested Food/ECD (%)**		
(mg/100ml)	**Instar III**	**Instar IV**	**Instar V**
Control	60,80±23,49a	32,30 ±18,02a	18,80±14,77a
0,1	47,00±27,46a	25,60±18,56a	13,40±04,35a
0,2	39,86±22,38a	18,80±04,96a	15,27±03,10a
0,3	68,30±28,78a	33,10±21,53a	21,50±11,25a
0,4	45,40±26,88a	21,70±04,54a	15,90±04,93a

Information: numbers followed by the same letter in the same column are no different real (p>0.05)

This means that vitamin B1 given to mulberry leaves does not affect the efficiency of the consumption of feed digested and eaten by silkworms (Table 3 and Table 4), because the possibility of vitamin B1 contained in mulberry leaves is enough to support the efficiency of silkworm feed consumption.

According to [9] the conversion efficiency of the food digested and eaten by caterpillars to measure the proportion of assimilation utilized for growth, ranging from eating hollow through the mouth, digested, absorbed and undigested food substances will be excreted through feces.

e. Approximate Digesstibility/AD

The estimate of the feed digested by silkworms in Table 5 does not differ markedly (p>0.05) between control and treatment after statistical tests on instar III, IV and V.

Table 5 Average estimate of feed digested by *Bombyx mori* L. given *Morus* sp leaves. + vitamin B1 with different concentrations

Conceration (mg/100ml)	**Approximate Digesstibility/AD (%)**		
	Instar III	**Instar IV**	**Instar V**
Control	52,40±13,77a	37,80±10,30a	21,50±08,48a
0,1	48,00±12,76a	31,80±11,17a	19,30±07,94a
0,2	56,90±22,17a	36,60±17,79a	21,18±12,48a
0,3	60,30±20,51a	44,80±13,44a	21,96±13,51a
0,4	47,60±24,73a	34,70±19,19a	18,60±05,75a

Information: numbers followed by the same letter in the same column are no different real (p>0.05)

This suggests that vitamin B1 given to mulberry leaves does not affect the estimated feed that caterpillars digest. It is likely that vitamin B1 contained in mulberry leaves is enough to support the growth of silkworms so there is no need for vitamin B1 intake from the outside. According to [9] states that the estimated feed digested in caterpillars is sufficient for higher food intake and does not always result in higher digestibility as well.

f. Oxygen Consumption (O_2) of SilkWorms

Silkworm oxygen consumption (Table 6) is statistically different in real (p<0.05) than instar III and IV which increases at concentrations of 0.1mg/100ml and 0.4mg/100ml, while in instar V is no different (p>0.05).

Table 6 Average oxygen consumption of *Bombyx mori* L. fed by *Morus* sp. leaves. + vitamin B1 with different concentrations

Conceration (mg/100ml)	**Oxygen Consumption (O_2) (ml)**		
	Instar III	**Instar IV**	**Instar V**
Control	0,024±0,005a	0,049±0,007a	0,060±0,008a
0,1	0,044±0,005b	0,052±0,004b	0,055±0,005a

0,2	0,026±0,005a	0,049±0,007a	0,059±0,005a
0,3	0,025±0,005a	0,052±0,006a	0,056±0,008a
0,4	0,046±0,005b	0,058±0,004b	0,062±0,006a

Information: numbers followed by the same letter in the same column are no different real (p>0.05)

g. Amount of Carbon Dioxide (CO_2) Production

The amount of carbon dioxide expenditure can be in Table 7 on statistical tests instar III and IV differs markedly (p<0.05) at concentrations of 0.1mg/100ml and 0.4mg/100ml which occurs increase, while in instar V does not differ noticeably (p>0.05) between control and treatment.

Table 7 Average amount of carbon dioxide expenditure *Bombyx mori* L. fed leaves *Morus* sp. + vitamin B1 with different concentrations

Conceration (mg/100ml)	**Amount of Carbon Dioxide (CO_2) (ml)**		
	Instar III	**Instar IV**	**Instar V**
Control	0,024±0,005a	0,047±0,006a	0,058±0,007a
0,1	0,034±0,008b	0,051±0,005b	0,057±0,008 a
0,2	0,024±0,005a	0,044±0,005a	0,059±0,005a
0,3	0,022±0,004a	0,046±0,005a	0,061±0,007a
0,4	0,043±0,004b	0,061±0,008b	0,062±0,009a

Information: numbers followed by the same letter in the same column are no different real (p>0.05)

This suggests that the rate of respiration of silkworms (Table 6 and Table 7) given vitamin B1 in mulberry leaves had more effect on concentrations of 0.4mg/100ml because vitamin B1 given to mulberry leaves to produce the rate of respiration affected their growth.

According to Hamano et al., (1995) the rate of respiration produced by silkworms can affect growth in larvae, because the high rate of respiration under normal physiological conditions greatly affects metabolic activity in nutrition which is considered most important as one of the determinants of growth, development and physiological activity in larvae.

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