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THE EFFECT OF PALM SUGAR SUPPLEMENTATION ON FEED CONSUMPTION AND PERCENTAGE OF SILKWORMS (BOMBYX MORI L.) IN THE END OF INSTAR V

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Abstract

Mulberry (Morus sp.) leaves used in this research were mulberry leaves, is a silkworm feed whose leaf production and quality affect the growth of larvae, cocoon production and quality. The availability of mulberry feed becomes an important factor in the business of silk because of the high demand for silk thread as raw material for silk. To increase the growth of larvae and the production of cocoons and silk thread, an alternative feed is made. The feed consists of mulberry leaf added with palm sugar as an energy source. The purpose of this study was to see the effect of mulberry leaf added with palm sugar on feed consumption and the percentage of silkworm moths (Bombyx mori L) on the 6th day of instar V. This research was conducted at the Perhutani Soppeng Public Corporation in South Sulawesi. 1000 silkworms were used in this research and were divided into 20 boxes. The mulberry leaves used were M. multicaulis leaves and palm sugar was added to the leaves by spraying sugar solution to the fresh leaves. The experimental design uses a Completely Randomized Design (CRD) followed by Least Significance Different (LSD) test. The treatments given are fresh mulberry leaves without palm sugar (G0), mulberry leaves + palm sugar and water (1: 2) (G1), mulberry leaves + palm sugar and water (1: 4) (G2), mulberry leaves + palm sugar and water (1: 6) (G3), and mulberry leaves + palm sugar and water (1: 8) (G4) with four replications. Results indicated that the treatments of feed gave significantly different results ($P<0.05$) on feed consumption and gave very significantly different results ($P<0.01$) to the percentage of larvae that still consumed the feed at 6th day of instar V.

Key words**:** *Bombyx mori. L, mulberry leaves, palm sugar, consumption*

INTRODUCTION

The development of silk textiles in Indonesia is experiencing a decline in silk production so that it has not been able to meet the needs of the weaving industry. This was stated by the Chairman of Indonesian Silk Association (ASIA) that Indonesia in 2014, was only able to meet the supply of domestic silk thread by 5% of the total requirement of 900 tons/year and 95% in imports from China. The fact that there are silkworm rearing areas have difficulty in supplying mulberry feed in quality and quantity. Allegedly extreme climate and weather globally has resulted in disruption of silk maintenance activities. In this season, silkworms are susceptible to continuous mulberry feed constraints.

Silkworm (*Bombyx mori* L) larvae, are included in the Order Lepidoptera. Silkworm is the main producer of silk fibers used as raw material for silk thread. This insect have a complete metamorphosis life cycle by undergoing perfect shape changes from hatching egg to larvae, larvae turn into pupae in cocoon and then the pupae turn into moths. Silkworm will pass the I-V instars for 25-27 days, cocoon periods for 4 days, and from pupae to imago for 10 days [10]. The life activity of silkworm is highly dependent on feed that has a harmony of nutrients to regulate metabolic processes. This process will take place in a digestive device that functions to synthesize or removes the food consumed.

Palm sap is a raw material for producing palm sugar that has a sweet taste that is different from white sugar. In addition to its sweet taste, palm sugar also tastes delicious so that it can stimulate appetite. Palm sugar, also called brown sugar, has advantages over other sugars, namely its organoleptic properties [6].

Besides, palm sugar is beneficial for health, if consumed will strengthen the Anti-Pathogenic Factors (APF), namely increasing stamina/ vitality or defense factors of the body [5]. The nutritional content of palm sugar is quite complete and has a total energy of 368 kcal. Mulberry leaf is the only food consumed by Bombyx mori caterpillar and is a determining factor for the success of silkworm cultivation, therefore various methods are pursued such as genetic improvements of mulberry and silkworm plants. Mulberry leaves, as the main feed of silkworm, will directly influence affect the amount of feed consumption and subsequently affect the growth, production, and quality of cocoon. Mulberry leaves have high palatability [4]. The content of mulberry leaf protein greatly affects the quality of the cocoons and silk fibers produced. In addition, other important nutrients that have the potential to influence the life cycle of silkworms are carbohydrates as an energy source.

Silkworm feed nutrition is one of the important factors that influence the growth of silkworm [9]. However, the silkworms energy needs during one life cycle are thought to be insufficient if it is in a critical / extreme climate. The calorie value of mulberry leaves decreases as the age of the leaves increase, whereas the calorie utilization by larvae increases according to age: young larvae, large larvae, pupae, moths. In this research, palm sugar as an energy source is given as additional feed on mulberry leaves to see the effect of palm sugar supplement on the final consumption of instar V and the percentage of silkworms caterpillar (Bombyx mori L.).

MATERIALS AND METHODS

This research uses 1,000 silkworms from Japanese and Chinese crosses obtained from Perum Perhutani Soppeng, South Sulawesi, aa well as silkworm feed, namely mulberry leaves (*Morus multicaulis*). The research was carried out at Perum Perhutani Soppeng, South Sulawesi Indonesia. Research procedure including preparation and implementation referred to [1]. The research site was prepared by disinfecting the room five days before silkworms were treated. Disinfection was performed by spraying a chlorine solution (0.5%) throughout the room (1-2 L / m2). The hatching chamber was set at 75-80 % humidity and at a temperature of 20-25ºC. Instar I-III caterpillars were kept in 10 boxes of a density of 100 individuals / box and were transferred to 20 boxes when the instar IV-V was reached. The silkworms' body was disinfected with a mixture of 0.5 g 95% fine lime and 5% chlorine. Mulberry leaves feed were given three times a day, in the morning, afternoon and evening. Mulberry leaves sliced into a size of about 0.5-1.0 cm, 1.5-2.0 cm and 3.0-4.0 cm were given as feed for instar I, II, and III caterpillars, whereas unsliced leaves were given for instar IV and V caterpillars. The feed was given to instar I, II, III, IV, and V caterpillar on an *ad lib* basis. The amount of the feed given and that remained was weighed. Treatments at molting. At each molting stage, the caterpillars were spread with a mixture of 95% fine lime and 5% chlorine. The amounts of the mixture were about 0.5, 1.0, and 1.5 g respectively at changes form instar I to II, II to III, III to IV, and IV to V. Box pads replacement and disinfection on instar I-III caterpillars were done after they woke up, while that on instar IV-V caterpillars were performed every day. The cocooning silkworms were placed in serial frame and the cocoons were harvested five days after the silkworms start to cocoon. The observed parameters were temperature, feed consumption, and percentage of cocooning silkworms. Treatments were classified into five groups with four replications for each treatment. Base ration G0: fresh mulberry leaves. Ration G1: mulberry leaves + palm sugar and water (1:2), Ration G2: mulberry leaves + palm sugar and water (1:4), Ration G3: mulberry leaves + palm sugar and water (1:6), Ration G4: mulberry leaves + palm sugar and water (1:8). Design used in this research was Completely Randomized Design after [2]:

$$Yij = \mu + \alpha i + \varepsilon ij$$

where:

Yij: observation value of treatment feed,
μ: average *i*-th and replication *j*-th,
αi: effect of treatment feed *i*-th level (*i* = G0, G1, G2, G3, G4),
εij: effect of feed experimental error on treatment *i*-th and replication *j*-th.
Data obtained were analyzed using Analysis of Variance (ANOVA) and followed by Least Significance Different (LSD) test.

RESULTS AND DISCUSSIONS

Feed consumption was obtained from the difference between the weight of mulberry leaves given at the beginning of the sixth day and that of the remaining mulberry leaves at the end of the sixth day in instar V and divided by the number of larvae at the sixth day on instar V. Feed consumed by silkworm in the sixth day on instar V is presented in Table 1. The treatments gave significantly different results (P<0.05) on feed consumption. Basically, as long as the larvae are still active the larvae will continue to eat and the feed needed by the silkworms increases with the increasing instar. The amount of food consumed by larvae depended on the instar and the quality of the mulberry leaves, as well.
The addition of palm sugar to mulberry leaves could affect the number of calories consumed. Palm sugar as an energy source is needed by silkworms in the last day of instar V in preparation for cocooning where the caterpillar changes into a pupa. Feed consumption gradually decreases in the last day of instar V after the energy needs are met. The energy is used for physiological processes in metabolism where the protein is converted into silk threads and after that, the energy is used for cocooning activities. This could explain why the treatments have a significant effect (P<0.05) on feed consumption.

Table 1. Average feed consumption by silkworms at the sixth day on instar V using different type of feeds

Replication	**Treatments**				
	G0	G1	G2	G3	G4
Gram/larva					
U1	0.713^{a}	0.654^{ab}	0.441^{b}	0.230^{b}	0.951^{ab}
U2	0.998^{a}	0.370^{ab}	0.372^{b}	0.305^{b}	0.250^{ab}
U3	0.490^{a}	0.470^{ab}	0.091^{b}	0.245^{b}	0.174^{ab}
U4	0.709^{a}	0.246^{ab}	0.049^{b}	0.131^{b}	0.259^{ab}
Average	0.727	0.435	0.238	0.228	0.408

Note: different superscript a, b, c, and d in the same row represents significantly different value (P<0,05). (a>b>c>d).
Source: Own results in the laboratory.

LSD test (Figure 1) shows that G0 treatment gave a very significantly higher effect (P<0.01) than G2 and G3. The amount of feed consumption of 0.727 gram/silkworminG0 treatment (mulberry without the addition of sugar palm) is more than that in mulberry added with sugar palm due to the unmet energy needs in G0and, as a consequence, silkworms continue to consume. In instar V, there should be an increase in consumption because the silk glands in the body are fully developed [3]. The lowest feed consumption was in the G2 treatment (0.238 gram/caterpillar) and in the G3 treatment (0.228 gram/caterpillar). It is assumed that the level of consumption of silkworms was decreased because the silkworms were about to approach the cocooning stage which indicated by the emerge of silk thread from their mouth and resulted in the decrease in consumption. Feed consumption in GO treatment continued to grow in the sixth day of instar V and there was a delay in cocooning. This was different from those in G2 and G3 treatments where the feed consumptions were decreased and the caterpillars were prepared to enter cocooning phase.
The percentage of consuming larvae on instar V was obtained from the difference between the remaining amount of larvae at the beginning of instar V and the number of larvae at the end of instar V and multiplied by 100%.

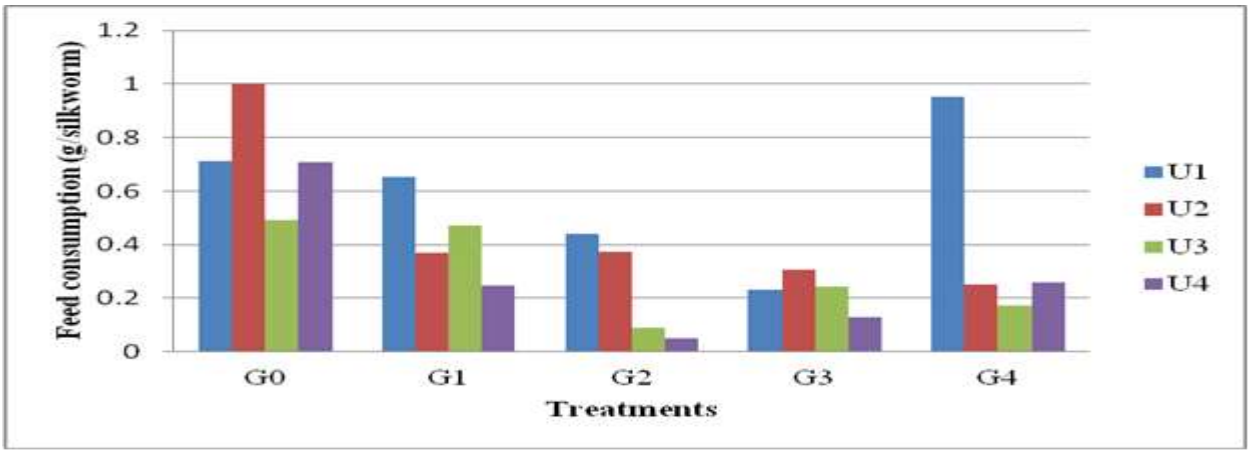

Fig. 1. Histogram of feed consumption in the sixth day of instar V using different type of feeds.
Source: Own results in the laboratory.

Table 2 shows that the treatment gave very significantly different results (P <0.01). Physiologically, changes in nutrition in the body of an insect result in an increase or decrease in the amount of food consumed [8]. The theory supports the results obtained through the treatment of mulberry leaves added with palm sugar which gave effect on the number of consuming silkworms at the end of instar V.

A decrease in the number of consuming larvae on the 6th day of instar V was due to more silkworms entered the pupa and cocooning phase at the end of instar V and, in consequence, decreased the consumption. In addition, the palm sugar supplement contains energy that could affect the rate of entering the pupa phase. The energy content of feed is very important especially at the end of instar V where silkworms undergo anabolism and catabolism. Both of these processes require energy for the formation of silk glands at the beginning of instar V and for the cocooning activity at the end of instar V.

Table 2. Percentage of consuming larvae in the sixth day of instar V

Replication	Treatments				
	G0	G1	G2	G3	G4
U1	84^{a}	46^{b}	44^{bc}	52^{c}	30^{bc}
U2	36^{a}	86^{b}	54^{bc}	30^{c}	38^{bc}
U3	90^{a}	54^{b}	32^{bc}	38^{c}	34^{bc}
U4	68^{a}	46^{b}	56^{bc}	38^{c}	30^{bc}
Average	69.500	58.000	46.500	39.500	33.000

Note: different superscript a, b, c, and d in the same row represents very significantly different value (P<0.01).
Source: Own results in the laboratory.

LSD test is presented in Figure 2 which shows that G0 gave a very significantly higher effect (P<0.01) than G1, G2, G3 and G4. In the G0 treatment the percentage of consuming silkworms on the 6th day of instar V was the highest. It was revealed that, by this treatment, silkworms were not physiologically ready to enter the cocooning phase, compared with other treatments where the number of consuming silkworms was reduced because they were ready to enter cocooning stage. [7] stated that the consumption of feed by larvae should increases rapidly from instar IV to instar V, where this is related to the formation of silk glands. It seems that the G0 treatment was not able to meet the nutritional needs, especially because the energy source from G0 was insufficient to meet the needs of silkworms compared to other treatments where the silkworms get palm sugar as an energy source supplement. As a result, more silkworms continued to consume the feed G0 and the number of larvae to enter the cocooning stage were low. It is clear that high energy feed could affect the metabolism in silkworms to enter the next phase in metamorphosis.

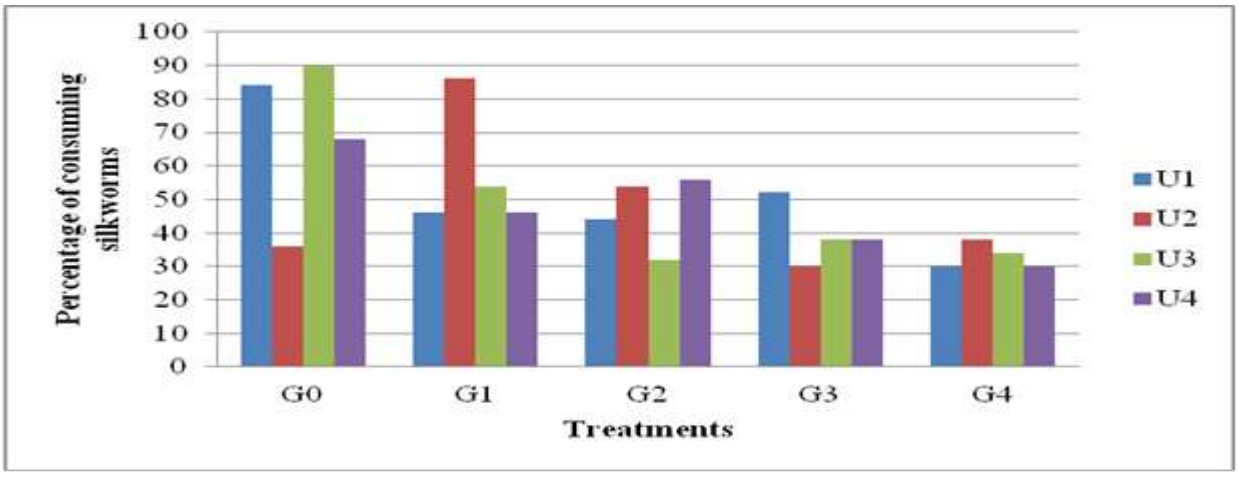

Fig. 2. Histogram of percentage of consuming larvae in the sixth day of instar V.
Source: Own results in the laboratory.

CONCLUSIONS

High energy feed in the form of formulated mixture of mulberry leaves and palm sugar had a significant effect ($P<0.05$) on feed consumption by silkworms and this, in turn, had a very significant effect ($P<0.01$) on the number of consuming silkworms in the sixth day of instar V.

Mulberry leaves without palm sugar added (G0) significantly resulted in the highest feed consumption and highest percentage of consuming larvae in the sixth day of instar V, but the lowest rate of cocooning silkworms. On the contrary, palm sugar-added mulberry leaves (G1, G2, G4. G4) resulting in the lowering feed consumption and percentage of consuming larvae, but the higher rate of cocooning larvae.

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