Pengaruh penggunaan substrat sintetik dengan bahan dasar yang berbeda terhadap produktivitas cacing sutra (*Tubifex sp.*)

The effect of using synthetic substrates with different base materials on the productivity of silk worms (*Tubifex sp.*)

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Abstract

The need for high-quality natural feed for fish farming and aquaculture industry is increasing along with the rapid growth of the fisheries sector worldwide. However, the problem faced is the great dependence on the availability of worms from nature so that silk worm cultivation is very important to ensure the availability of quality natural feed for fish farming. This study aims to determine the effect of the use of synthetic substrates made from different materials on the productivity and absolute weight growth of silk worms, as well as to determine the effectiveness of harvesting in each treatment and business analysis. This experiment was designed in a completely randomized design (CRD) with 3 treatments which are: P1 (Cotton substrate), P2 (Net substrate), and K (as control). Each treatment was quadriplicated and the data analysis was run in One-way ANOVA for CRD. Worms were kept for 30 days with the results of silk worm productivity. The highest productivity figures were in P2 with a value of 689.48 ± 52.80 g / m2 / cycle and K 622.52 ± 121.60 g / m2 / cycle. Statistical tests showed that there was no significant effect (sig.>0.05) of substrate use on silkworm productivity. Absolute weight growth K 12.75±12.25 g/m2/cycle, P1 13.5±7.59 g/m2/cycle, P2 19.5±5.32 g/m2/cycle. Water quality parameters during the study period ranged from optimal values. Business analysis was assumed and the results of the business analysis obtained were loss and not feasible. It can be concluded that the synthetic substrate used did not provide significant benefits in silkworm cultivation.

***Keywords*:** Silkworms, Substrate Synthesis, Productivity

Abstrak

Kebutuhan pakan alami berkualitas tinggi untuk industri budidaya ikan dan akuakultur semakin meningkat seiring dengan pesatnya pertumbuhan sektor perikanan di seluruh dunia. Namun, masalah yang dihadapi adalah ketergantungan yang besar terhadap ketersediaan cacing dari alam sehingga budidaya ulat sutera sangat penting untuk menjamin ketersediaan pakan alami berkualitas untuk budidaya ikan. Penelitian ini bertujuan untuk mengetahui pengaruh penggunaan substrat sintetis berbahan berbeda terhadap produktivitas dan pertumbuhan berat mutlak cacing sutera, serta mengetahui efektivitas pemanenan pada setiap perlakuan, dan analisis usaha. Percobaan ini dirancang dengan rancangan acak lengkap (RAL) dengan 3 perlakuan yaitu: P1 (substrat kapas), P2 (substrat jaring) dan K (kontrol). Setiap perlakuan diulang empat kali dan analisis data dilakukan dengan ANOVA satu arah untuk RAL. Cacing dipelihara selama 30 hari dengan hasil produktivitas cacing sutera. Angka produktivitas tertinggi terdapat pada P2 dengan nilai 689,48 ± 52,80 g/m2/siklus dan K 622,52 ± 121,60 g/m2/siklus. Hasil uji statistik menunjukkan bahwa penggunaan substrat tidak memberikan pengaruh yang nyata (sig.>0,05) terhadap produktivitas ulat sutera. Pertumbuhan berat mutlak K 12,75±12,25 g/m2/siklus, P1 13,5±7,59 g/m2/siklus, P2 19,5±5,32 g/m2/siklus. Parameter kualitas air selama masa penelitian berkisar dari nilai optimal. Analisis usaha diasumsikan dan hasil analisis usaha yang diperoleh adalah rugi dan tidak layak. Dapat disimpulkan bahwa substrat sintetis yang digunakan tidak memberikan keuntungan yang nyata dalam budidaya ulat sutera.

***Kata kunci*:** Ulat Sutera, Sintesis Substrat, Produktivitas

INTRODUCTION

In recent years, the need for high-quality natural feed for fish farming and the aquaculture industry has increased along with the rapid growth of the fisheries sector worldwide. Data from the Food and Agriculture Organization (FAO) shows that global aquaculture production has reached 130.9 million tons in 2022, with an annual increase of around 5%. One important aspect in fish farming, especially for ornamental fish and freshwater fish, is the availability of quality natural feed, such as silkworms (*Tubifex sp.*), which are very much needed as a source of optimal nutrition for the growth of fish larvae and small fish (FAO, 2024). However, the main problem faced in meeting the need for silkworms is the heavy dependence on the availability of worms from nature, which is greatly influenced by environmental conditions. The quality of silkworms obtained from nature is often not optimal because they are exposed to pollutants and environmental contamination, and are not available throughout the year, especially during the rainy season when the worms are carried away by water currents (Cahyono et al., 2015; Komariyah et al., 2022). This causes supply instability, so intensive silkworm cultivation is a very important solution to ensure the availability of quality natural feed for fish farming (Fatah et al., 2021). Therefore, a more targeted and innovative strategy is needed to produce silkworms in a controlled manner through cultivation activities with the selection of the right substrate.

The substrate used in silkworm cultivation plays an important role in supporting the growth and productivity of the worms. A good substrate not only provides a place for the worms to attach, but also becomes a source of food and an environment that supports the reproduction of silkworms (Efendi, 2013). One of the organic materials that is often used as a substrate is tofu dregs, because of its high protein content, which can support the growth of silkworms optimally (Akhril et al., 2019). The fermentation process can be carried out to increase the nutritional value of tofu dregs, which in turn can increase worm productivity (Lestari et al., 2020). However, the challenges in silkworm cultivation are not only related to the availability of the substrate. Silkworm cultivation without mud, although considered a solution to avoid contamination by pathogenic bacteria, faces other obstacles such as decreased productivity and growth. In addition, worm eggs often only stick to the walls of the container, not to the substrate, thus reducing cultivation efficiency compared to traditional methods using mud (Aminnun et al., 2020; Setiadi, 2021; Suryadin et al., 2017).

This problem emphasizes the importance of selecting the right cultivation media and sources of organic materials that can support the optimal growth of silkworms. Synthetic substrates made from cotton have been introduced as a promising alternative. In Aminnun et al (2020), it was found that silkworms were able to attach and survive on dacron cotton, which shows the potential of cotton as an alternative substrate. Thus, this study aims to determine the effect of using synthetic substrates made from different materials on the productivity and absolute weight growth of silkworms (*Tubifex sp.*). This study will also evaluate the most effective harvesting method for synthetic substrates and analyze the economic aspects of silkworm cultivation with synthetic substrates. This research can contribute to increasing the production of silkworms that are more stable, safe from contamination, and more economically efficient, so that it is hoped that this research can provide solutions for fish farmers in meeting the need for high-quality natural feed in a sustainable manner, so that it can support the growth of the aquaculture industry as a whole. This study aims to evaluate the productivity and growth of silk worms (*Tubifex sp.*) with the use of synthetic substrates from various materials and to determine effective harvesting methods. In addition, this study will also conduct an economic analysis to assess cost efficiency, profitability, and the feasibility of silk worm cultivation.

METHODS

This study used an experimental method with a Completely Randomized Design (CRD) design, consisting of 2 treatments and 1 control, with 4 replications in each treatment. The three treatments tested in this experiment were: "P1" synthetic substrates made from dacron cotton, "P2" synthetic substrates made from nets, and "C" as control. The study was conducted at the Teaching Factory Cultivation Laboratory of the AUP Polytechnic, Jakarta Campus from April 20, 2023 to June 7, 2023. The containers used for cultivating silkworms are rectangular plastic containers, as many as 12 pieces, which are arranged into 3 levels using iron batten shelves. Each container measuring 36 cm x 28 cm is filled with 6 cm of water so that the surface area is 0.1008 m^2.

Each container is equipped with an outlet hole from a ½" pipe in the middle of the container, and there is a water tank under each container for water circulation. The cultivation system uses a water recirculation method, where water is pumped back into the cultivation container through an inlet that is regulated using a tap. The pump used has a thrust of 1 meter, and water is continuously flowed from the tank to the cultivation container. Silkworms were fed diets consisting of 80% tofu dregs, 10% fish meal, and 10% bran (formula adapted from Setiadi, 2021).

Feed fermentation was carried out for 7 days using activated probiotics. The probiotic activation process involved mixing EM4 probiotics (6 ml/kg), molasses (15 ml/kg), and water (70 ml/kg). The probiotic mixture was then mixed with feed ingredients that had been weighed according to the dosage, then fermented for 7 days in a tightly closed container. After fermentation was complete, the feed was aired for 30 minutes before being given to the worms. Feeding was carried out every 3 days, with a dose of 50 g/container. Before feeding, the water flow was turned off for 5-10 minutes to prevent the feed from being carried away by the water current. The feed was then spread evenly on the surface of the container, especially in areas where there were many worms clustered, after which the water flow was turned back on. Silkworm experiment lasted for 30 days. During the experiment period, water quality was maintained through continuous aeration, and water parameters such as temperature, pH, and dissolved oxygen levels were monitored periodically.

Harvesting was carried out on the 30th day, by turning off the water flow for 30 minutes before harvesting to trigger the worms to come to the surface and form colonies. In the control group, worms that clustered on the surface of the natural substrate were manually removed. For the P1 treatment group (cotton substrate), harvesting was carried out by tearing the cotton layer (about 0.2 cm per layer) and then flowing water to facilitate the separation of the worms from the substrate. The worms were then slowly removed from the cotton substrate. In the P2 group (net substrate), a similar harvesting method was applied, where the net pad was soaked with water to separate the worms before harvesting. The harvesting method can be seen in Figure 1.

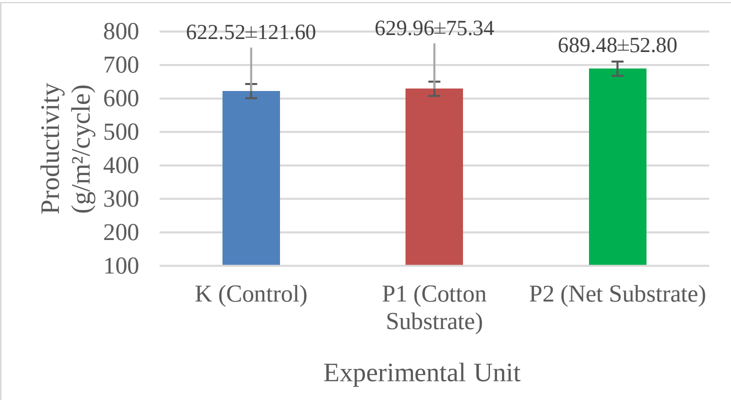
After the experiment period is over, measurements are made by weighing the biomass of silkworms to calculate the absolute weight. Measurements also include the daily growth rate (DGR) to evaluate the effectiveness of each substrate. Data were taken from each experimental unit and control at the end of the cultivation period. To achieve the research objectives, the following are the steps of the One-Way ANOVA analysis carried out:

1. Initial data collection: Collect all observation data during the silkworm experiment process, including parameters: Water temperature, water pH, nitrite, dissolved oxygen (DO), ammonia, absolute weight of silkworms, productivity, production costs, and income. Data is taken from experimental units: K (control), P1 (cotton substrate), P2 (net substrate).
2. Calculation of productivity: Calculate the productivity of each treatment (K, P1, P2) in g/m^2/cycle. Compare productivity per cycle between treatments.
3. Profit/Loss Analysis and B/C Ratio:
   a) Calculate profit/loss based on production costs and sales results for each treatment,
   b) Calculate the Benefit-Cost Ratio (B/C Ratio) for each treatment: B/C Ratio = Total income / Total costs,
   c) Determine whether the business is feasible or not feasible based on the B/C Ratio value: B/C Ratio > 1: Business is feasible - B/C Ratio < 1: Business is not feasible

RESULT AND DISCUSSION

Silkworm Productivity

The productivity results of silkworms*bifex sp.*) cultivated with synthetic substrates made from different materials during 30 days of experiment are shown in Graph 1.



Experimental Unit	Productivity (g/m^2/cycle)
K (control)	622.52±121.60
P1 (cotton substrate)	629.96±75.34
P2 (net substrate)	689.48±52.80

Graph 1. Silkworm Productivity

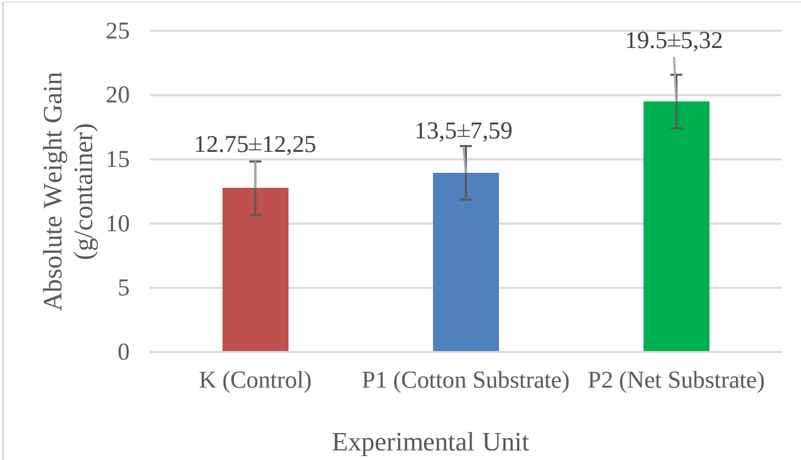
In Graph 1, the productivity values in each treatment show variations, with treatment P2 (net substrate) achieving the highest productivity value of 689.48±52.80 g/m^2/cycle, followed by treatment P1 (cotton substrate) with a value of 629.96±75.34 g/m^2/cycle, and control (natural tofu dregs substrate) with the lowest productivity of 622.52±121.60 g/m^2/cycle. Although P2 (net substrate) has the highest productivity, the results of the One-Way ANOVA test showed that the difference between treatments was not statistically significant (sig. > 0.05). This indicates that the use of synthetic substrates made from different materials does not have a significant effect on the productivity of silkworms. These results indicate that the use of net pads (P2) can increase the productivity of silkworms, but the difference is not significant when compared to cotton substrates (P1) and natural substrates (control). Factors such as substrate type and feed fermentation process can affect the growth and productivity of worms, although the effect is not too large in this test. According to Poluruy et al (2019), there is no significant effect of differences in stocking density in maintaining silkworms. However, recent research by (Maulana et al., 2023) states that there is a significant effect on the growth of silkworms fed with different weights. In the context of this study, although there was no statistically significant effect of differences in substrates, the highest productivity was still achieved in the P2 treatment (net pad).

The higher productivity difference in P2 compared to P1 (cotton) is likely due to the different substrate structures. The net pads have more open cavities, allowing the distribution of fermented tofu dregs as a source of organic material for silkworms to be more evenly distributed throughout the media. This makes it easier for worms to access food sources more effectively. In contrast, the cotton substrate has a denser structure, so that organic matter is absorbed more slowly and tends to be retained on the surface of the media, causing some of the feed to dissolve and be carried away by the water current. As a result, the feed is not fully utilized by the worms, which naturally protrude their tails and immerse their heads to absorb organic matter in the media (Wulandari et al., 2020). In addition to the substrate factor, there are several other factors that are thought to affect the productivity of silkworms. One of them is light fermented feed, which has the potential to be washed away by the water flow when the circulation is turned back on. This results in a reduction in the source of organic matter, which is needed by worms for optimal growth (Suharyadi, 2012; Umidayati et al., 2020). Some silkworms are also washed away by the water flow to the outlet, although they can still be put back into the container because they gather in the water reservoir. In addition, the experiment duration of only 30 days may be another factor affecting productivity. According to (Suryadin et al., 2017), the peak growth period of silkworms usually occurs on the 45th day. Thus, this study has not reached the peak productivity period, so the results obtained do not reflect the maximum potential of silkworms.

Another factor to consider is the difference in the silkworm's living media. The thickness, softness, and organic content of the living media play an important role in the growth and reproduction of silkworms. Studies by (Begum et al., 2015) and (Komariyah et al., 2022) noted that increasing the thickness of the media to a certain level can increase productivity, but if the thickness exceeds the optimal limit, worm growth will decrease. Considering all these factors, it can be concluded that the net substrate (P2) offers more optimal conditions for feed distribution and worm growth compared to the cotton substrate (P1), although the difference in productivity is not yet statistically significant.

Absolute Weight Gain

The results obtained from 30-day experiment with three different types of substrates, namely Control (without media), P1 (dacron cotton substrate), and P2 (net substrate), can be seen in Graph 2 which shows that there is absolute biomass growth in each treatment, with the highest growth in P2 (net substrate) which reached an average of 19.5 ± 5.32 g/container. Conversely, the lowest growth was found in the control (without media), with a biomass growth value of 12.75 ± 12.25 g/container. P1 (dacron cotton substrate) showed absolute weight growth of 13.5 ± 7.59 g/container.



Graph 2. Absolute Weight Growth

Table 1. One-Way ANOVA Test Result

Experimental Unit	Mean Biomass Growth (g/container)	Standard Deviation (SD)	p-Value	Interpretation
K (control)	12.75	12.25	>0.05	Not Significant
P1 (cotton substrate)	13.5	7.59		
P2 (net substrate)	19.5	5.32		

The results of the One-Way ANOVA test in Table 1 showed that the absolute weight growth of silkworms cultivated with different synthetic substrates had no significant effect (sig.>0.05) although the absolute weight growth of P2 was the highest compared to the others. The relatively small absolute weight growth compared to the study (Setiadi, 2021), which reached an average of 447.0 g/container with a tofu dregs fermentation composition, is thought to be caused by several factors. One of them is the lack of optimal living media for silkworms, which inhibits their growth (Akbar et al., 2017). In addition, the thickness and softness of the media are also known to affect the growth of silkworms, as stated by (Bintaryanto & Taufikurohmah, 2013) and (Suryadin et al., 2017). The optimal media thickness and softness of the media can increase the access of silkworms to food sources, which in turn affects their biomass growth.

The results of the study also showed that there were several other factors that caused the low overall growth of silkworm biomass. One significant factor was the worm feed that was often carried away by the water flow to the outlet, where some of the wasted feed and worms contributed to the reduction in total biomass. The 30-day silkworm experiment period was also suspected to be one of the causes of low growth. Research conducted by Putri et al. (2014) showed that silkworms experienced a decrease in weight from day 0 to day 20, with a slight increase in weight from day 20 to day 30. The peak growth of silkworms occurred on day 40 to day 50. This finding is in line with the results of research by Supriyono et al (2015), which also reported a similar growth pattern, where worms experienced a decrease in weight on day 0 to day 20, followed by an increase on day 20 to day 30, and peak growth occurred between day 40 to day 50, before decreasing again after day 50.

In the synthetic substrate treatment, both made of cotton and cocoon nets, visual observation showed that worms tended to gather in the inner part of the substrate. In Treatment 1 (cotton), many worms attached and hid inside the cotton, while in Treatment 2 (net), the dark-colored net pad made it difficult to observe the actual number of worms, because many worms also gathered inside the net. In addition, there were also worms that did not attach to the substrate and clustered on the side of the container, indicating an uneven distribution of worms in the cultivation container.

Effectiveness of Silk Worm Harvesting Method

Silkworm harvesting was carried out on the 30th day by turning off the water flow for 30 minutes before harvesting. The aim is to encourage the worms to come to the surface and form colonies (Umidayati et al., 2023). Table 2 clearly shows the effectiveness of each silkworm harvesting method used.

Table 2. Effectiveness of Silk Worm Harvesting Method

Harvesting Method	Description	Harvesting Time	Difficulty
Control	Worms gather and are filtered using a micron sieve, then transferred to a container for weighing.	Relatively fast	Easy
Dacron cotton	Worms gather in the cavity in the cotton. The cotton is torn, then water is poured to separate the worms from the media.	About 10 minutes	Difficult, worms stick tightly
Net Pad	The net cover is opened and water is poured so that the worms can go down to the micron sieve. The process of separating worms from the net is relatively easy.	About 5 minutes	Easier, worms do not stick tightly

In the control treatment, the harvesting process was the easiest and relatively fast. Worms that had gathered on the surface were taken and filtered using a micron sieve, then transferred to another container to be weighed. This method is considered the most efficient because the worms gathered well and the filtering and cleaning processes ran smoothly (Aminnun et al., 2020). Unlike the control treatment, the harvesting method on dacron cotton substrates required more effort. Most of the worms gathered in the cavities in the cotton, so the cotton needed to be torn into layers (about 0.2 cm per layer) to separate the worms. After that, the cotton was irrigated with water so that the worms could easily be released. This process took about 10 minutes per container and was relatively difficult, because the worms stuck very tightly to the cotton, so that some individuals were still left in it. In the treatment using net pads, the harvesting method was easier than with dacron cotton. The net cover was opened and irrigated with water, so that the worms that were attached could easily be released and went down to the micron sieve. The net pads were also opened slowly to release the worms that were attached to the net. This process takes about 5 minutes per container, faster than harvesting with dacron cotton, because the adhesion of the worms to the net is not as strong as to cotton.

Water Quality Parameters

During the silkworm experiment period, routine measurements were carried out on several water quality parameters that were considered important to maintain the environmental conditions of the worms. The parameters measured included temperature, pH, nitrite, dissolved oxygen (DO), and ammonia. Temperature and pH were measured using a digital measuring instrument every three days. Meanwhile, DO, nitrite, and ammonia were measured three times, namely at the beginning, middle, and end of the experiment period. Water quality parameters can be seen in Table 3.

Table 3. Water Quality Parameters

No.	Water Quality Type	Measurement Results	Optimal Value	Source
1.	Temperature	26-28°C	23-27°C	(Efendi, 2013; Ngatung et al., 2017)
2.	pH	6,8-7,2	6,02–7,7	(Efendi, 2013)
3.	Nitrit	0,0–1,0 $mg.l^{-1}$	0,01 – 0,20 $mg.l^{-1}$	(Wenda et al., 2018)
4.	DO/Dissolved Oxygen	4,3–4,7 $mg.l^{-1}$	2,5–7 $mg.l^{-1}$	(Efendi, 2013)
5.	Ammonia	0	<0,5	(Efendi, 2013)

During the 30-day silkworm experiment period, the water temperature parameters were recorded to range between 26-28°C, with the lowest temperature being 26.1°C and the highest being 28°C. There was no significant temperature variation because the experiment was carried out in a semi-outdoor place, where the container and media were not exposed to direct sunlight, so the temperature remained optimal. According to (Fadhlullah et al., 2017), a temperature range of 25-30°C is still ideal for silkworm experiment. However, (Ngatung et al., 2017) stated that temperature greatly affects the reproduction and growth of silkworms, especially if the temperature reaches ≥27°C, which makes it difficult for worms to reproduce. This is in line with the opinion of (Efendi, 2013), which states that the optimal temperature for silkworm growth is 23-27°C.

Measurement of water pH during experiment showed values ranging from 6.8-7.2. According to (Putri et al., 2014) and (Supriyono et al., 2015) stated that the ideal pH range for silkworm growth is 6-8, while pH below 4 and above 11 can cause biota death (Efendi, 2013). Nitrite levels increased during experiment, starting from 0.0 mg/l at the beginning of experiment, then increasing to 0.6-1 mg/l in the middle and end of experiment. This increase in nitrite is related to the use of tofu dregs as a feed source, which contains high protein (21.91%) and is a source of nitrogen (Akhril et al., 2019; Syahputra et al., 2020). The optimal nitrite value for silkworms is 0.1-0.20 mg/l (Wenda et al., 2018), however, nitrite of 1 mg/l is still safe for the life of the worms (Putri et al., 2014).

The measurement value of nitrite during the beginning of experiment, middle of experiment, and end of experiment using a test kit ranged from 0.0 mg/l and increased to 0.6 mg.l-1 to 1 mg.l-1 in the middle and end of experiment. The increase in nitrite is related to the input of tofu dregs fermentation applied to each container because tofu dregs are a high source of protein worth 21.91% (Akhril et al., 2019), the protein source then becomes a source of nitrogen (Syahputra et al., 2020). Nitrite is one of the determining factors for the success of silkworm cultivation (Aminnun et al., 2020). The nitrite value in the middle and end of experiment is less than optimal for silkworms because according to (Wenda et al., 2018), the optimal nitrite value for silkworms is 0.1-0.20 mg.l-1. However, a nitrite value of 1 mg.l-1 is still safe for silkworms to live (Putri et al., 2014).

Dissolved oxygen (DO) during experiment is in the range of 4.3-4.7 mg/l, which still supports the life of silk worms. Research by (Efendi, 2013) states that the lowest DO value that can still be accepted by silk worms is 2.5 mg/l, while optimal DO is in the range of 2.5-7 mg/l. According to (Fadhlullah et al., 2017), silk worms can even survive in extreme DO conditions, ranging from 0.2 to 5.5 mg/l. Ammonia levels were measured at the beginning, middle and end of experiment, with consistent results below 0.5 mg/l. This value is considered optimal to support the growth of silk worms, in accordance with the ammonia limits suggested by (Efendi, 2013).

Business Analysis

Based on the research data on productivity and absolute weight growth, the assumption of business analysis is carried out with several treatment comparisons. The calculation of the silkworm cultivation business analysis is assumed as follows, and the results of the business analysis are presented in Table 4:

a) Production of silkworms with synthetic substrates using cotton and nets as the basic materials assuming a production capacity of up to 1000g/cycle then calculating how many containers are needed to reach 1000g/l.
b) Selling price of Rp.30,000 per liter.
c) The final average weight is in accordance with the research results, K (control) 62.75g, P1 (Cotton) 63.5g, and P2 (Net) 69.5g.

Table 4. Business Analysis

No.	Calculation	Control	P1	P2
1.	Profit/Loss	Loss	Loss	Loss
2.	B/C ratio	0,14	0,14	0,14
3.	Eligible/Uneligible	Uneligible	Uneligible	Uneligible

The results of the profit/loss comparison of each treatment in the silkworm cultivation business showed that all treatments consistently resulted in losses. This was due to low sales results that were unable to cover production costs. The losses most likely occurred because the growth of silkworms was relatively small, so that production did not reach adequate amounts. In addition, high investment costs, especially related to the need for experiment containers, also contributed to the losses. Based on the results of the study, 17 containers were needed in the control treatment, 16 containers in P1 (cotton), and 15 containers in P2 (net) to achieve 1 liter of production.

The lowest B/C Ratio value was in the control treatment with a figure of 0.14, but this value was not significantly different from the B/C Ratio value in P1 and P2 which were both at 0.14. In the three treatments, the business analysis concluded that the silkworm cultivation business was considered economically unfeasible. This low feasibility was caused by low productivity and growth in worm weight, so that sales results were also low. In addition, the assumption of high investment costs due to the large number of containers needed and expensive water quality equipment was also a determining factor in losses. Profit in the silkworm cultivation business will only be achieved if worm growth is higher and operational costs can be reduced without reducing the sustainability of cultivation. Efforts to reduce operational costs can be done by only using tools and materials that are essential for the sustainability of cultivation, such as containers, pumps, and fermentation materials. Reducing investment costs can also be achieved by replacing the purchase of water quality measurement tools with water quality measurement services.

According to Setiadi's research (2021), an absolute weight growth of 450 g/container is required for silkworm cultivation to be economically feasible. The results of this study also showed that there was no significant effect of the use of synthetic substrates with different basic materials on the productivity and absolute weight growth of silkworms (*Tubifex sp.*), based on the SPSS test with the One-Way ANOVA method (sig. value> 0.05). The highest absolute weight growth was found in P2 (net) with an average of 19.5 ± 5.32 g/container, while the lowest growth was in the control with an average of 12.75 ± 12.25 g/container. In terms of productivity, the P2 treatment also showed the highest results with a value of 689.48 ± 52.80 g/m²/cycle, while the control had the lowest productivity, namely 622.52 ± 121.60 g/m²/cycle. In terms of ease of harvest, the control treatment is the easiest and fastest, followed by P2, which is relatively faster than P1 (cotton) which takes longer because the harvesting process is more complicated. Overall, the analysis of silk worm cultivation efforts with synthetic substrates showed a loss, with B/C Ratio values in the control, P1, and P2 each of 0.14 (below 1, so it is not feasible).

CONCLUSION

There was no significant effect on the use of synthetic substrates with different basic materials on the productivity and absolute weight growth of silkworms (*Tubifex sp.*) (sig.> 0.05). The highest absolute weight growth was in P2 (net substrate) with an average value of 19.5 ± 5.32 g/container and the lowest value was in K (control) with an average value of 12.75 ± 12.25 g/container. The highest productivity figure was in P2 (net substrate) with a value of 689.48 ±

52.80 g/m2/cycle and the lowest productivity in K with a value of 622.52 ± 121.60 g/m2/cycle. Based on the ease and speed of harvest, the control treatment was the fastest because it only needed to collect and clean the worms. Then followed by treatment P2 (which is easy and relatively faster than treatment P1 (cotton) which is the most difficult and relatively longest because it needs to be torn first when harvesting. Analysis of silk worm business with synthetic substrate shows loss results, with a B/C Ratio K value of 0.14 (<1, not feasible), B/C Ratio P1 & P2 value of 0.14 (<1, not feasible) so it is recommended that in silk worm cultivation activities, organic substrates/media are still needed with adjusted density and combined with synthetic substrates with a reduced thickness level from this study, because the role of synthetic substrates can be a place to live or attach silk worms and help egg attachment and facilitate the removal of silk worms when harvesting. Then organic media helps the growth and development of silk worms. So that the combination of organic and synthetic substrates can synergize to adjust to their respective roles.

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