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GROWTH OF SILKWORM (*Tubifex* sp.) IN VERTIQUA MEDIA WITH THE ADDITION OF A BIOFICAL FILTER

Pertumbuhan Cacing Sutra (*Tubifex* sp.) di Media Vertiqua dengan Penambahan *Biofical Filter*

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ABSTRACT

Silkworm (*Tubifex* sp.) is an important natural feed for fish hatcheries due to its high nutritional value and suitable body size for fish larvae. However, the availability of wild silkworms is highly dependent on environmental conditions and may pose risks of disease, parasites, and contaminants because they are commonly collected from organically polluted waters. This study aimed to evaluate the effectiveness of a Vertiqua (Vertical Aquaculture) system equipped with a biofical filter on the growth performance of silkworms. The experiment was conducted for 58 days using a Completely Randomized Design with one treatment and three replications. The Vertiqua system with a biofical filter was compared with conventional media consisting of chicken, goat, and cattle manure without a filtration system. Observed parameters included absolute weight gain, specific growth rate (SGR), feed conversion ratio (FCR), and water quality. The results showed that the Vertiqua system produced the highest absolute weight gain of 266.01 g/m² with an SGR of 4.59% day^{-1}, outperforming the conventional media. The FCR value of 2.43 indicated that feed utilization efficiency was still influenced by biological and microbiological processes within the culture system. The application of a biofical filter-maintained water quality and provided a more stable culture environment, thereby supporting optimal silkworm growth. Therefore, the Vertiqua system has considerable potential as a hygienic, productive, and sustainable alternative for silkworm culture.

Keywords: Biofical Filter, Growth, *Tubifex* sp., Vertiqua, Worm Culture

ABSTRAK

Cacing sutra (*Tubifex* sp.) merupakan pakan alami yang banyak digunakan dalam kegiatan pembenihan ikan karena memiliki kandungan protein tinggi dan ukuran tubuh yang sesuai dengan bukaan mulut larva ikan. Namun, ketersediaan cacing sutra dari alam masih bergantung pada kondisi lingkungan serta berpotensi membawa penyakit, parasit, dan kontaminan akibat berasal dari perairan yang tercemar limbah organik. Penelitian ini bertujuan menganalisis efektivitas sistem Vertiqua (*Vertical Aquaculture*) dengan penambahan biofical filter terhadap pertumbuhan cacing sutra. Penelitian dilaksanakan selama 58 hari menggunakan Rancangan

Acak Lengkap (RAL) dengan satu perlakuan dan tiga ulangan. Budidaya dilakukan menggunakan sistem Vertiqua yang dilengkapi biofical filter, sedangkan media pembanding menggunakan kotoran ayam, kambing, dan sapi tanpa sistem filtrasi. Parameter yang diamati meliputi pertumbuhan bobot mutlak, laju pertumbuhan spesifik (*Specific Growth Rate*/SGR), rasio konversi pakan (*Feed Conversion Ratio*/FCR), dan kualitas air. Hasil penelitian menunjukkan bahwa sistem Vertiqua menghasilkan bobot mutlak tertinggi sebesar 266,01 g/m² dengan nilai SGR 4,59% per hari, lebih tinggi dibandingkan media konvensional. Nilai FCR sebesar 2,43 menunjukkan bahwa efisiensi pemanfaatan pakan masih dipengaruhi oleh proses biologis dan mikrobiologis dalam sistem budidaya. Penerapan biofical filter mampu menjaga kualitas air dan menciptakan lingkungan budidaya yang stabil sehingga mendukung pertumbuhan cacing sutra secara optimal. Dengan demikian, sistem Vertiqua berpotensi menjadi alternatif budidaya cacing sutra yang higienis, produktif, dan berkelanjutan.

Kata Kunci: *Biofical Filter*, Cacing Sutra, Pertumbuhan, *Tubifex* sp., Vertiqua

INTRODUCTION

Natural feed is a critical factor determining the success of fish farming operations. During the larval stage, the availability of feed that is appropriately sized for the mouth opening, easily digestible, highly palatable, and nutritionally complete is crucial for the growth, organ development, and survival rates of fish fry (Melaku et al., 2024). Silkworms possess high nutritional value, containing protein (57%), fat (13.3%), crude fiber (2.04%), ash (3.6%), and water (87.7%) (Batubara et al., 2023).

In Indonesia, the demand for silkworms is largely met through harvesting from natural habitats. Their availability is heavily influenced by seasonal changes, environmental conditions, and water quality, resulting in unstable production (Hamron et al., 2019). Furthermore, the natural habitats of these worms are typically waters rich in organic matter and potentially contaminated with waste; consequently, the harvested worms risk carrying diseases, parasites, or contaminants that can degrade the quality of the rearing medium and increase fish fry mortality. Reliance on wild harvesting often results in a supply that fails to meet the high demand from the hatchery sector, necessitating alternative production methods through more controlled cultivation systems (Lestari et al., 2021).

Various studies have explored the cultivation of silkworms using organic media, such as chicken, goat, and cattle manure. These media serve as nutrient sources for the worms following decomposition (Umidayati et al., 2020). However, the direct use of organic media presents several drawbacks, including slow decomposition rates, accumulation of organic matter, elevated ammonia concentrations, reduced dissolved oxygen levels, and water quality fluctuations, all of which can inhibit the growth and reproduction of the worms (Liu et al., 2020). These conditions indicate that the culture medium requires not only an adequate nutrient source but also a water quality management system capable of maintaining stable environmental conditions throughout the rearing period (Timmons et al., 2013).

One innovation with the potential to address these issues is the Vertiqua (Vertical Aquaculture) system combined with a biofical filter. The Vertiqua system is designed to utilize culture space vertically, thereby enhancing land and water use efficiency. Implementing a recirculation system equipped with a biofical filter enables the continuous filtration of organic matter and feed residue, as well as the reduction of toxic compounds like ammonia; this preserves water quality and supports the growth of the cultured organisms (Kamil et al., 2024). Consequently, water quality remains more stable, creating a culture environment that is more conducive to the growth of silkworms (Asmito et al., 2021). Beyond increasing productivity, this system is expected to yield silkworms that are more hygienic and safe for use as natural feed in fish hatchery operations.

This research was conducted to evaluate the effectiveness of silkworm culture using the Vertiqua system supplemented with a biofical filter. The evaluation involved monitoring absolute weight gain, specific growth rate (SGR), feed conversion ratio (FCR), and water quality conditions during the rearing period. The findings are expected to serve as a foundation for developing more productive, efficient, and sustainable silkworm culture technology to supply natural feed for aquaculture operations.

RESEARCH METHODS

Time and Location

The research was conducted over a period of 58 days, from November 21, 2025, to January 17, 2026, at the Bossbaster Experimental Pond in Kampung Legoknyenang, Muaradua Village, Kadudampit District, Sukabumi Regency, West Java.

Equipment and Material

Table 1. Equipment and Material

Equipment	Total	Unit	Function
Worm inoculant	90	gram	Research medium
Fine pellets	870	gram	Silk worm feed
Water	90	Liter	Research medium
Charcoal	3	kg	Research medium
Husk	3	bag	Research medium
Sand	6	kg	Research medium
Water spinach	6	bunch	Research medium
Mud	90	kg	Research medium
Material			
Box Container 60x30 cm	9	unit	Research medium
Bucket	3	unit	Research medium
Scales	1	unit	Scale
Pump	3	unit	Research medium
PVC	4	meter	Research medium

Research Design

The study employed a Completely Randomized Design (CRD) with a single treatment: the cultivation of silkworms using the Vertiqua system equipped with a biofical filter, with three replicates. The selection of this treatment was based on the research objectives and findings from previous studies indicating that silkworm growth is influenced by the quality of the culture medium and water. Consequently, the Vertiqua system with a biofical filter was utilized to establish more controlled cultivation conditions. The treatment was conducted with three replicates to obtain data that better represented the experimental conditions. Each experimental unit started with homogeneous conditions—including the culture medium, inoculum quantity, feed, and rearing location—followed by randomization to minimize the influence of external factors on the results. A conventional culture medium using chicken, goat, and cow manure without a filtration system served as the control. The CRD approach is appropriate for research involving relatively homogeneous experimental units, where each unit has an equal chance of receiving the treatment through randomization, ensuring that any observed variation is primarily attributable to the treatment and experimental error (Malau, 2023).

Research Procedure

The Vertiqua medium setup was arranged vertically using nine containers divided into three experimental units. Each unit was equipped with a biofical filter and a water recirculation system operating 24 hours a day. The culture units were filled with sludge as a substrate, and 10 grams of silkworm inoculum were seeded into each container. Throughout the rearing period, the worms were fed fine pellets daily. Maintenance was performed periodically by cleaning the piping, pumps, and biofical filters every week to maintain stable water quality. Daily observations were conducted regarding the activity, growth, and population development of the silkworms. After a 58-day rearing period, the worms were harvested, rinsed under running water, and weighed to determine the final biomass.

Observed Parameters

The parameters observed included:

1. Absolute weight growth

Absolute weight growth is derived from the difference in average weight during the rearing period; the formula for calculating absolute growth according to Suseno (1983) is:

$$W = Wt - Wo$$

Where:

W = Absolute growth (g)
Wt = Average total weight of individuals at the end of the experiment
Wo = Average total weight of individuals at the start of the experiment

2. Specific Growth Rate (SGR)

The specific growth rate (SGR) is calculated based on the change in the natural logarithm of initial and final biomass during the rearing period (Crane et al., 2020).

$$SGR = \frac{Wt - Wo}{t} \times 100\%$$

Where:

SGR = Specific growth rate (%/day)
Wo = Fish weight at the start of the study (g)
Wt = Fish weight at the end of the study (g)
t = Time (days)

3. Feed Conversion Ratio (FCR)

The FCR value is calculated based on the ratio between the amount of feed provided and the biomass gain during the rearing period (Goda et al., 2024).

$$FCR = \frac{F}{(Wt + D) - Wo}$$

FCR = Feed conversion ratio
F = Weight of feed provided (grams)
Wt = Biomass of test animals at the end of rearing (grams)
Wo = Biomass of test animals at the start of rearing (grams)
D = Weight of dead animals (grams)

Data Analysis

Research data were analyzed using descriptive quantitative methods, employing mean values to describe the growth response of silkworms to the treatments. Subsequently, a One-Sample t-Test was conducted using Microsoft Excel. Statistical testing via the One-Sample t-Test was performed to determine whether observed values differed significantly from a specific reference value at a 95% confidence level ($\alpha = 0.05$) (Ghozali, 2018). Analysis results are presented in tables and graphs to facilitate data interpretation.

RESULT

Absolute Weight Growth

Research results indicate that silkworm cultivation using the Vertiqua system supplemented with a biofilter yielded the highest absolute weight growth compared to conventional media. The absolute weight value in the Vertiqua system reached 266.01 g/m², whereas it was 60 g/m² for chicken manure media, and −2 g/m² for both goat and cow manure media. Statistical analysis showed that absolute weight growth in the Vertiqua system differed significantly from that in conventional media ($P<0.05$). These results indicate that a recirculation system combined with a biofilter can maintain more stable water quality, improve nutrient utilization efficiency, and produce higher silkworm biomass compared to conventional cultivation systems (Patekar et al., 2024).

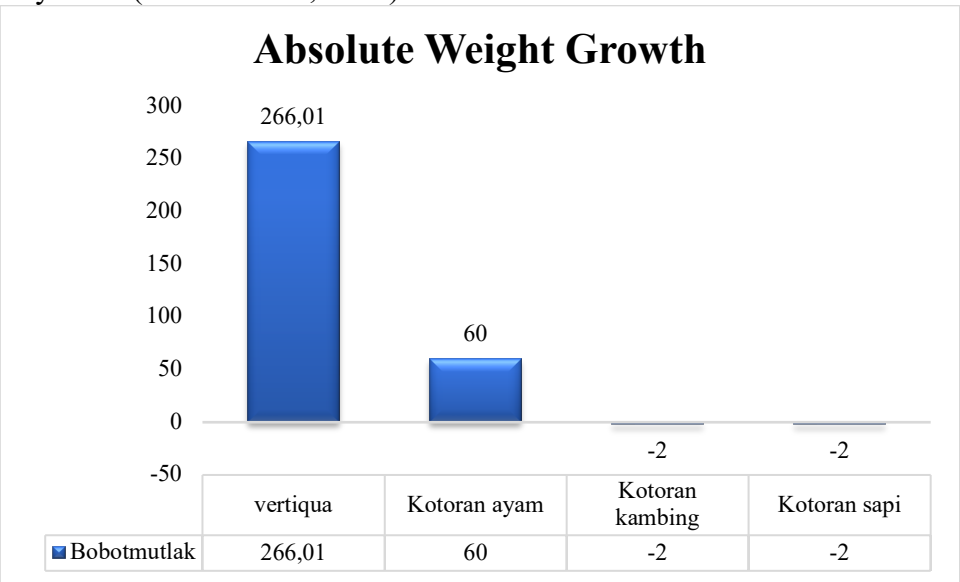

Figure 1. Absolute Weight Growth of Silkworms in Vertiqua vs. Conventional Systems

Specific Growth Rate (SGR)

The specific growth rate (SGR) values for silkworms varied across the cultivation media. The Vertiqua system yielded an SGR of 4.59% per day with a final biomass of 276.01 g/m². In contrast, conventional media yielded an SGR of 1.03% per day for chicken manure, while goat and cow manure media both showed values of −0.03% per day. These differences in SGR values indicate that the cultivation medium and rearing system influence the worms' ability to utilize nutrients for growth. A stable cultivation environment with an appropriate supply of organic matter can enhance the growth rate and biomass accumulation of *Tubifex* sp. (Santoso et al., 2022).

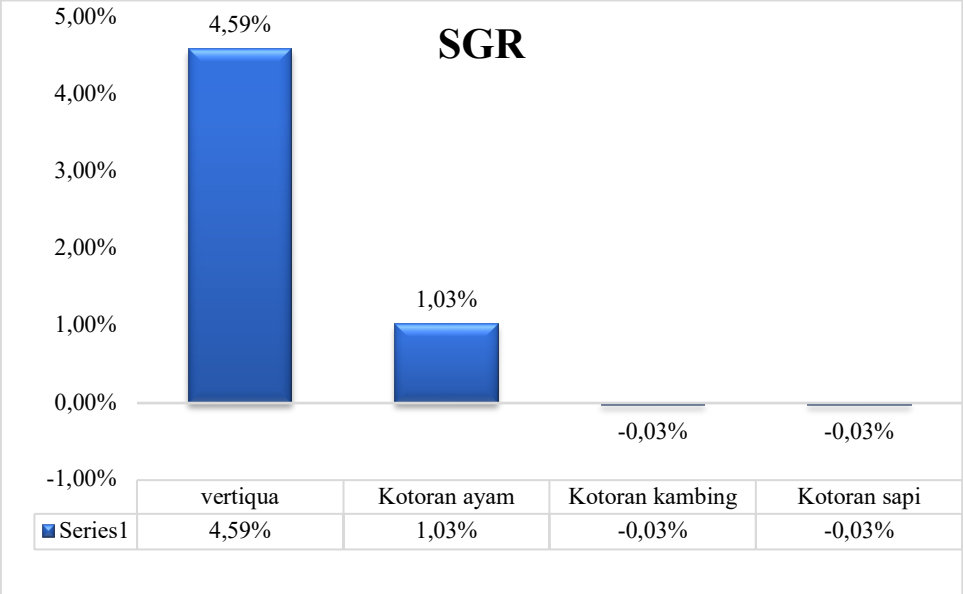

Figure 2. Specific Growth Rate (SGR) of Silkworms in Vertiqua and conventional systems

Feed Conversion Ratio (FCR)

Observations indicate that silkworm cultivation using the Vertiqua system resulted in a Feed Conversion Ratio (FCR) of 2.43. This value implies that the production of 1 gram of Tubifex biomass required approximately 2.43 grams of feed. The high FCR value is thought to stem from the fact that a portion of the fine, paste-like feed was not fully consumed by the worms; instead, it settled onto the substrate or was carried away by the recirculating flow before it could be utilized. This resulted in some nutrients failing to convert into biomass, thereby reducing feed utilization efficiency, even though the recirculation system successfully maintained stable culture medium quality (Putri et al., 2024).

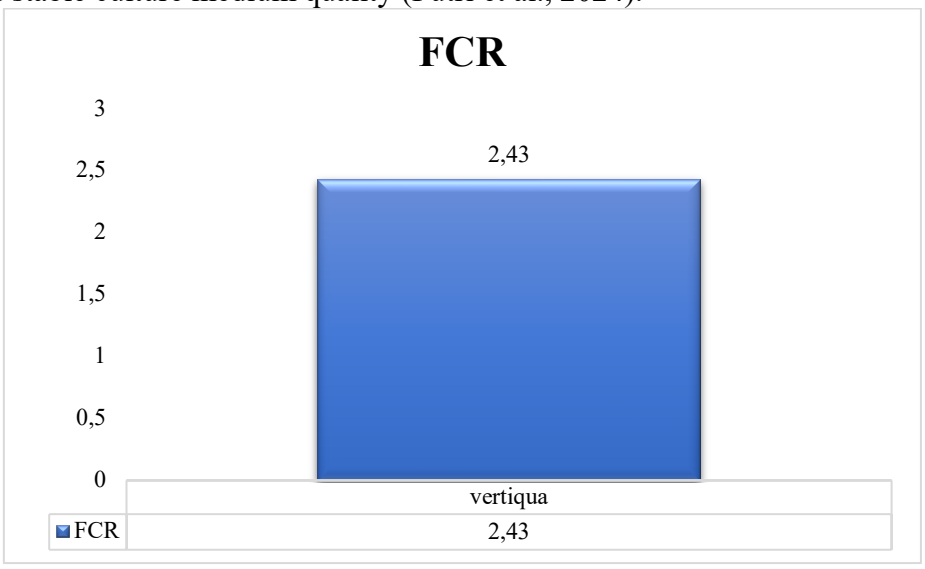

Figure 3. Feed Conversion Ratio (FCR)

Cultivation Duration

The study was conducted over a period of 58 days. Throughout this rearing period, Tubifex biomass increased gradually until the study's conclusion. Observations revealed that the worms underwent two reproductive cycles during this time, leading to an increase in biomass compared to initial levels. The rise in biomass during the rearing period demonstrates

that the culture medium conditions and nutrient availability were sufficient to support the sustainable population growth of *Tubifex* sp., allowing biomass to continue increasing alongside the reproductive cycles (Murni et al., 2022).

Productivity based on Culture Medium Area

Tubifex cultivation using the Vertiqua system—with a culture medium area of 0.18 m²—yielded higher biomass and growth rates compared to the conventional medium, which had an area of 0.24 m². Despite utilizing a smaller medium area and starting with lower initial biomass, the Vertiqua system achieved higher biomass productivity than the conventional method. Cultivation systems utilizing technology and effective culture medium quality management can enhance the production efficiency of aquatic organisms by optimizing space and nutrient availability (Putra et al., 2017).

DISCUSSION

Research results indicate that cultivating silkworms (*Tubifex* sp.) using the Vertiqua system—supplemented with a biofical filter—significantly enhances biomass growth compared to conventional media. The absolute weight gain of 266.01 g/m² in the Vertiqua system was substantially higher than that observed in media based on chicken manure (60 g/m²), goat manure (−2 g/m²), or cow manure (−2 g/m²). This disparity demonstrates that a cultivation system incorporating effective water quality management plays a more pivotal role in supporting silkworm growth than the use of organic media lacking a filtration system (Bana et al., 2024).

The high biomass growth observed in the Vertiqua system is attributed to the biofical filter, which effectively filters dissolved organic matter, reduces ammonia accumulation, and maintains stable water quality throughout the rearing period. These stable environmental conditions allow metabolic energy to be optimally utilized for body tissue formation rather than merely for maintaining physiological functions. Conversely, in conventional media, organic matter decomposition occurs without a filtration system, potentially leading to increased ammonia concentrations and a decline in the quality of the cultivation medium (Martudi et al., 2017).

The specific growth rate (SGR) of 4.59% per day in the Vertiqua system confirms that the cultivation environment effectively supports optimal silkworm growth. In contrast, the low SGR observed with chicken manure media (1.03% per day) and the negative values recorded for goat and cow manure media (−0.03% per day) indicate that these media conditions failed to provide an environment conducive to growth. According to Umidayati et al. (2020), silkworm growth is influenced by nutrient availability, media conditions, and water quality—factors that facilitate metabolic processes. Therefore, water quality stability is a critical determinant of successful silkworm growth (Giawa et al., 2023).

The study results also indicated a Feed Conversion Ratio (FCR) of 2.43. This value suggests that feed utilization within the Vertiqua system is not yet fully efficient. Observations suggest that the high FCR value was likely caused by a portion of the fine, paste-like feed not being fully consumed by the silkworms; instead, it settled onto the substrate or was carried away by the recirculating flow before it could be utilized. Furthermore, microbial decomposition processes resulted in some nutrients being consumed by the microbial community, preventing their complete conversion into silkworm biomass (Febrianti et al., 2023).

The 58-day rearing period provided sufficient time for the silkworms to progress through their adaptation, growth, and reproduction phases. Two reproductive cycles occurred during this period, leading to a gradual increase in biomass throughout the study. This demonstrates that the Vertiqua system provides an environment conducive to sustaining the silkworm life

cycle during the rearing period. In contrast, with conventional media, slow organic matter decomposition and fluctuating water quality are thought to limit growth and reproduction, thereby hindering optimal biomass accumulation (Umidayati et al., 2020).

In addition to promoting greater growth, the Vertiqua system demonstrated superior productivity despite utilizing a smaller cultivation area (0.18 m²) compared to conventional media (0.24 m²). These results indicate that productivity gains are determined not only by the cultivation area or initial biomass quantity but also by the effectiveness of the recirculation system and bio-filter in maintaining culture environment quality (Kamil et al., 2024). Consequently, Vertiqua technology offers a potential alternative for silkworm cultivation that is more efficient in terms of land and water use while yielding higher biomass than conventional methods (Asmito et al., 2021).

CONCLUSION

Cultivating silkworms (*Tubifex* sp.) using the Vertiqua system, supplemented with a biofical filter, has proven effective in enhancing biomass growth compared to conventional culture media. The Vertiqua system yielded an absolute weight of 266.01 g/m² and a specific growth rate (SGR) of 4.59% per day—figures exceeding those achieved with media based on chicken, goat, and cattle manure. Although the Feed Conversion Ratio (FCR) of 2.43 indicates that feed utilization efficiency still requires improvement, the integration of a biofical filter fosters a more stable culture environment, thereby supporting optimal silkworm growth. Consequently, the Vertiqua system holds potential as a productive, efficient, and sustainable cultivation technology for providing natural feed for fish hatchery operations.

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