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Abundance of Silkworms (*Tubifex* sp) Fed Swallow Feces as an Alternative Natural Feed for Ornamental Fishes

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ABSTRACT

The ornamental fish in the aquaculture business is growing over time and continuing to be a promising sector. To ensure success, natural feed is crucial for the larvae stage. Tubifex has a high protein content and can provide all the nutrition fish larvae need. This study aims to investigate the abundance of silkworms using different doses of Swallow feces. Swallow feces were collected from wild forest areas of Central Halmahera, North Maluku Province. Tubifex was grown in mixed media of mud and four swallow feces doses: 50 g, 100 g, 150 g, and without feces as a control. The experimental setup was conducted at the Wet lab station, Khairun University. Results show that giving 150 grams of swallow feces increases the growth and abundance of tubifex in about 1174.33 individuals in 30 days. Water quality parameters such as temperature, pH, dissolved oxygen (DO), and ammonia support the survival of *Tubifex sp*.

Key words: Natural feed, Ornamental fish, Silkworm abundance, Swallow feces

INTRODUCTION

Natural food is an important factor influencing the success of fish farming businesses. Natural food are mentioned to be effective in promoting the growth and health of fish like eels (*Anguilla sp*.), catfish (*Ictalurus punctatus*), goramy (*Osphronemus goramy*), milkfish (*Chanos chanos*), carp (*Cyprinus sp*), guppy (*Poecilia reticulate*), angel fish (*Pterophylum scalare*), koi carp (*Cyprinus carpio*), comet goldfish (*Carassius auratus auratus*), and goldfish (*Carassius auratus*) in the cultivation of freshwater and seawater fish as well as ornamental fish (Budianto et al., 2019; Kautsar et al., 2022). Common natural foods for the larval or juvenile stage are plankton, mosquito or insect larvae, crustacean larvae, and silkworms.

Traditionally, silkworms have been widely used in freshwater aquaculture as a natural food source (Barkhordar et al., 2018; Nuraini et al., 2019). These animals are caught in rivers that contain a lot of organic waste, i.e., rivers in urban areas (Kaeser & Sharpe, 2006). The growth of silkworms (*Tubifex sp*), especially the abundance of individuals and the increase in body weight, is greatly influenced by the organic material contained in the waters (Triputra, 2023). Nuraisyah et al. (2023) found that the specific growth rate of silkworms reared in parallel ponds at BBPBAT Sukabumi was 17.73% per day with a weight of 249.12 g and was an important source of protein for farmed fish larvae. Meanwhile, Masaniku et al. (2024), who raised silkworms in a semi-closed recirculation system (SCRS), obtained the results

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that the best biomass weight (118 g/m^2) was obtained if 500 g/m^2 of cow dung was given to grow silkworms. Fish farmers generally use organic materials such as livestock manure, for example, cow and chicken manure, to grow silkworms. However, the N content of these two organic materials is high, so it can produce high levels of ammonia in the water, which may decrease the dissolved oxygen and become toxic to the cultured fish. As an alternative, one of the available livestock manures in North Maluku Province is swallowtail bird (*Aerodramus fuciphagus*) droppings that also contain organic N, P, K, and organic-C, which can enrich the nutrients in the waters. According to Sulmartiwi et al. (2003), swallowtail birds' feces contain 6.11% N, 15.65% P, 21.90 ppm K, 50.46% organic-C, 0.30% Ca, and 0.01% Mg. The protein (66%) and fat (12%) contents of this polychaete class of worms make this species very promising for further development (Simangunsong et al., 2023).

Wallet bird droppings (*Aerodramus fuciphagus*) can be an alternative in reducing high levels of N and ammonia in waters. According to Sulmartiwi et al. (2003), swallow droppings contain 6.11% N, 15.65% P, 21.90 ppm K, 50.46% organic C, 0.30% Ca, and 0.01% Mg. This N level is lower than in other bird droppings, such as bats (7- 17%N, 8-15%P, and 1.5- 2.5%K) (Syofiani & Oktabriana, 2018), seabird guano (8-16%N) (Tangguda et al., 2022), or chickens (100%N) (Sergeeva & Gasimova, 2020). Apart from that, the abundance of swallowtail bird droppings in North Maluku Province can be used as fertilizer for the growth of silkworms or otherwise as waste that pollutes the environment.

Silkworms are much needed, especially in household hatchery units, fish seed centers, and small-scale ornamental fish-rearing businesses (Patekar et al., 2022). Because of the increasing cost and growing demand from consumers for both commercial and recreational uses, ornamental fishes such as guppy (*Poecilia reticulate*), ramiraze fish (*Mikrogeophagus ramiraze*), angelfish (*Pterophylum scalare*), koi carp (*Cyprinus carpio*), comet goldfish (*Carassius auratus* auratus), and goldfish (*Carassius auratus*) have been widely cultivated (Alam et al., 2021; Barkhordar et al., 2018; Budianto et al., 2019; Görelşahin et al., 2018). Furthermore, decorative fish needs a diet rich in protein. Guppies grow very well when fed with Tubifex three times a week as compared to two or four. Guppies can reach a maximum length of 4-5 cm when fed natural food in the form of tubifex. It was also reported that throughout the 80–100 days that they were being raised in ponds, they had good survival rates (97–99%) (Görelşahin et al., 2018). However, due to the lack of freshwater streams and rivers in the Ternate region, silkworms are difficult to find. Therefore, these organisms must be bred in controlled areas, such as earthen puddles or on an indoor shelf.

MATERIALS AND METHODS

The materials used were swallow bird manures (*Aerodramus fuciphagus*) and silkworms (*Tubifex sp*) collected from the wild forest areas of Central Halmahera, North Maluku Province, and Tatelu freshwater cultivation center, North Sulawesi, respectively. 12 rounded plastic buckets (50 x 35 x 20 cm) were filled with mud as a growth medium and placed in the wooden rack. The experiment was conducted for 30 days at the Marine wet lab of the Fisheries and Marine Faculty at Khairun University.

1. Experimental design
   A 3x4 randomized complete design was used to evaluate the effect of using swallow birds' manures to grow silkworms in four different doses, which are treatment A (50 grams), B (100 grams), C (150 grams), and D (no manures) as a control.

2. Preparation of fertiliser and growing media
   – Swiftlet droppings collected from nature are dried manually under the sun until completely dry.

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- Dried swallow droppings are filtered using a sieve of 1-2 mm.
- The finely ground material is mixed with 50 g of mud media according to the treatment dose and placed in the buckets. Mud was collected from the local rice field.

3. Spreading silkworm larvae
   The primary condition for using silkworm seeds is their high quality, indicated by a bright red color, which signifies an adequate level of erythrocruorine in their blood.
   Before being sown, the silkworm larvae are placed for 1.5 hours in mud media to be sufficiently adapted to their new habitat. Each bucket was stocked with 120 silkworm larvae and gradually fed with swift bird droppings every week.

4. Rearing techniques
   The first thing is to organize good water circulation in the maintenance media to provide adequate oxygen exchange. Water changes must remove the ammonia content, which is toxic to silkworms. Water flow rates are controlled, containers are frequently cleaned of dirt, and nuisance animals or predators must be removed. The optimal water flow for the growth of silkworms is 750 ml/minute or around 3 l/minute for every m^2 of container used. According to Sulmartiwi (2006), the highest silkworm population growth was 525 ml/minute water flow. Meanwhile, Shafruddin et al., (2005) stated that 300 ml/minute or 1.87 l/minute for every m^2 of a container is better to be used.

5. Observation and data collection
   The types of observations conducted were the initial number of individuals per week until the end of the study and the water quality of the media during silkworm rearing, such as pH, temperature, and dissolved oxygen. Silkworm abundance is measured using Welch's test (1984) in Rachmawaty, (2011) equation:
   N = 1000 (S) / A, where N is abundance, S is the number of resulting individuals, and A is the area of rearing media, which is 50x35x20 cm^3

6. Data analysis
   Data obtained was first analysed for normality with the normality test. Furthermore, using the homogeneity test, the data that had been checked for normality were retested for homogeneity. If the data is decided to be abnormal or non-homogeneous, the data transformation is performed before checking for variance. Meanwhile, if the data obtained are normal and homogeneous, analysis of variance can be used to test the diversity.

RESULTS AND DISCUSSION

Result

A. Growth and Abundance of Silkworms

Results show that the most Tubifex numbers each week are pointed by treatment C, which has 1174.33 individuals, followed by treatment B (859.33 individuals), A (678.33 individuals), and D (390.67 individuals).

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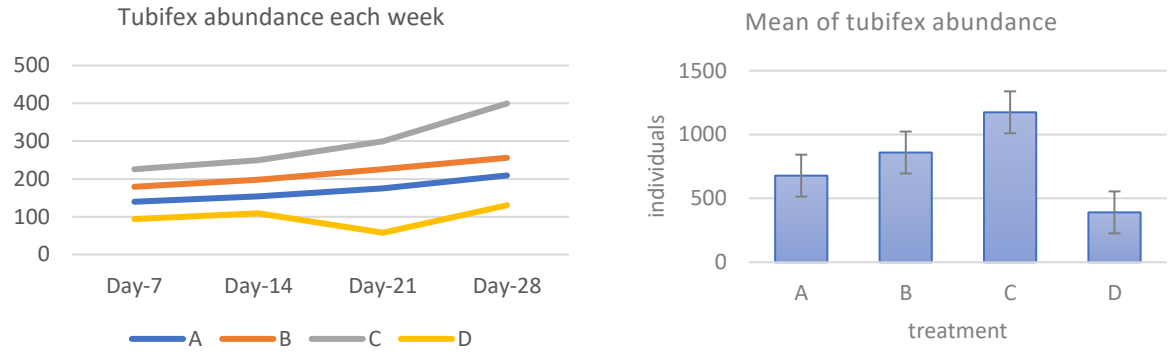

Figure 1. The increasing numbers of silkworms during rearing time.

B. Water Quality in the Silkworms' rearing days

The effectiveness of fish farming is highly dependent on the condition of the water. Throughout the study, measurements of the water quality, including temperature, pH, dissolved oxygen (DO), and ammonia, were made once a week. Table 1 presents the findings from the study's measurements of the water quality.

Table 1. Water quality parameters measurement for 30 days.

Parameter \ Treatment	A	B	C	D
Temperature (°C)	26-27	26-27	26-27	26-27
DO (ppm)	3.31-5.28	3.5-4.51	3.5-4.51	4.1-4.82
pH	6.8-7	6.8-7	6.9-7	4.9-7
Ammonia (mg/l)	0.05-0.08	0.05-0.09	0.05-0.10	0.04-0.07

Discussion

The highest tubifex abundance is in treatment C, and the lowest is in the control (treatment D), revealing that tubifex is more suitable with higher organic manure than lower. This is related to the nutrient content in swiftlet feces, which can support the growth and abundance of silkworms, in line with research conducted by Kesumawati et al. (2024), which obtained significant results from the provision of bird droppings fertilizer. The statistical analysis results show that the swallow faeces dose treatment significantly affects the variables of the increasing number of silkworms. Swallow droppings can serve as a natural fertilizer, enriching the soil with essential nutrients and acting as an alternative to manure (Reni, 2021). Their benefits include enhancing the soil's water retention capacity, improving its chemical composition by increasing nutrient levels, and supporting biological activity by promoting the growth and function of beneficial microorganisms (Rahman et al. 2024). Moreover, the nutrient ingredients contained in swallow droppings include C-organic 57.35%, N/Total 3.95%, and C/N Ratio 14.52 with pH 5.64, Phosphorus 2.00%, Potassium 0.13%, Calcium 0.92%, and Magnesium 0.24% (Marato et al., 2021).

Good growth is characterized by appropriate adaptation to the tubifex-rearing medium, namely, rice field mud. Rice mud contains nitrogen, phosphorus, and potassium, which are sources of nutrition for

silkworms (Mariom and Mollah, 2012). However, based on Barades and Witoko (2018), rice field mud generally contains 74-85% organic material, which contains toxic compounds. Rice field mud should be processed by fermentation using specific bacteria to reduce this toxicity level. On the other hand, the use of mud other than from rice fields is usually also used as a medium, for example, Lapindo mud (Erwinsyah et al. 2015). A comparison of rice field mud and Lapindo mud shows that rice field mud produces better weight growth of silkworms than Lapindo mud. The 100% rice mud proportion produced the highest silkworm biomass with a weight increase of 1.1 grams from the initial weight. This is because the C-organic content of rice field mud is higher than Lapindo mud (Jaya, 2010). According to Santoso (2022), the proper media for tubifex growth is a combination of 75% mud and 25% sand, which resulted in 13.244 grams biomass, 370 individuals, and 2.741 of mean weight. However, in this study, only a combination of rice field mud and swiftlet droppings was used to maximize the use of bird droppings, which are widely available in nature, and not using sand.

The temperature range recorded during the 30 days was 26-27ºC. According to the findings, the water temperature during the study was optimal for the survival of silkworms (*Tubifex sp*), where, based on Khaerunnisa et al (2021) study, the ideal water temperature range for tubifex is 24-31°C. During rearing time, the pH of the water ranged from 4.49 to 7, as measured by the degree of acidity. Based on these findings, the dissolved pH concentration appears to be ideal for silkworms' survival on applied treatments (A, B, C). Still, it has a low degree of pH on treatment D. It is assumed that without manures, the lack of soil fertility could affect the soil pH. For maintaining *Tubifex*, a pH of 6.9 to 7.6 is ideal (Prakash et al. 2024). It is advised that silkworms be kept in an environment with a pH of neutral to support a variety of biological processes, including respiration, fermentation, microbiological processes, biodegradation, balanced dissolved oxygen levels, and other naturally occurring biochemical processes that occur in water (Khaerunnisa et al., 2021).

In this study, the water exchange rate given was 500 ml/minute, and it gave good results for the survival of silkworms. A flow-through system needs to be implemented to meet the oxygen needs of silkworms, even though silkworms can survive in low oxygen conditions. However, water changes need to be made to remove the ammonia content, which is toxic to silkworms. The ammonia value in the media must range between 0.01-1.76 ppm, and if the ammonia content is > 3 ppm, it is a lethal condition for silkworms (Suprapto (1986) *in* Suharyadi 2012).

The maritime and fisheries sector is one of the resource-based industry sectors that has a competitive advantage to drive the national economy, so it is appropriate for this sector to be developed. This sector has a variety of potential, both fisheries and other natural resource potential. Ornamental fish are a fishery commodity that has the potential to generate foreign exchange for the country and a source of income for the fishing community (cultivators) (Tatang, 2014). The potential for ornamental fish in Indonesia is spread across the islands of Sumatra, Java, Kalimantan, Bali, Sulawesi, Maluku, and Papua. What is no less important is the development of the aquaculture industry, from small-scale/home/indoor to large-scale/mass/outdoor.

Natural feed from aquaculture, such as Daphnia, microalgae, copepods, moina, rotifers, Artemia nauplii, and some nematodes, has been used extensively during the development of fish larvae (Eryalcin & Tinkir, 2024). In practice, the usage of this natural feed can be applied according to the size of the mouth of the fish larvae that are raised. Recently, natural feeds can be supplemented with essential fatty acids and additional protein. As to Safrina et al. (2015), Tubifex, possessing a protein content of up to 64%, is a viable substitute for the larval stage development of farmed fish. Tubifex is widely employed in hatcheries for several catfish, cork, and ornamental fish types, according to Mandal et al., (2016). Young

fish require a high-protein diet for their bodies to grow and develop appropriately. Fish with proper nutritional intake will have increased metabolic processes. To construct their bodies, fish in their fragile catfish larval stage require a lot of protein. Nuswantoro and Rahardjo (2018) state that tubifex that has been diced and fed to catfish larvae first will make it easier for 5-10 days of tilapia fry. Guppies thrive when fed Tubifex three days a week rather than two or four. When provided natural food in the form of Tubifex, guppies can grow to be 4-5 cm long. Furthermore, during their 80-100 days of raising in ponds with high survival rates (97-99%), female fish grew at twice the rate of male fish (Alam et al., 2021).

CONCLUSION

Based on the results of the study, it can be concluded that the addition of swallow bird feces as an alternative feed had a significant effect on the growth and abundance of silkworms (*Tubifex sp*) for 30 days. The best dose of feces as manure in soil media is 150 grams, which achieves 1174.33 individuals. The more birds' nest manure fertilizer, the higher the abundance of silkworms. Tubifex is one of the better options to be used for ornamental fish aquaculture industries.

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