Potential of Fly Larva and Anchovy Process Waste Powder as Protein Source in Tilapia Fish Pellet

Muhammad Shukri Mohd Yusof
Politeknik Sandakan Sabah
mshukriyusof@pss.edu.my

Mohd Hafizzie Hajini
Politeknik Sandakan Sabah
hafizzie@pss.edu.my

Nurul Yusniza Yusof
Politeknik Sandakan Sabah
nurulyusnizaash@gmail.com

Abstract
Feeding is one of the most crucial aspects of fish culture activities. The rise of pellet prices due to the lack of raw material has led the farmers to shift to alternative protein sources. This research aims to study the potential of fly larva flour and anchovy process waste as a cheap alternative protein source for tilapia farming. Tilapia fishes with average length were divided into four different treatments. T1 is a control treatment (fish pellet) while T2, T3 and T4 contain a mixture of fly larva powder and anchovy process waste powder (45%, 50% and 55% mixture of fly larva flour and anchovy head flour). Fish growth rate, survival rate and water quality were recorded weekly throughout the study period. Data analysis shows that there are no significant differences amongst each treatment. This study indicates that fish supplied with a mixture of fly larva powder and anchovy process waste powder shared the same growth rate as the fish supplied with commercial pellets.

Keywords: alternative protein, anchovy,pellet

1.0 Introduction

The trend for aquaculture products demand is increasing (Martinez et al, 2012). This is due to the increase in the human population and the need for a cheap protein source (Bhujel, 2014). Due to the substantial increase in demand for fishery products, wild-catch fisheries is no longer an option. Therefore, human had to turn to aquaculture to ensure the stability of the food supply. It is previsedthat aquaculture will surpass wild-catch fisheries production (Mobsby & Curtoitti, 2019). The production of aquaculture is majorly influenced by the feeding and nutrition content (Glencross, 2020).

Feeding is considered one of the most crucial aspects of fish culture activities. Complete nutrition will ensure fish life and stay healthy (Lock et al., 2018). The ideal fish diet should be balanced in terms of nutrition to ensure that the fish get all the nutrients needed to support metabolic activity and thus accelerate the growth of tilapia (Lee et al., 2016; Sun et al, 2016 and Ali et al, 2016). Additionally, various factors such as species, size, behavior, environment,

water quality and also the level of rearing should be taken into account to determine nutrient content needed (Salin et al., 2018).

Fish meals are made of forage fish, it is the most popular source of protein in fish pellets (Hua et al., 2019). Overexploitation has caused a significant reduction in the forage fish population and resulted in the increase of fish meal price (Cao et al, 2015). The rise of fish meal prices due to the lack of raw material has forced farmer to increase the price of aquaculture products (Dorothy et al., 2018). Alternative protein sources are thought to be the best option to support aquaculture industry growth while also protecting the wild ocean population (Montoya-Camacho, 2019). Fly larva powder and anchovy process waste powder are high nutritional profile ingredients with low environmental footprint that are ideal substitute for fish meals (Tilami et al, 2020).

This research aims to study the potential of fly larva powder and anchovy process waste powder as a cheap alternative protein source for tilapia farming.

2.0 Material and methods

A total of 144 tilapia fish with an average initial length of 7.50 ± 0.71 cm were used in this study. Fish is divided into four treatments, T1 is a control treatment (fish pellet) while T2, T3 and T4 contain a mixture of fly larva powder and anchovy process waste powder (45%, 50% and 55% mixture of fly larva flour and anchovy head flour). Table 1 shows the composition of ingredients for each treatment.

Table 1. The composition of ingredients for each treatment.

Treatment	1	2	3	4
Fly Larva powder	0%	22.5%	25%	27.5%
Anchovy process waste powder	0%	22.5%	25%	27.5%
Commercial pellet	100 %	55 %	50%	45%
Total	100%	100%	100%	100%

Fly larva and anchovies process waste were dried using an oven before it was ground to desired texture. Then it will be mixed to commercial fish pellets according to the specified ratio. Fish mortality rates, growth measurements (weight and length) of fish and water quality readings of the culture system were recorded weekly throughout the eight-week study period. The measurement of fish survival rate is based on the formula proposed by Samson (2019) as follows:

Survival rate (%) = (A/B) × 100
Where,
A = Number of fish alive
B = Number of fish at the beginning of the study

Feeding is done twice a day. Food weight during the study period was determined based on the average weight of all fish in each week which is around 3% -5% of the weight of fish. A comparison analysis was performed to evaluate the efficacy of each pellet used in treatments 1, 2, 3, and 4.

3.0 Results

Weekly survival rate graph for eight weeks of sampling shown in Figure 1. T2 (45% mixture of fly larvae and anchovies' powder) display the lowest survival rate compared to the other three treatments. However, all four treatments recorded a high survival rate which is higher than 75%.

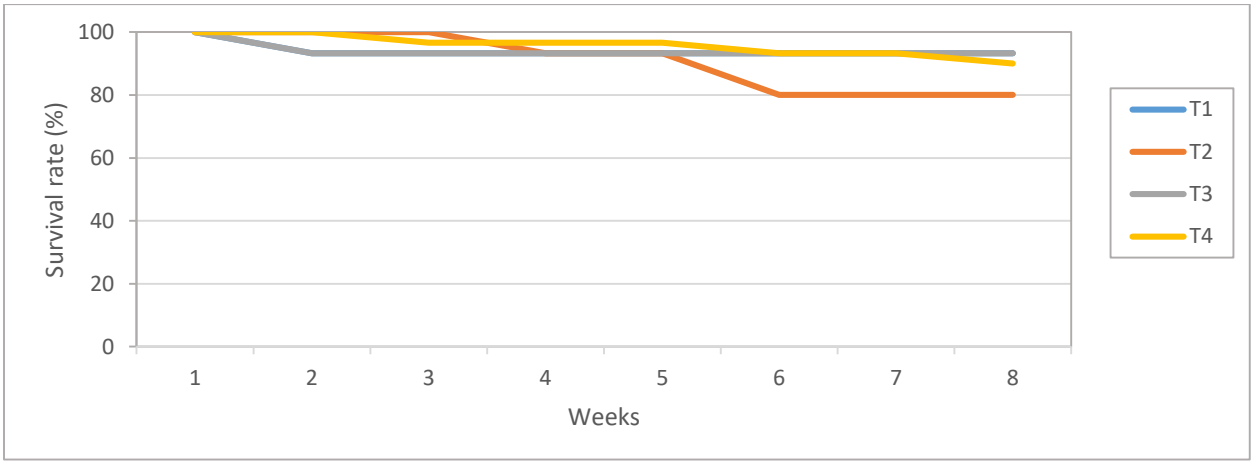

Figure 1. Graph of tilapia survival rate fed with 4 different treatments for 8 weeks.

Throughout 8 weeks of the sampling period, there are no distinguished differences in the tilapia length growth rate readings of fish supplied with 4 different treatments. Parallel to the fish length, a similar situation can be observed for the tilapia fish weight reading where there are no significant differences for the fish in four different treatments. However, the tilapia weight growth reading is a bit fluctuate. Tilapia weight and length growth that supplied with four different treatments for the duration of 8 weeks is shown in figure 2.

Water quality parameter recorded such as temperature (25 ^{o}C – 30.1 ^{o}C), Dissolved oxygen (9.61 ± 3.55 mg/L) and pH (6.28 ± 0.51) were in the suitable range for Tilapia culture activities (Makori et al., 2017). There are no significant differences on the water quality parameter recoded in each treatment.

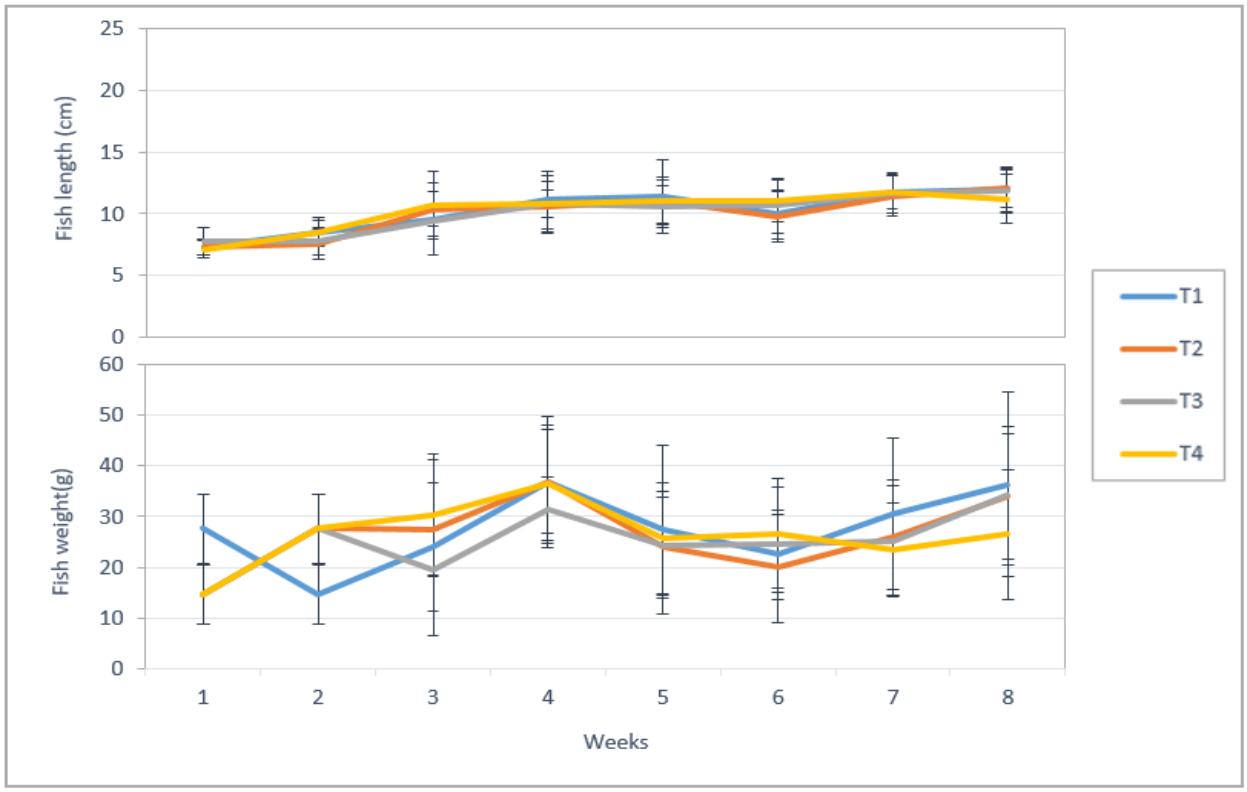

Figure 2. Tilapia weight and length growth that supplied with four different treatments for the duration of 8 weeks.

4.0 Discussion

Fish nutrition and feeding strategies have very crucial impact on the growth of cultured fish (Kwasek et al., 2020 The surge in fish feed costs could be addressed by exploring new possible protein sources (Gasco et al., 2020). Feed costs can be lowered by integrating fly larva powder and anchovy process waste as an alternate for protein source (Ali et al, 2015; Nyakeri et al., 2017).

Growth comparison highlights that the combination of fish feed with fly larva powder and anchovy process waste powder shared the same growth rate with fish fed with commercial feed. Previous findings by Ali et al., (2018) stated that high protein contained in anchovy waste might be the major contributor to the good growth rate and high survival rate. Anchovy process waste contains amino acids, fatty acids and other nutrients that are essential in fish growth. The crude protein content of anchovy meals is as high as the protein content of sardines (Zynudheen et al., 2019). The intrusion of insect's protein such as fly larva in fish feeds also enriched it with favourable amino acids that lack in the plant (Tschirner & Kloas, 2017). The combination of fly larva powder and anchovy process waste is considered as more sustainable alternative for aquaculture production (Ali et al, 2015; Ali et al., 2018; Nyakeri et al., 2017; Llagostera et al., 2019).

5.0 Conclusion

As a less expensive alternative protein source for tilapia culture, combination of fly larva powder and anchovy process waste powder mixture can be added to fish pellets. The mixture of fly larva powder and anchovy process waste powder provide the same growth rate with commercial feed. This may significantly lower the price of fish feed, which will lower the cost of farming.

However, the study is still in its early phases and has certain drawbacks. More sophisticated techniques and analysis are needed, like research on the amino acids in anchovy waste and how they affect tilapia growth.

6.0 References

Ali, T. E. S., Martínez-Llorens, S., Moñino, A. V., Cerda, M. J., & Tomás-Vidal, A. (2016). Effects of weekly feeding frequency and previous ration restriction on the compensatory growth and body composition of Nile tilapia fingerlings. *The Egyptian Journal of Aquatic Research*, 42(3), 357-363.

Ali, M., L. Santoso & D. Fransisca. (2015). The substitution of fish meal by using anchovies head waste to increase the growth of tilapia (*Oreochromis* sp.). *Maspari,* 7 (1): 63-70

Ali, M., Efendi, E., Noor, N. M., No, J. P. S. B., Gedongmeneng, B. L., & No, J. S. H. (2018). Potentialas Raw Material For Feed In Implementing Zero Waste Concept. *Jurnal Perikanan,* 8(1), 47-54.

Bhujel, R. C. (2014). Recent advances in Asian aquaculture and sustainability. In *World Nutrition Forum, Munich, Germany,* October 15e18.

Cao, L., Naylor, R., Henriksson, P., Leadbitter, D., Metian, M., Troell, M., & Zhang, W. (2015). China's aquaculture and the world's wild fisheries. *Science*, 347(6218), 133-135.

Dorothy, M. S., Raman, S., Nautiyal, V., Singh, K., Yogananda, T., & Kamei, M. (2018). Use of potential plant leaves as ingredient in fish feed-a review. *International Journal of Current Microbiology and Applied Science* 7(07), 112-125.

Gasco, L., Acuti, G., Bani, P., Dalle Zotte, A., Danieli, P. P., De Angelis, A., & Roncarati, A. (2020). Insect and fish by-products as sustainable alternatives to conventional animal proteins in animal nutrition. *Italian Journal of Animal Science*, 19(1), 360-372.

Glencross, B. D. (2020). A feed is still only as good as its ingredients: An update on the nutritional research strategies for the optimal evaluation of ingredients for aquaculture feeds. *Aquaculture Nutrition*, *26*(6), 1871-1883.

Hua, K., Cobcroft, J. M., Cole, A., Condon, K., Jerry, D. R., Mangott, A., & Strugnell, J. M. (2019). The future of aquatic protein: implications for protein sources in aquaculture diets. *One Earth*, 1(3), 316-329.

Kwasek, K., Thorne-Lyman, A. L., & Phillips, M. (2020). Can human nutrition be improved through better fish feeding practices? a review paper. Critical Reviews in *Food Science and Nutrition*, 60(22), 3822-3835.

Lee, S., Haller, L. Y., Fangue, N. A., Fadel, J. G., & Hung, S. S. O. (2016). Effects of feeding rate on growth performance and nutrient partitioning of young-of-the-year white sturgeon (*Acipenser transmontanus*). *Aquaculture Nutrition*, 22(2), 400-409.

Llagostera, P. F., Kallas, Z., Reig, L., & De Gea, D. A. (2019). The use of insect meal as a sustainable feeding alternative in aquaculture: Current situation, Spanish consumers' perceptions and willingness to pay. *Journal of Cleaner Production*, 229, 10-21.

Lock, E. J., Biancarosa, I., & Gasco, L. (2018). Insects as raw materials in compound feed for aquaculture. In *Edible insects in sustainable food systems* (pp. 263-276). Springer, Cham.

Martinez-Porchas M & Martinez-Cordova L.R. (2012). World aquaculture: environmental impacts and troubleshooting alternatives. *The Scientific World Journal* 2012: 1–9

Makori, A. J., Abuom, P. O., Kapiyo, R., Anyona, D. N., & Dida, G. O. (2017). Effects of water physico-chemical parameters on tilapia (*Oreochromis niloticus*) growth in earthen ponds in Teso North Sub-County, Busia County. *Fisheries and Aquatic Sciences,* 20(1), 1-10.

Mobsby, D., & Curtotti, R. (2019). Fisheries. *Agricultural Commodities*, *9*(1), 87-95.

Montoya-Camacho, N., Marquez-Ríos, E., Castillo-Yáñez, F. J., Cárdenas López, J. L., López-Elías, J. A., Ruíz-Cruz, S., & Ocaño-Higuera, V. M. (2019). Advances in the use of alternative protein sources for tilapia feeding. Reviews in *Aquaculture,* 11(3), 515-526.

Nyakeri, E. M., Ogola, H. J., Ayieko, M. A., & Amimo, F. A. (2017). An open system for farming black soldier fly larvae as a source of proteins for smallscale poultry and fish production. *Journal of Insects as Food and Feed*, 3(1), 51-56.

Salin, K. R., Arun, V. V., Nair, C. M., & Tidwell, J. H. (2018). Sustainable aquafeed. In *Sustainable Aquaculture* (pp. 123-151). Springer, Cham

Samson, J. S. (2019). Oral Administration of Pulverized Wood Charcoal on Growth, Feed Utilization, Survival and Waste Excretion of Red Tilapia (Oreochromis Sp). Published in *International Journal of Trend in Scientific Research and Development (ijtsrd),* ISSN: 2456-6470, Volume-3 | Issue-4, June 2019, pp.417-421, URL: https://www.ijtsrd.com/papers/ijtsrd23724.p

Sun, M., Hassan, S. G., & Li, D. (2016). Models for estimating feed intake in aquaculture: A review. *Computers and Electronics in Agriculture***,** 127, 425-438.

Tschirner, M., & Kloas, W. (2017). Increasing the sustainability of aquaculture systems: Insects as alternative protein source for fish diets. *GAIA-Ecological Perspectives for Science and Society*, 26(4), 332-340.

Tilami, S. K., Turek, J., Červený, D., Lepič, P., Kozák, P., Burkina, V., & Mráz, J. (2020). Insect meal as a partial replacement for fish meal in a formulated diet for perch P*erca fluviatilis*. *Turkish Journal of Fisheries and Aquatic Sciences,* 20(12), 867-878.

Zynudheen, A. A., Nambiar, M. L., Ravindran, R., Anandan, R., & Ninan, G. (2019). Nutritional quality evaluation of feeds developed from secondary raw material from fish processing industry. *Fishery Technology* 56, 125 - 129