The Effect of Maggot Flour (*Hermetia illucens*) on the Growth of Sangkuriang Catfish (*Clarias gariepinus*)

Rusdi Rusdi[1*], Yulilina Retno Dewahrani[1], Tiara Putri Chaerunnisa[1], Bunga Ainindya Balqis[1], Nur Novita[1], Rahma Noviati[1], Melta Rini Fahmi[2], Naufal Ma'arif[3]

[1] Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Indonesia
[2] Agency for Marine and Fisheries Research and Development, Indonesia
[3] Indonesian Bioinformatics Institute (INBIO-Indonesia)
*rusdi@unj.ac.id

Abstract. The public's need for catfish consumption increases every year. To increase catfish production, good quality feed is needed that meets nutritional needs and stimulates catfish production. Catfish can grow well if their nutritional intake is adequate, especially protein requirements. However, fish need that is high in protein is often difficult to find, so other alternative feeds are needed to meet protein needs. This research was conducted to determine the effect of feeding with a mixture of maggot flour (*Hermetia illucens*) on the growth of sangkuriang catfish (*Clarias gariepinus*). This research used an experimental method with a randomized block design consisting of 4 treatments, namely A. 0% maggot flour, B. 70% pellets + 30% maggot flour, C. 60% pellets + 40% maggot flour, and D. 50% pellets + 50% maggot flour. Data were analysed using a one-way ANOVA test. The statistical analysis showed that: 1. feeding maggot flour had a significant effect on the growth catfish ($p < 0.05$), 2. there is an effect of maggot flour on the length of catfish ($p < 0.05$). Measuring the protein content in catfish and maggot meat, it was found that the highest average protein content was in the 30% maggot treatment, namely 15.84 mg/mL, while the lowest protein content was in the 50% maggot treatment with an average protein content of 12.54 mg/mL. From the result of this research, it was alson found that the average protein content in maggots was 60.38 mg/mL, which was far above catfish protein.

Keywords: catfish, growth, protein maggot

T. A. Aziz et al. (eds.), *Proceedings of the 4th Science and Mathematics International Conference (SMIC 2024)*, Advances in Physics Research 11,
https://doi.org/10.2991/978-94-6463-624-6_6

1. Introduction

Catfish farming, especially the sangkuriang catfish, has great potential in supporting the fulfillment of the community's animal protein needs. In addition to being known for its high nutritional content and popular taste, catfish is one of the main commodities of freshwater fisheries that is relatively easy to cultivate. In the cultivation process, feed plays a major role, accounting for up to 70% of the total cost of production. Therefore, feed alternatives that are not only economical but also environmentally friendly are needed, such as maggot flour (black army fly larvae, Hermetia illucens). Maggot flour has a high content of protein, essential amino acids, healthy fats, as well as bioactive compounds such as lauric and chitin fatty acids, which support optimal growth, health, and resistance to disease (Xiao, 2021; Jayanegara, 2023).

Several studies have shown that the substitution of fishmeal with maggot flour up to 30% in fish feed formulations not only improves feed efficiency, but also supports the growth of sangkuriang catfish without causing negative effects on the physiological condition of fish (Taufek, 2020; Jayanegara, 2023). Maggot flour-based feed can also improve the quality of catfish meat consumed, making it a suitable choice to support high-quality catfish production. From an environmental point of view, the use of maggot flour has a positive impact, because its production uses organic waste as a substrate. This process helps reduce waste while creating a more sustainable and environmentally friendly feed production system compared to conventional fishmeal (Barragan, 2022; Lock, 2022).

The various advantages of maggot flour are not only promising as an efficient solution for consumption catfish cultivation, but also have the potential to support the sustainability of the fishery industry in the future. This innovation can be an important step in reducing dependence on fish-based feed sources that are increasingly depleted, while supporting the circular economy by utilizing organic waste as a production substrate. In addition, the application of maggot flour on a large scale can open up new business opportunities in waste management and alternative feed production, which not only supports smallholder farmers, but also helps create a more inclusive and sustainable agribusiness ecosystem.

2. Method

This experiment took place from October 29 to November 26, 2023 and was implemented in the fish pond of campus B, State University of Jakarta. The samples used were catfish fry that had a length ranging from 13-14 cm and an initial weight ranging from 7-10 grams. The tools used in this study are a wooden frame measuring 50 x 50 x 100 cm, a cloth meter, digital scales, and fish scrapers. Meanwhile, the materials needed are 2-month-old sangkuriang catfish, maggot flour, and fish pellets.

The design used in this study is a Randomized Group Design (RAK) using 4 treatments, where one plot contains 6 fish and one catfish is considered as one replicate. Thus, the total repetition used in this study was 6 replicates. The method used is the experimental method to determine the positive effect on the object used as an experiment with certain treatments. Experiments in this study provide feed to objects with different doses in a treatment. The treatments given are: Treatment A or control (0% maggot flour), Treatment B (70% pellet feed mixed with 30% maggot flour), Treatment C (60% pellet feed mixed with 40% maggot flour), Treatment D (50% pellet feed mixed with 50% maggot flour).

Feed is given twice a day, in the morning and evening, with an amount of about 3-5% of the total weight of the fish. The feed given is a mixture of pellets and maggot flour that has been mixed well. Feed is given gradually while observing the response of the catfish; feeding is stopped when the fish looks full, given the high appetite of catfish (Mulyani et al., 2021). Catfish fry were adapted for a week in a basin before being transferred to a pond bordered by wood and netting. During the adaptation period, the fry were fed with pellets ad satition. Maintenance continued for one month.

The growth rate of catfish will be measured every 7 days by looking at the weight or body weight and body length of catfish as growth data. Data is taken directly through measurements made by researchers, catfish seeds will be weighed in a wet state by putting the fish in a container filled with water, then for measuring the length of the fish using a meter measured from the tip of the head to the tail of the catfish. Measurement and recording are carried out systematically on changes in objects that are influenced by external and internal objects. Furthermore, the data obtained in this study will be analyzed using one way analysis of variance (ANOVA).

To measure the protein content contained in the catfish body, catfish meat is taken as much as 5 grams and then mashed and added 5 ml of distilled water, then the catfish meat is homogenized. The homogenized solution is then separated from the supernatant and pellet using a centrifuge. After that, the supernatant component was taken and tested for protein content contained therein. Measurement of protein levels was carried out by laboratory staff at the University of Indonesia and the measurement results were received on February 16, 2024. The same thing was done to measure the protein content in maggot flour, namely maggot flour was taken as much as 5 grams then mashed and 5 ml of distilled water was added, then the maggot flour was homogenized. The homogenized solution is then separated from the supernatant and pellet using a centrifuge. After that, the supernatant component was taken and tested for protein content contained therein.

3. Result and Discussion

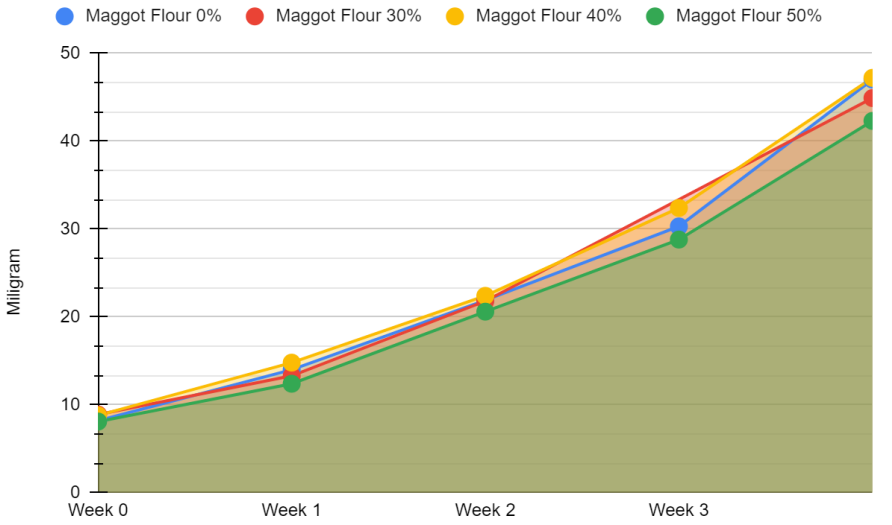

Fig. 1. Catfish Weight Gain Chart

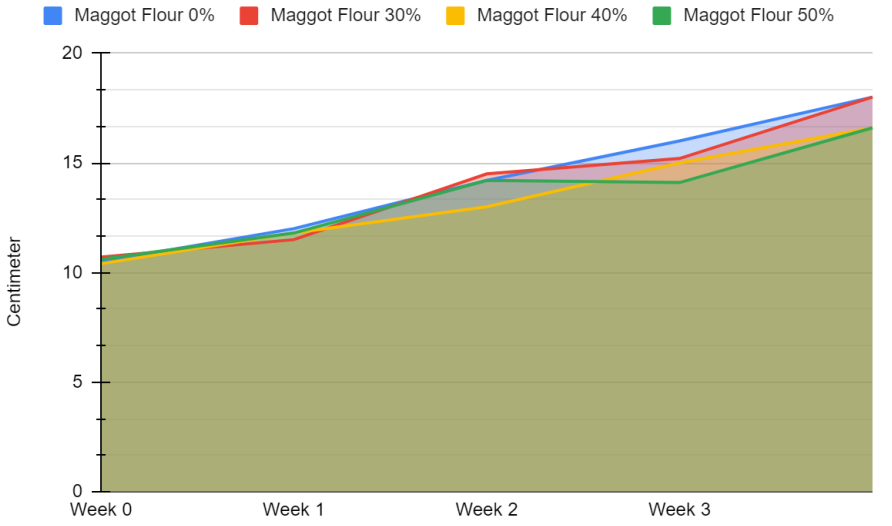

Fig. 2. Catfish Length Gain Chart

The results of the research that has been carried out with the method of feeding fish pellets and substitution of maggot flour for 28 days were obtained with 4 measurements every week. The growth of the absolute average weight of catfish and the absolute average length of catfish can be seen in **fig. 1.** and **fig. 2.** This study also calculates the protein levels contained in catfish. The data on the average test results of catfish protein levels in each treatment can be seen in **fig. 3.**

The results of the data testing were carried out using SPSS software version 25, the results of measuring the length of catfish were carried out on four different types of fish feed dosage treatments, namely using substitution between fish pellets and maggot flour. Measurements were taken 4 times in a span of 4 weeks of maintenance. Based on the t-test at a significance level of < 0.05, it is proven that the weight and length growth of 100% fish pellets is significantly different from the feeding of maggot flour by 30%, 40%, and 50%. The results of statistical analysis on the weight of catfish obtained a significance level of 0.017 < 0.05 which showed that maggot flour feeding had a significant effect on the growth of catfish. The results of the statistical analysis on the length of the catfish obtained a significance level of 0.022 < 0.05 that the feeding of maggot flour had a significant effect on the growth of catfish.

Growth is a process of changing the dimensions of the body that can include changes in the size or length of an organism over a period of time (Effendie, 2003). According to Firdaus et al (2018), growth is influenced by a number of factors, namely internal factors and external factors. Internal factors are factors that are difficult to control including heredity, sex, age, and health. On the other hand, the most important external factors that affect fish growth include water temperature, dissolved oxygen level, ammonia level in water and the type and quality of feed given to fish (Firdaus, et al. 2018). Catfish or in Latin called Clarias gariepinus is a fish that belongs to the Clariidae Family and has characteristics in the form of a slimy body, slippery, has no scales and has a mustache or what is called a tentacle (Windriani, 2017). Maggot flour is also often used as fish feed, including catfish, because of its abundant nutritional content. The high protein content in maggot flour can accelerate the growth of fish, including weight gain. After conducting research with the method of feeding fish pellets and substitution of maggot flour for 4 weeks, the results of the study were obtained with 4 measurements every week. The absolute weight gain of the most optimal fish at the feed dose with a mixture of 70% pellets and 30% maggot flour was 44.68 grams (average weight of fish at the end of rearing - average weight of fish at the beginning of rearing). This is because the protein content of maggot flour is high enough so that it is able to provide the necessary nutrient intake for optimal growth of fish (Santoso and Hudaidah, 2015).

Long growth is positive growth, namely the body length of a living thing cannot decrease with the age of the living thing, while weight growth can decrease so that weight growth can be said to be positive and negative growth (Prasetiyo, et al. 2020). NRC (1983) in Rachmawati (2013) stated that an increase in protein in feed does not always result in an increase in growth. An increase in protein in feed that is not accompanied by a balance of non-protein energy sources can result in the protein in the feed being used as an energy source. Based on the study on the increase in the length of sangkuriang catfish for 4 weeks, results were obtained that showed that sangkuriang catfish with treatment B (70% pellet feed mixed with 30% maggot flour) had better length growth when compared to other treatments in treatment D (50% pellet feed mixed with 50% maggot flour), which was 8.4 cm. This is suspected to be due to the excess protein in the test feed. If the intake of protein contained in feed is too excessive, then only part of the protein is absorbed and used for growth and repair damaged cells, then the excess protein that is not used will be removed from the body (Rachmawati et al, 2013).

Protein is a type of substance that contains amino acids that are connected to each other in long chains through peptide bonds. This substance consists of the elements carbon (C), hydrogen (H), oxygen (O), and nitrogen (N) (Sa'diyah and Lusiani, 2022). Based on the results of the analysis, the average protein content was the highest in treatment B (70% pellet feed mixed with 30% maggot flour), which was 15.84, while the lowest protein content was in treatment D (50% pellet feed mixed with 50% maggot flour), which was 12.54. The average results of protein content in treatment B (70% pellet feed mixed with 30% maggot flour) have shown that the combination of maggot feed and pellet feed has protein levels that are in accordance with the protein needs of

catfish. According to Usman et al. (2010) The protein content in fish feed should be in the optimal amount with a balanced amino acid composition, so that it can be used optimally for fish growth.

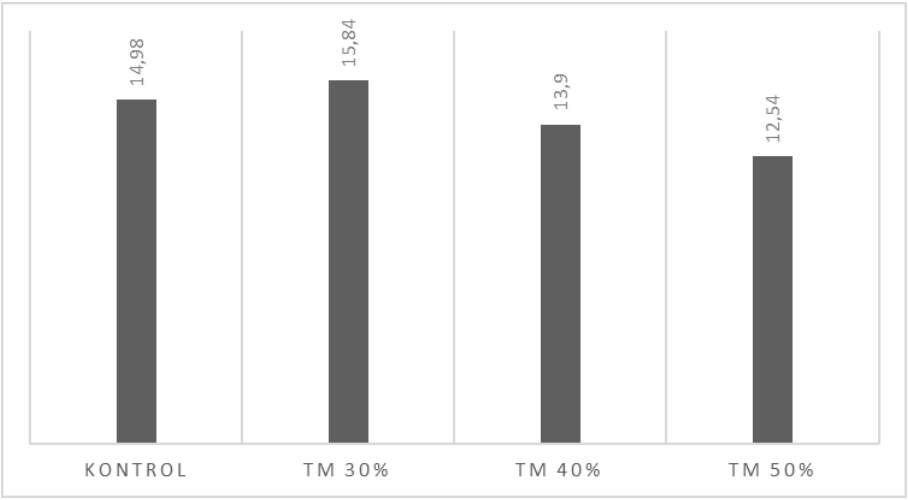

Fig. 3. Protein content of Catfish

Based on the results of the protein test on catfish meat with the treatment of maggot flour at various percentages, there was a significant difference between the control group (0% maggot flour) and the treatment groups (30%, 40%, and 50% maggot flour). In the control catfish pond, the protein content was 14.98%, which can be considered the protein standard without the influence of maggot flour.

In the 30% maggot flour treatment, the protein content increased to 15.84%. This increase indicates that the substitution of feed with maggot flour at this level has a positive effect on the enhancement of protein synthesis in catfish. Research by Gagaoua et al. (2020) showed that insect proteins, such as maggots, are rich in essential amino acids that can improve metabolic efficiency and growth in fish. Additionally, the study by Chakraborty et al. (2021) found that maggot flour significantly contributes to the increase in growth rates and protein content in various fish species. However, in the 40% maggot flour treatment, the protein content decreased to 13.90%. This reduction may be due to nutritional imbalance, where the high percentage of maggot flour might reduce the intake of other nutrients needed for optimal fish growth. This result is consistent with the research by Makkar et al. (2019), which found that using maggot flour at high doses can cause nutrient imbalances, ultimately lowering growth efficiency. Furthermore, in the 50% maggot flour treatment, the protein content dropped more drastically to 12.54%. This sharp decline indicates that using maggot flour in excessive amounts may not be beneficial for protein synthesis in catfish. Research by Henry et al. (2018) also indicated that excessive use of maggot flour in fish feed can lead to a decrease in nutritional quality and metabolic efficiency due to certain components that may inhibit protein digestion.

Overall, these results show that using maggot flour at a level of 30% can provide the best results in increasing the protein content of catfish meat, while higher percentages actually reduce protein content. This is consistent with the findings of Hua et al. (2021), which stated that optimizing feed composition with maggot flour should be done carefully to maintain nutritional balance and improve fish growth quality.

4. Conclusion.

Based on the conducted research, a significant difference was observed in the weight and length growth of catfish between feeding with 100% fish pellets and partially substituting them with maggot meal, as demonstrated through statistical analysis. Catfish, characterized by their slimy bodies, nocturnal behavior, and active feeding at night, are fed both in the morning and at night. Providing feed in the form of pellets with a minimum protein content of 25% promotes catfish growth, while maggot meal, as an alternative feed, is also effective due to its high protein content. A treatment using a mix of 70% fish pellets and 30% maggot meal resulted in optimal growth, with protein levels meeting the nutritional needs. However, it is important to note that increasing protein levels does not always lead to growth improvement if not accompanied by a balance of non-protein energy sources. Therefore, this combined feeding approach can significantly enhance catfish farming productivity, making it a favorable option for achieving optimal catfish growth.

Acknowledgments. The researcher would like to thank Mr. Ishak and Mr. Ibnu as employees at the Biology Laboratory of FMIPA UNJ who have helped during this research. The researcher also thanked the laboratory at the Biology Laboratory of FMIPA who were willing to lend the necessary tools for this research so that the research could be carried out. The researcher also thanked the University of Indonesia Laboratory for supporting our research.

References

1. Asyhariyati, A. I., Samidjan, I., & Rachmawati, D. (2013). Pemberian Kombinasi Pakan Keong Macan Dan Ikan Rucah Terhadap Pertumbuhan Dan Kelulushidupan Kepiting Bakau (Scylla paramamosain). *Journal of Aquaculture Management and Technology*, 2(4), 131-138.
2. Barragán-Fonseca, K. B., et al. (2022). Nutritional and functional properties of *Hermetia illucens* larvae in aquafeeds: A review. *Aquaculture Reports*, 25, 101273. https://doi.org/10.1016/j.aqrep.2022.101273.
3. Chakraborty, S. B., Horn, P., & Sen, A. (2021). "The potential of insect meals as a sustainable feed ingredient for aquaculture." *Aquaculture International, 29*(1), 359-376.
4. Fahmi, M. R. (2015). Optimalisasi proses biokonversi dengan menggunakan mini-larva Hermetia illucens untuk memenuhi kebutuhan pakan ikan. In Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia Vol.1:139-144). https://doi.org/10.13057/psnmbi/m010124
5. Gagaoua, M., Picard, B., Monteils, V., & Sentandreu, M. A. (2020). "Current advances in proteomic applications to improve meat quality: Focusing on farm animal species." *Comprehensive Reviews in Food Science and Food Safety, 19*(5), 1740-1764.
6. Harefa, D., *et al*. (2018). Pemanfaatan fermentasi tepung maggot (*Hermetia illucens*) sebagai substitusi tepung ikan dalam pakan buatan untuk benih ikan baung (*Hemibagrus nemurus*). *Jurnal Online Mahasiswa (JOM) Bidang Perikanan dan Ilmu Kelautan*, *5*(1), 1-15.
7. Henry, M., Gasco, L., Piccolo, G., & Fountoulaki, E. (2018). "Review on the use of insects in the diet of farmed fish: past and future." *Animal Feed Science and Technology, 203*, 1-22.
8. Hua, K., & Bureau, D. P. (2021). "Insects in fish diets: A review." *Animal Feed Science and Technology, 277*, 114769.
9. Jayanegara, A., et al. (2023). Utilization of insect-based proteins in aquaculture. *Journal of Sustainable Aquaculture*, 15(2), 134-145.

10. Kementerian Kelautan dan Perikanan. (2022). *Rilis Data Kelautan dan Perikanan Triwulan I Tahun 2022*. Pusat Data, Statistik dan Informasi Sekretariat Jenderal Kementerian Kelautan dan Perikanan.
11. Lock, E. R., et al. (2022). Environmental and economic analysis of black soldier fly larvae as fish feed. *Sustainability*, 14(5), 3217. https://doi.org/10.3390/su14053217
12. Makkar, H. P. S., Tran, G., Heuzé, V., & Ankers, P. (2019). "State-of-the-art on use of insects as animal feed." *Animal Feed Science and Technology, 197*, 1-33.
13. Manik, R. R. D. S., & Arleston, J. (2021). *Nutrisi dan pakan ikan.*
14. Mulyani, Y., *et al*. (2021). Edukasi Manajemen Pemberian Pakan Dalam Budidaya Ikan Lele DiPekarangan Sempit Bagi Masyarakat Desa Raharja, Kecamatan Tanjungsari, Kabupaten Sumedang. *Farmers: Journal of Community Services*, *2(2)*, 7-10. DOI;https://doi.org/10.24198/fjcs.v2i2.32535
15. Muntafiah, I. (2020). Analisis Pakan pada Budidaya Ikan Lele (Clarias Sp.) di Mranggen. *Jurnal Riset Sains dan Teknologi*, *4*(1), 35-39. DOI: http://dx.doi.org/10.30595/jrst.v4i1.6129
16. Nasrudin. (2010). *Jurus Sukses Berternak Lele Sangkuriang*. Jakarta. PT AgroMedia Pustaka.
17. Prasetiyo, H., Sri, M., dan Purnama, S. 2020. Mikroenkapsulasi Ekstrak Kasar Maggot sebagai Pakan Substitusi pada Penyapihan Pakan Larva Ikan Nila (Oreochromis niloticus). Jurnal Kemaritiman: Indonesian Journal of Maritime. 1(2): 68-79.
18. Priyadi, A., Azwar, Z. I., Subamia, I. W., & Hem, S. (2016). Pemanfaatan Maggot sebagai Pengganti Tepung Ikan dalam Pakan Buatan untuk Benih Ikan Balashark (*Balanthiocheilus melanopterus Bleeker*). *Jurnal Riset Akuakultur*, *4*(3), 367-375. DOI: http://dx.doi.org/10.15578/jra.4.3.2009.367-375
19. Rachmawati, D., & Istiyanto, S. (2013). Efektivitas Substitusi Tepung Ikan dengan Tepung Maggot dalam Pakan Buatan terhadap Pertumbuhan dan Kelulushidupan Ikan Patin (*Pangasius pangasius*). *Jurnal Saintek Perikanan,* 9(1), 62-67.
20. Santoso, L., & Hudaidah, S. (2015). Pengaruh pemberian pakan alami Daphnia sp yang diperkaya dengan tepung spirulina terhadap kelangsungan hidup dan pertumbuhan larva ikan komet (Carassius auratus). *e-Jurnal Rekayasa dan Teknologi Budidaya Perairan*, *4*(1), 461-470.
21. Setyono, B. (2012). Pembuatan pakan buatan. *Unit pengelola air tawar. Kepanjen. Malang*.
22. Sepang, D. A., Mudeng, J. D., Monijung, R. D., Sambali, H., & Mokolensang, J. F. (2021). Pertumbuhan Ikan Nila (Oreochromis niloticus) yang diberikan pakan kombinasi pelet dan maggot (Hermetia illucens) kering dengan presentasi berbeda. E-Journal Budidaya Perairan, 9(1).
23. Sopha, S., Santoso, L., & Putri, B. (2015). Pengaruh Subtitusi Parsial Tepung Ikan Dengan Tepung Tulang Terhadap Pertumbuhan Ikan Lele Sangkuriang (*Clarias Gariepinus*.). *e-Jurnal Rekayasa dan Teknologi Budidaya Perairan*, *3*(2), 403-410.
24. Taufek, N. M., et al. (2020). Dietary inclusion of black soldier fly larvae meal for improving aquaculture sustainability: Effects on growth and feed conversion. *Aquaculture International*, 28(5), 1863–1877. https://doi.org/10.1007/s10499-020-00524-9
25. Xiao, X., et al. (2021). Nutritional and growth performance effects of black soldier fly larvae meal inclusion in aquafeeds. *Reviews in Aquaculture*, 13(1), 404–420. https://doi.org/10.1111/raq.12483
26. Zaenuri, R., Suharto, B., & Haji, A. T. S. (2014). Kualitas pakan ikan berbentuk pelet dari limbah pertanian. *Jurnal Sumberdaya Alam dan Lingkungan*, *1*(1), 31-36.