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THE EFFECT OF FLOATING AQUAPONIC SYSTEM WITH DIFFERENT TYPES OF PLANTS ON THE NUTRITION OF TILAPIA (*Oreochromis niloticus*) MEAT

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ABSTRACT

The floating aquaponic system using different types of plants can be an environmentally friendly cultivation solution, easy to apply on a household scale and profitable. However, various types of plants in aquaponics have different nutrient absorption capacities that can affect the quality of fish meat. This research aimed to see the type of plant that is best at producing quality tilapia (*Oreochromis niloticus*) meat produced from cultivation with a floating aquaponic system using different types of plants. The types of plants used included spinach (*Ipomoea aquatica),* pacoy (*Brassica rapa*), lettuce (*Lactuca sativa*), and control (without plants), which were repeated three times. An experimental method is used in this research. The results showed that the best treatment was *I. aquatica* plant treatment which produced a dry weight of tilapia meat of 19.608%; protein of 61.575% DW (Dry Weight); fat of 3.586% DW and ash content of 8.239% DW. The results showed that using *I. aquatica* plants produced better meat quality than the other two plants. Compared to the control treatment, the difference was very significant. This method has the potential to be widely applied at the household scale in urban and semi-urban areas to get a source of nutritious animal protein and vegetables with minimal use of land, facilities and water.

Keywords: *Brassica rapa*; Fish Meat; *Ipomoea aquatica*; *Lactuca sativa;* Protein

INTRODUCTION

Development of the aquaponic system as one of the technologies in sustainable fisheries and plant cultivation. Aquaponics combines fish and plant cultivation activities in one mutually beneficial and innovative system (Khalil *et al*., 2023; Shobihah *et al*., 2022). Waste from fish can be used as nutrients for plants, while plants help maintain water quality for fish.

Tilapia (*O. niloticus*) is a type of freshwater fish that is popularly cultivated because of its rapid growth and high adaptability (Anam *et al*., 2018; Ririhena & Palinussa, 2021). Market demand for *O. niloticus* is increasing along with public awareness of the importance of consuming fish as a source of healthy animal protein. However, the quality of tilapia meat is greatly influenced by the conditions of the cultivation environment (Ariwinata *et al*., 2021). One of them includes the aquaponic system used.

The floating method in aquaponics is an interesting approach because it allows plant roots to be directly submerged in nutrient-rich water, increasing the efficiency of nutrient uptake by plants. According to (Farida *et al*., 2019) the floating raft aquaponic irrigation system positively affects water quality. In addition, the types of plants used in this system are also thought to affect water quality and ultimately the quality of fish meat.

Certain plants may be more effective in absorbing nutrients and maintaining the balance of the aquaponic ecosystem, thus potentially improving the quality of *O. niloticus* meat in terms of texture, taste, and nutritional content. The study's results (Zidni *et al*., 2019) stated that the use of spinach (*I. aquatica)* plants provided ideal results for water quality that supports the growth of catfish. Spinach is known to have extensive roots and is able to absorb ammonia efficiently. Besides spinach, packoy can be used for phytoremediation. Ammonium reduction percentage in the treatment of spinach (78.42%) and pakcoy (52.16%) (Effendi *et al*., 2015). Furthermore, (Hormati *et al*., 2023) stated that using pakcoy, lettuce and spinach plants resulted in better growth and water quality in tilapia aquaponic cultivation systems than conventional cultivation.

However, research on fish nutrition produced by the aquaponic system is still very minimal. Therefore, this study aims to explore the effect of using different types of plants in a floating aquaponic system on the nutrition of *O. niloticus* meat. The results of this study are expected to contribute to the development of aquaponic cultivation technology that can be applied on a household scale and is more efficient and positively impacts the quality of fishery products.

RESEARCH METHODS

Time and Place

The research conducted includes preparation to sample testing which takes 3 (three) months, namely from May to July 2024. The maintenance location with the floating aquaponic system is carried out in the dry land fisheries laboratory and testing of *O. niloticus* meat nutrition is carried out in the feed chemistry laboratory of the Faculty of Animal Husbandry, Marine Sciences and Fisheries, Universitas Nusa Cendana.

The floating aquaponic system in this study did not use a filtration and aeration system, so the water was changed every week. The fish feed given was commercial feed with 35% protein content. The feeding frequency was twice, namely in the morning and evening.

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Preparation for Tilapia Maintenance (*Oreochromis niloticus*) with the Floating Aquaponic System

The tools used in this study include tarpaulin pools measuring 50 × 50 × 100 cm as many as 12 units. Each tarpaulin pool is filled with water as high as 25 cm. The *O. niloticus* used are 7-9 cm in size with a stocking density of 15 per unit. The types of plants used include spinach (*I. aquatica),* pakcoy (*B. rapa*) and lettuce (*L. sativa*) with the seeding method (Zidni *et al*., 2019). The total of plants used is 12 plants per unit. The mechanism for making a floating aquaponic system is to use a rectangular tarpaulin pool with plants placed on a 50×50 cm floating styrofoam on top. Each plant uses charcoal media placed in a plastic cup container. The maintenance period is 56 days with feeding of 3% of the total fish biomass daily.

After the maintenance period, each treatment was analyzed for its nutritional content. The analysis process was carried out by taking 100 g of fish meat from each treatment. The nutritional content analyzed includes dry matter (drying oven), ash, crude protein (kjeldahl), and crude fat (ether extract) according to the AOAC procedure (1970).

Experimental Design

The types of plants used include *I. aquatica, B. rapa*, *L. sativa* and control (without plants) using a completely randomized design (CRD) which was repeated three times.
K = Control (Maintenance without using plant media
A = Use of spinach (*I. aquatica)* plants with the floating method in the aquaponics system
B = Use of pakcoy (*B. rapa*) plants with the floating method in the aquaponics system
C = Use of lettuce (*L. sativa*) plants with the floating method in the aquaponics system

Data Analysis

The research data were then processed and analyzed using ANOVA (Analysis of Variance) with SPSS. The data analyzed had significant differences ($p < 0.05$) followed by Duncan analysis.

RESULT AND DISCUSSION

Dry Weight of Tilapia Meat (*O. niloticus*)

The dry weight of the fish indicates the content of *O. niloticus* meat without water content, so the subsequent nutritional analysis is expressed in the form of dry weight. The results of the dry weight analysis of *O. niloticus* meat maintained using the floating method aquaponics system with different types of plants produced various results. The results of the research can be seen in Figure 1.

Based on the results of observations, the dry weight of *O. niloticus* meat has nonsignificant value ($p > 0.05$). The dry weight of *O. niloticus* meat from cultivation with the floating aquaponic system ranges from 19.37 ± 1.1 - 19.61 ± 1.67%. The nonsignificant results are caused by the water content in fish meat generally being almost the same. Dry weight is the difference between fish meat's total weight and water content. The water component is the largest content of fish meat. The same comparison was also obtained in the study result (Sulistijowati *et al*., 2020) which stated that the water content of fresh tilapia was 80.7%. These results indicate that the dry weight of *O. niloticus* meat in the previous research was 19.3%.

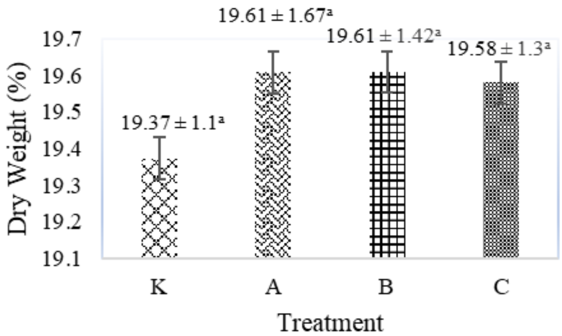

Figure 1. Dry Weight of Tilapia (*O. niloticus*) Meat in the Floating Aquaponic System with Different Types of Plants
Gambar 1. Berat Kering Ikan Nila (*O. niloticus*) pada Sistem Akuaponik Terapung dengan Jenis Tanaman yang Berbeda

Protein Content of Tilapia (*O. niloticus*) Meat

Protein as the main nutritional content in *O. niloticus* meat. The body of *O. niloticus* utilizes protein content for growth, survival and other functions. The results of the analysis of the protein content of *O. niloticus* can be seen in Figure 2.

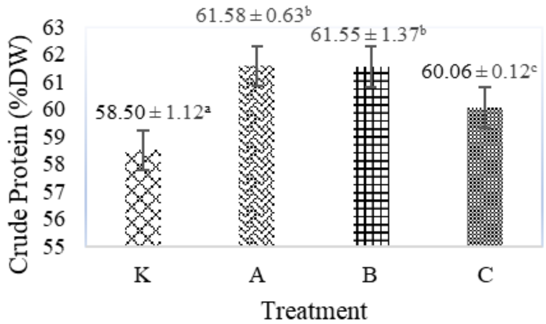

Figure 2. Crude Protein of Tilapia (*O. niloticus*) Meat in the Floating Aquaponics System with Different Types of Plants
Gambar 3. Protein Kasar DagING Ikan Nila (*O. niloticus*) pada Sistem Akuaponik Terapung dengan Jenis Tanaman yang Berbeda

Based on the analysis results, it was obtained that the use of different types of plants in the floating aquaponics system significantly ($p < 0.05$) affected the crude protein content of *O. niloticus*. Based on the results of ANOVA, the protein content in treatments A (*I. aquatica*) and B (*B. rapa*) was not significantly different with values of 61.58 ± 0.63% DW and 61.55 ± 1.37% DW respectively. This makes treatments A (*I. aquatica)* and B (*B. rapa*) the treatments with the highest protein content. The lowest in treatment K (without plants) at 58.50 ± 1.12% DW.

The effect of different protein content is caused by the use of plants in the floating aquaponics system and without the use of plants. Plants such as *I. aquatica*, *B. rapa* and *L. sativa* function as biofilters (Zidni *et al*., 2019). *I. aquatica* and *B. rapa* plants showed better results than *L. sativa* plants. Different absorption abilities of plants can cause this.. According to (Hapsari *et al*., 2020) *I. aquatica* plants have a hollow, long, and branched stem morphology that allows for more optimal storage of dissolved waste products absorbed by the roots. The roots of plants are able to absorb residual organic matter and feces which make the water conditions in the aquaponics system cultivation pond more ideal (Irawan *et al*., 2023). With this condition, nutrient absorption becomes more optimal and the body of *O. niloticus* utilizes this for growth which also affects the protein content of *O. niloticus* meat.

In this study, using plants in *O. niloticus* maintenance was able to optimize the absorption process of feed, nutrients, organic matter and feces. In the study (Mulqan *et al*., 2017) use of different plants such as spinach, mustard greens and lettuce resulted in the highest growth in spinach plants. However, this resulted in better growth and quality of tilapia cultivation water with the aquaponic system than conventional methods.

Fat Content of Tilapia (*O. niloticus)* Meat

The fat content in *O. niloticus* meat can also be utilized by the fish's body as an energy source. The research results show different fat levels in *O. niloticus*, as shown in Figure 3.

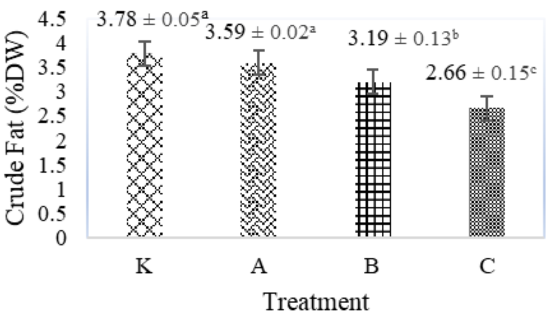

Figure 3. Crude Fat of Tilapia (*Oreochromis niloticus*) Meat in the Floating Aquaponic System with Different Types of Plants

Gambar 3. Lemak Kasar Ikan Nila (*Oreochromis niloticus*) pada Sistem Akuaponik Terapung dengan Jenis Tanaman yang Berbeda

Based on the research results, it was obtained that the fat content of the cultivation results with the floating aquaponic system had a significant effect. Treatment K (without plants) as 3.78% DW and A (*I. aquatica*) as 3.59 DW% were not significantly different ($p > 0.05$). These two treatments were statistically the treatments with the highest fat content. The lowest was found in treatment C (*L. sativa*) at 2.66% DW. The resulting fat content varies. According to (Ramlah *et al*., 2016) fat content is influenced by physiological and environmental conditions which will impact the level of fish feed consumption.

Fish are a source of long-chain fatty acids such as omega 3 which has a higher content compared to other animals and plants (Andhikawati *et al*., 2021). The decrease in fish fat content is proportional to the increase in protein content in fish. The fat content in *O. niloticus* is used for growth. The fat content in fish is influenced by environmental factors of the fish, the age of the fish and the growth of the fish (Nadia *et al*., 2020).

The aquaponics system provides stability to the living environment of *O. niloticus*, supporting the fish's metabolism process. The fish's body utilizes the nutrient content optimally, using fat content as an energy source for growth.

Ash Content of Tilapia (*O. niloticus*) Meat

The ash content in food ingredients is related to the mineral content in the ingredients (Pratama *et al*., 2022). The results of the analysis of ash content in tilapia meat can be seen in Figure 4.

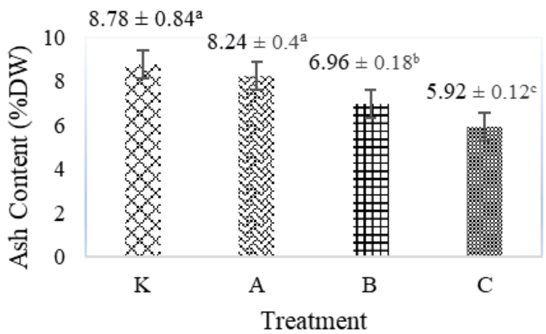

Figure 4. Ash Content of Tilapia (*O. niloticus*) Meat in the Floating Aquaponics System with Different Types of Plants

Gambar 4. Kadar Abu Kasar Ikan Nila (*O. niloticus*) pada Sistem Akuaponik Terapung dengan Jenis Tanaman yang Berbeda

Based on observations, the ash content in *O. niloticus* meat had a significant effect ($p < 0.05$). The highest ash content was found in the K treatment (without plants), 8.78% DW, and the lowest was found in the C treatment (*L. sativa*) 5.92% DW.

The ash content in seawater and freshwater fish ranges from 0.850–4.350% wet weight (Ullah *et al*., 2022). The lowest ash content was in the C treatment (*L. sativa*) which was 5.92% DW or equal to 1.16% wet weight and the highest in the K treatment (without plants) which was 8.78% DW or equal to 1.7% wet weight. These results indicate that the ash content in the study had the same results as the previous study. The low ash content in treatment C *(L. sativa*) is thought to be due to aquaponic systems having limitations in providing sufficient minerals for plants. Although fish produce waste containing nutrients, concentrations of minerals such as calcium, potassium, and iron are often low in the water of aquaponic systems. Excessive ash content may indicate the presence of inorganic contaminants or nutritional imbalances (Sirait *et al*., 2022), whereas insufficient ash content may reflect a deficiency of essential dietary minerals required for normal physiological functions.

CONCLUSION

The results of the research showed that the best treatment was in the treatment of *I. aquatica* plants which produced a dry weight of tilapia meat of 19.608%; protein of 61.575% DW; fat of 3.586% DW and ash content of 8.239% DW. The results showed that water spinach plants produced better meat quality than the other two plants. Compared to the control treatment, the difference was very significant. This can be a solution for the people of Kupang City to get nutritious animal protein and vegetables with minimal use of land, facilities and water.

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