**Incorporation of Fermented Cassava Leaf Flour into Commercial Feed to Enhance the Growth of Tilapia Fry (*Oreochromis niloticus*)**

**Abstract**

The success of tilapia cultivation is influenced by several factors, one of which is feed. This research was conducted to enhance the quality of feed and evaluate the benefits of incorporating fermented cassava leaf flour into feed on the growth and survival of Nile tilapia (*Oreochromis niloticus*) fry. The research used a Completely Randomized Design (CRD). Three levels of substitution of commercial feed with cassava were used: A: Incorporating 15% fermented cassava leaf flour, B: Incorporating 25% fermented cassava leaf flour, C: Incorporating 35% fermented cassava leaf flour. These were compared with Using 100% commercial feed. The results of the study indicated that the inclusion of fermented cassava leaf flour in the feed significantly affected absolute weight growth (p<0.05). The optimal treatment was observed with the incorporation of 15% fermented cassava leaf flour in treatment A, where the average weight of tilapia seeds reached 3.49 g. The highest absolute length growth was recorded at the optimal treatment dose in treatment A, with a value of 2.05 cm in comparison to the other treatments. The survival rate results demonstrated that the highest value of 83% was achieved with the best treatment of 15% fermented cassava leaf flour. The water quality in the rearing media remains within the appropriate range for tilapia cultivation.

**Key words:** Nile Tilapia; growth; fermented cassava leaf flour; feed.

Introduction

Nile tilapia (*Oreochromis niloticus*) is a valuable fishery commodity with significant economic importance. It is highly favored among the Indonesian population for its excellent flavor, firm texture, and rich nutritional content, making it suitable for various processed products (Li et al, 2023). As one of the top export commodities, tilapia is experiencing a growing demand (Lusiana et al., 2021). This increased demand is reflected in the rising production of tilapia each year. The Directorate General of Aquaculture (2020) reported average tilapia production of 1,474,742 tons in 2019 and 1,235,514 tons in 2020. This data indicates that tilapia is a fishery commodity with bright and profitable prospects.

Feed is a crucial factor that influences the growth and survival of cultured fish. Forage, presented as wet feed or flour, serves as a cost-effective source of protein. Local feed ingredients, which fish farmers may not yet be familiar with, can also be utilized to prepare fish feed, including rubber seed cake, cassava leaves, bananas, and kale. Several studies have examined sources of vegetable raw materials, such as cassava leaf flour (Mohidin et al., 2023).

Fish growth occurs when the feed consumed contains appropriate protein content and maintains a proper protein-energy balance. The availability and balance of energy sourced from protein enable it to serve as a building block for growth, while non-protein energy from fats and carbohydrates provides the necessary energy source (Carbon & Pasiakos., 2019). However, as a primary source of nutrients and energy, feed represents the largest component in utilizing natural resources, which must be available in sufficient quantities and balanced to meet growth needs and ensure easy digestion. Cassava leaves and and can be incorporated into fish feed formulations. This study aimed to determine the effect of adding cassava leaf flour on fish growth )absolute length, absolute weight), and survival rate, and to identify the appropriate dose of cassava leaf flour to be added to commercial feed that can support the growth and survival of tilapia fry

# **Materials and Methods**

## Experimental Set-Up

## This research was conducted at the Tatelu Freshwater Aquaculture Center (BPBAT) in the Dimembe sub-district of North Minahasa, North Sulawesi, from August to September 2023. A completely randomized design (CRD) was used to distribute assign three treatments and a control to twelve experimental units. Twenty 20 tilapia fry measuring 3 to 5 cm were stocked in each system. The treatments were as follows: (A) 85% commercial feed + 15% fermented cassava leaf meal, (B) 75% commercial feed + 25% fermented cassava leaf meal, (C) 65% commercial feed + 35% fermented cassava leaf meal and the control, (D) 100% commercial feed.

**Preparation of fermented cassava leaf flour**

Cassava leaves were washed, chopped, and steamed for 15 minutes. Afterward, the steamed cassava leaves were dried until they were no longer hot. Next, 0.5% yeast per kilogram was evenly added to the cassava leaves. They were placed in a jar and sealed tightly with duct tape for 4 days. Then, the cassava leaves were sun-dried for 2 days. Finally, the cassava leaves were ground using a flour grinder.

**Mixing cassava leaf meal with commercial feed**

Commercial feed was weighed according to the desired dose, along with cassava leaf flour. Water was sprayed onto the feed, and cassava leaf meal was added and mixed thoroughly. The feed was aerated for half a day. After the feed dried, it was placed in a labeled jar and it was stored at room temperature.

### Fish Tanks

### Twelve aquariums, each measuring 60 cm x 40 cm x 40 cm were used for the fish tanks Before using the aquariums, they were thoroughly cleaned and dried. Once dry, each aquarium was labeled according to the randomized treatment assigned and filled with 40 liters of water, with aeration provided in each aquarium.

### Stocking of Test Fish

### Nile tilapia fry that hade been acclimated in temporary holding tanks were placed into each 40-liter aquarium at a density of 1 fish per 2 liters. The rearing duration for tilapia fry was 40 days.

**Feeding**

The were feed twice per day (morning and evening) at a daily rate of 5% of the biomass of the tilapia fry..

**Water Quality Monitoring**

Every two days at 08:00 and 16:00 temperature, pH, and dissolved oxygen (DO) were measured in the tanks.

The body length and weight of tilapia fry was measured every 10 days. Length measurements were taken by placing the fry on a flat surface, such as a cutting board, and measuring them with a ruler. The measurement results were recorded, and the average body length per individual in each treatment was calculated. To determine the absolute length, the formula used was from Abdourhamane et al. (2021). Fish were weighed with a digital scale accurate to \_\_\_\_\_were Before weighing, the container filled with water was weighed and then balanced. The fry were weighed individually, and the average body weight per individual was recorded. Absolute growth rate was determined using the Abdourhamane et al. formula (2021), while the survival rate was recorded during the rearing period. Survival calculations were performed using the Abdourhamane et al. formula (2021).

**Data Analysis**

Analysis of variance was used to test differences among diets in mean growth (length and weight) and survival.

**Results & Discussion**

**Absolute Weight Gain**

All three treatments including casava produced significantly higher weight gain than the commercial diet without casava (Figure 1). Nevertheless, treatment A with only 15% casava leaf flour, produced the highest growth in tilapia fry (3.49g).

Figure 1. Average Absolute Weight Growth of tilapia fry over 40 days based on various proportions of casava leaf flour substitutions for commercial feed. Error bars represent standard errors . Letters indicated significant differences at the p<0.05 level.

**Absolute Length Growth**

**Differences in length growth was not significantly different among treatments with casava, but treatment A with only 15% casava produced significantly higher growth in length (2.05 cm) than commercial feed (1.07 cm) (Figure 2).**

Figure 2: Absolute Length Growth (cm) of tilapia fry over 40 days based on various proportions of casava leaf flour substitutions for commercial feed. Error bars represent standard errors . Letters indicated significant differences at the p<0.05 level.

**Survival Rate**

**Survival rate of tilapia fry was significantly higher with all the casava treatments than commercial feed, but treatment A with only 15% casava produced the highest survial rate at 83% (Figure 3).**

Figure 3. Survival rate (%) of tilapia fry over 40 days based on various proportions of casava leaf flour substitutions for commercial feed. Error bars represent standard errors . Letters indicated significant differences at the p<0.05 level.

**Water Quality**

The water quality parameters observed include temperature, pH, and DO. The results of water quality measurements obtained during the study can be seen in the following table:

Table 1. Water quality parameters; pH, DO and Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **pH** | **DO** | **Temperature** |
| **A** | 8 | 6,9 | 26 - 27ºC |
| **B** | 8 | 6,7 | 26 - 27ºC |
| **C** | 8 | 6,6 | 26 - 27ºC |
| **D** | 7,9 | 6,4 | 26 - 27ºC |
| **SNI** | 6,5-8,5 | >5 ppm | 25-30oC |

According to Table 1, the average water quality data collected during the study remained within a reasonable range. The results of the water quality observations indicate that variations in research findings can be attributed to different treatments, with no impact from the quality of the water media.

Discussion

Length

produced the highest growth rate in length and weigh and also in survival. Interestingly, more casava was not better as the treatments with increased percentages of casava substituted for commercial food gererally produced lower weight growth and survival. Growth in length showed a similar pattern but differences were not significant. Nevertheless, addition of casava generally was beneficial over commercial diet without casava.

Both internal and external factors influence survival of fish. Internal factors arise from the individual fish, while external factors relate to the quality of the feed and water. This aligns with Vardian et al. (2013), who claimed that survival can be affected by biotic and abiotic factors. Biotic factors encompass the age of the fish and their ability to adapt to the environment, whereas abiotic factors involve the availability of food and the quality of the water in their living medium (Mahavadiya et al., 2018).

The high survival rate in this study can be attributed to the effective use of the provided feed by tilapia fry, which creates favorable environmental conditions in the maintenance media that support fish survival and reduce stressors that could lead to mortality during the rearing period (Nurfitasar et al., 2020). The survival rate of tilapia showed no significant differences across treatments and remained high (68-83%), likely due to the fish's positive response to the feed.

Conclusion

A dosage of 15% fermented cassava leaf flour mixed with commercial feed promotes absolute weight growth, absolute length growth, and survival of tilapia. In light of these conclusions, further research is necessary to explore the effects of adding cassava leaf flour at a lower dosage in commercial feed for the optimal growth of tilapia fry.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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