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UTILIZING WATER HYACINTH (*Eichornia crassipes*) AS AN ALTERNATIVE FEED SOURCE FOR GRASS CARP (*Ctenopharyngodonidella*)

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ABSTRACT

Research conducted at the Aquaculture Laboratory of the Fisheries Department, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, focuses on utilizing water hyacinth (*Eichorniacrassipes*) as aquatic weed vegetation as an alternative feed source to grass carp (*Ctenopharyngodonidella*). The primary objective of this research is to investigate the impact of water hyacinth-based feeding on the growth and survival rate of grass carp. Employing a Completely Randomized Design (CRD), the study comprises five treatments, each replicated three times. Parameters assessed include the growth rate and survival rate of grass carp. Data were subjected to analysis of variance, and differences among treatments were assessed via the Duncan Test. The findings revealed that feeding grass carp with water hyacinth a 5% level resulted in the highest absolute growth (4.076 grams), and the greatest survival rate (95.23%).

KEYWORDS:

Water hyacinth, aquatic weeds, fish feed, growth, grass carp.

INTRODUCTION

Indonesia currently grapples with a challenging issue concerning the management of its public water bodies, including rivers, reservoirs, and lakes, primarily due to the unchecked proliferation of aquatic vegetation. The overabundance of aquatic flora, most notably water hyacinth (*Eichornia crassipes*), poses a formidable challenge, as observed in several critical locations like Tondano Lake (Moningkey *et al.*, 2021), Jatiluhur reservoir (Poernama *et al.*, 2023), Lake Taliwang (Sukimin and Nurlatifah, 1999), and numerous other public water resources. Factors such as an increasing population in the surrounding areas, expanding agricultural activities, the burden of industrial waste, and a diminishing water body area due to urban development all pose significant threats to the continued existence of waters.These mounting environmental pressures have had a detrimental impact on the ecological health of waters. This includes a reduction in both the quality and quantity of the lake's water, shallowing of certain water bodies, eutrophication, the proliferation of water weeds such as waterhyacinths, and a decline in biodiversity, particularly among fish and other aquatic species that call the lake home (Amirkolaie, 2011). If these trends persist, the waters will struggle to fulfil its intended functions, both in terms of its technical and ecological roles. Specifically, from an ecological perspective, it will experience a decrease in its environmental carrying capacity for aquatic life, resulting in reduced diversity and abundance of fish in the lake and, consequently, diminished aquatic productivity.

To address the burgeoning issue of water weed overgrowth and its ecological impact, one proposed solution is biological control. This entails using herbivore fish, such as grass carp (*Ctenopharyngodonidella*) as biological agents to consume excess aquatic vegetation. Grass carp are known to be herbivorous fish which have the ability to consume aquatic plants at high levels. Zolfinejad *et al.* (2017) state that the plants utilized more by fish were *Lemna minor* (with91.5% decrease) and *Myriophyllum spicatum* (with 89.2% decrease). Similarly, grass carp fish serves as a bio-cleaning agent, aiding in the purification of turbid water due to its plankton-eating habits (Yang and Liu, 1990; Effendi *et al*., 2017).

Nonetheless, an essential step in this process involves studying the identification of nutritional content of water hyacinthand understanding the response of fish to this vegetation. This preliminary research is crucial in gauging the potential effectiveness of herbivore fish in managing water weed growth.Water hyacinth represents a promising source of alternative fish feed. Its utilization as nourishment for herbivore fish holds a pivotal role: it can curtail feed expenditures in aquaculture while simultaneously managing the proliferation of aquatic weeds, thus contributing to improved ecological conditions in aquatic environments. Nevertheless, before implementing aquatic weed vegetation-based feeding, it's imperative to conduct a comprehensive study to assess its impact on the growth of grass carp. This research endeavors to elucidate the extent to which aquatic weed vegetation-based feeding influences the growth and survival rate of grass carp. The aim of this study's findings are finding the optimal level of water hyacinth-based feeding, growth and survival rates of grass carp. This, in turn, promises to be a valuable strategy for mitigating the issue of weed overgrowth in waters.

MATERIALS AND METHOD

This study was conducted at the Aquaculture Laboratory of the Fisheries Department, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. The proximate analysis of the test feed was performed at the Ruminant Animal Nutrition and Animal Feed Chemistry Laboratory, Faculty of Animal Husbandry, Universitas Padjadjaran. Tools and equipment were employed in this research, including 15 aquariums (20 x 40 x 20 cm), pelletizer, aeration equipment, heaters, etc. Additionally, a $1m^3$fiber tank was used to reserve fish stock, while small sieves and plastic containers were utilized for fish weighing. Digital scales from Mettler Toledo with a precision of 0.01 were employed for fish and test feed weighing.

The research materials comprised 200 fishes with an average weight of 2 grams each, procured from the Ciparay Seed Centre in Bandung Regency. Malachite green was used to prevent fish from contracting diseases during the study. The test feed was prepared by modifying commercial feed (25% protein) through the addition of weed vegetation meal. The nutritional content of the test feed was analyzed using proximate analysis, and the results are presented in Table 1.

Table 1. Proximate analysis of test feed nutritional content (as fed)

Treatment	Protein (%)	Crude Fiber (%)	Energy(kcal/kg)
T0	26.03	4.02	4085.99
T1	25.70	4.96	4082.34
T2	23.42	7.33	3807.72
T3	21.58	6.79	3432.14
T4	21.25	8.06	3779.55

The research methodology employed in this study was experimental, utilizing a Completely Randomized Design (CRD) comprising 5 treatments, each replicated 3 times. The treatments administered were as follows:

- Treatment T0: Feed with 0% water hyacinthmeal
- Treatment T1: Feed with 5% water hyacinthmeal
- Treatment T2: Feed with 10% water hyacinthmeal
- Treatment T3: Feed with 15% water hyacinthmeal
- Treatment T4: Feed with 20% water hyacinth meal

The allocation of treatments within this experiment was done randomly. The design model employed is as follows:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

Where:
Y_{ij} = observed value in the i treatment of the j replication

μ = mean response across treatments and replications.

T_i = effect of treatment i.

ε_{ij} = experimental deviation from the i treatment and the j replication.

The impact of each treatment was assessed using F Test statistical analysis, followed by the Duncan Test to identify distinctions between each treatment.The parameters observed in this research encompass:

Absolute Weight Growth

Absolute weight growth or weight gain is calculated as per Effendi (1997) with the formula:

$H = W_t - W_o$

Where:

H = Absolute growth (grams)

W_t = Total weight of test fish at the end of the experiment (grams)

W_o = Total weight of test fish at the start of the experiment (grams)

Survival Rate (SR)

Survival Rate (SR) was calculated using the formula:

$SR (\%) = (N_t / N_o) \times 100\%$

Where:

SR = Survival Rate (%)

N_t = Number of individuals at time t

N_o = Number of individuals at stocking

RESULTS AND DISCUSSION

Identification of Nutrition Content of Water Hyacinth

Water hyacinth (Figure 1) offers excellent nutritional value, particularly as a source of carbohydrate. The nutritional composition of waterhyacinth is outlined in Table 2.The selection of waterhyacinth as the aquatic plant for feed is in line with the criteria set forth by Fraser (1984) for the use of aquatic plants, which include: 1) rapid growth rate, 2) substantial standing crop per unit area, 3) nutrient-rich, 4) ease of harvest, and 5) suitable nutritional value for feed.

Table 2. Nutritional Composition of Waterhyacinth (*Eichornia crassipes*)

No	Nutritional Content	Value (%)
1	Ash content	11.98
2	Water content	9.10
3	Crude Protein	12.63
4	Crude Fat	14.62
5	Crude Fiber	20.29
6	Dry Ingredients	90.90
7	Organic Ingredients	78.92
8	Organic Matter Without Nitrogen	66.29
9	Carbohydrates	51.67
10	Extract Ingredients Without Nitrogen	31.38

Figure 1. Water hyacinth (*Eichornia crassipes)*

Source: Prasetyo*et al*. (2021)

Variations in the nutritional content and mineral composition of aquatic plants have been documented by Etse*et al*. (2018) for four species*: Nymphaea lotus*, *Typha australis, Ipomoea aquatica,* and *Scirpuscubensis*, and by Zolfinejad *et al*. (2017) for six species: *Myriophyllum spicatum, Ceratophyllumdemersum, Azolla filiculoides, Lemna minor, Cynodondactylon,* and *Medicago sativa.* These differences are likely attributed to variations in the genus and species of the plants as well as the substrates on which they grow.

Absolute Growth

Growth is a pivotal parameter in assessing feed research outcomes. The findings from this study revealed that the average absolute growth of *grass carp* fish fed with added weed vegetation protein was slightly lower than the control group (without weed vegetation protein). The highest average absolute growth was achieved with the addition of 5% weed vegetation meal protein, reaching 4.076 grams, while the lowest average absolute growth was observed at the 20% addition level, amounting to 3 grams.

Table 3. Absolute Growth of Grass carp (grams)

Treatment	Average Absolute Growth (grams)
T0 (0%)	4.441[a]
T1(5%)	4.076[a]
T2 (10%)	3.880[a]
T3(15%)	3.783[a]
T4 (20%)	3.00[a]

Note: Values with different letters in the same column are significantly different (P<0.05).

The analysis of variance did not reveal a significant difference in the absolute growth of grass carp fish among different percentages of added water weed vegetation meal in their feed. This suggests that the inclusion of aquatic plantmeal in the feed did not exert any negative or antagonistic effects on fish growth.The study demonstrated that up to the 20% level of vegetation meal in the feed, there was no statistically significant difference in growth when compared to the 5%, 10%, and 15% levels. This indicates a broad tolerance level of grass carp to plant-based feed, aligning with the herbivorous nature of grass carp.

Plant-based feeds are characterized by low protein content and high crude fiber content. In this study, the test feed in treatment A had the lowest crude fiber content at 4.02%, while treatment E had the highest at 8.06%. Interestingly, this relatively high crude fiber content did not negatively impact the growth of grass carp. This phenomenon is likely due to the long intestines of herbivorous fish, like grass carp, which are several times the length of their body, creating a circular configuration in the abdominal cavity (Affandi *et al.*, 1992).

The ability of grass carpto thrive on feed containing high crude fiber is attributed to their specific digestive tract and the presence of enzymes and digestive fluids. Unlike cellulose-producing animals, fish cannot produce cellulose enzymes in their intestines to digest cellulose from their food. Instead, the digestion of high-fiber foods is thought to occur through intestinal microbial fermentation to break down cellulose, suggest that cellulose is produced by intestinal microflora and that the digestive process is enhanced through exogenous enzymes consumed with artificial food, such as pellets, containing more than 18% cellulose derived from plants.The uniform growth response observed up to the 20% level of weed vegetation indicates the potential for further increasing the use of weed vegetation in grass carp feed without negatively affecting growth rates.This aligns with the findings of Toutou*et al*. (2018), who noted that in general, substituting formulated feed with aquatic plants in grass carp culture can lead to fish with improved health and reduced production costs. However, a trade-off is observed in the form of significantly slower growth performance.

Survival Rate

Survival rate is the comparison between the number of living organisms at the end of a period and the number at the beginning. This metric provides insights into a fish's tolerance and ability to survive.The research findings indicate that the highest survival rate among grass carp fish occurred when they were fed with 5% and 10% water weed vegetation meal, reaching an impressive 95.23%. Conversely, the lowest survival rate was observed at the 20% addition level, with a value of 61.89%.

Table 4. Survival Rate (%)

Treatment	Survival Rate (%)
T0 (0%)	90.46[a]
T1(5%)	95.23[a]
T2 (10%)	95.23[a]
T3(15%)	71.40[a]
T4 (20%)	61.89[a]

Note: Values with different letters in the same column are significantly different (P<0.05).

The results of the variance analysis revealed that the addition of aquaticvegetation meal in varying percentages to the feed did not significantly affect the survival rate of *grass carp* fish. This suggests that, even at the highest dose (20%), plant-based feed does not pose a lethal risk to *grass carp* fish.Although no significant statistical differences were observed, there was a trend of decreasing survival with increased levels of weed vegetation meal in the grass carp fish feed. This could be linked to the energy required for feed digestion. Feeds high in fiber, like plant-based feeds, contain significant amounts of crude fiber that fish find challenging to digest. The breakdown of crude fiber in the digestive tract demands more energy, potentially reducing the available energy for other bodily functions, including immune mechanisms. Diets high in crude fiber (above 12%) can lead to digestive issues and increased mortality rates (Nasir, 2002).Zhang *et al*. (2023) report the survival rates of yellow catfish in four experiment groups effects of dietary cellulose content. Dietary supplemented with 4.00–6.00% cellulose can improve the growth and blood health, and ensure intestinal structure integrity anddigestive enzyme activity, and maintain intestinal microbiota stability, and enhance ammonia tolerance of yellow catfish. Furthermore, plant-based feeds exhibit bulkiness due to their high water content. This property can trigger a quicker sensation of satiety in fish, leading to reduced feed consumption. Consequently, this decreased feed intake can impact their survival rates.

Conclusion

The inclusion of water hyacinthmeal, at levels of up to 20% in the feed, did not have detrimental effects on the growth of grass carp. This suggests that grass carp exhibit a broad tolerance for plant-based feeds, such as waterhyacinth. Secondly, the survival rate of grass carpremained stable even when subjected to a 20% inclusion of waterhyacinthmeal in their diet. This resilience in survival rates is promising for further investigations into optimizing the utilization of waterhyacinth in aquatic ecosystems. Lastly, considering that both growth and survival remained unaffected at the 20% level, it is advisable to conduct further research with higher inclusion rates of water hyacinth in fish feed. This could help to fully explore and optimize the potential of water hyacinth as a viable feed source in aquaculture. In summary, the study underscores the potential of water hyacinth as an alternative feed source for grass carp, opening doors for further research to harness its benefits in aquatic ecosystems and aquaculture practices.

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