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Effects of Water Hyacinth (*Eichhornia crassipes)* Leaf Meal Supplementation on Growth and Survivability of Pangasius Catfish (*Pangasianodon hypophthalmus)* Juvenile

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aquaculture is rapidly expanding sector having crucial role in global food security. Feed ingredients and feed quality are essential factors for the sector's development. The present study was aimed to evaluate the effects of water hyacinth *(Eichhornia crassipes*) diet as a supplement on growth and survivability of Pangasius catfish (*Pangasianodon hypophthalmus*) Juvenile. A total number of 120 juvenile pangasius catfish were stocked into 12 tanks, each tank having ten (10) pangasius juvenile with three replicates. Four iso-nitrogenous diet having water hyacinth leaf meal replacing fish meal with different concentrations were divided into four groups viz. control group (0%), T1 (10%), T2 (20%), and T3 (30%) water hyacinth diet, respectively. Juvenile mean body weight of each group were recorded on the 1st day of experiment as (15.22±1.72 g) and after 45 days of experiment, the final mean body weight gain of each group was recorded as control group (30.82±2.24 g), T1 (30.98±1.67g), T2 (33.52±2.13 g) and T3 (37.26 ± 1.47 g). The specific growth rate of each group was recorded (0.31±0.03, 0.32±0.03, 0.39±0.02 and 0.43 ± 0.05 g/day). The highest protein efficiency ratio was recorded in group T3 (1.66 ± 0.19), when compared with other groups. The lowest feed conversion ratio was recorded in group T3 (2.28 ± 0.38). Among the treatment groups, the highest survival rate were recorded in group T3 (96.33%). The study revealed that a better performance indices as the percentage of water hyacinth increases However, best performance was found with inclusion of 30% water hyacinth diet were significant different ($p<0.05$).

Keywords: Water hyacinth leaf meal (WHLM); Pangasiandon hypophthalmus; growth; survivability.

1. INTRODUCTION

In recent year, aquaculture has become one of the most growing sector in fisheries industry and recognized for its vital contribution to global food security and nutrition in the twenty-first century. India stands as the world's third largest producer of fish, accounting for 8.0% of global fish production and ranking second in aquaculture. In the fiscal year 2022-23, India achieved a record fish production of 175.45 lakh tons, underscoring its pivotal position in global fisheries [1].

Successful growth in aquaculture hinges significantly on aqua feed formulations. Expansion of aquaculture can help meet increasing fish demand and alleviate pressure on dwindling capture fisheries [2], However, the rising prices of fish oil and fish meal pose challenges to commercial aquaculture production [3].

Feed constitutes the highest recurring cost in modern aquaculture, comprising about 50-60% of total production expenses. To achieve the targeted freshwater fish production of 17.0 MMT by 2050 in India, approximately 23 MMT of feed will be necessary, highlighting the critical role of feed in fish production [4].

Water hyacinth (*Eichhornia crassipes)* is aquatic plant known for its ability to proliferate in freshwater environments, serves various ecological roles including nutrient cycling, water purification, and habitat support for fauna, despite being a persistent aquatic weed issue [5]. The leaf of water hyacinth, particularly rich in protein (55.4% on a dry matter basis) and essential amino acids like leucine and phenylalanine, presents a viable alternative protein source in catfish diets [6-7].

Catfish (*Pangasianodon hypophthalmus*) valued for its rapid growth and high market demand, has been extensively studied in aquaculture, particularly regarding feed costs and nutritional strategies. Incorporating water hyacinth into catfish diets offers a promising approach to mitigate the reliance on costly fish meal, promoting economic sustainability and environmental stewardship in aquaculture production.

2. MATERIALS AND METHODS

2.1 Location/ Place of Work

The present study was conducted in the wet laboratory of College of Fishery Science and Department of Animal Nutrition, College of Veterinary Science & Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Jabalpur (M.P.), India.

2.2 Collection and Acclimatization of Experimental Fish

The investigation was carried out to evaluate the effect of water hyacinth leaves on growth and survivability of Pangasius catfish A total number

of 120 Pangasius (*Pangasianodon hypophthalmus*) juvenile with an average weight (15.22±1.72 g) and an average length of 10-12 cm were collected from cage rearing unit, Bargi reservoir, Jabalpur and kept in the wet lab of College of Fishery Science, (Nanaji Deshmukh Veterinary Science University, Jabalpur). Fish juvenile were kept in circular plastic tanks having 25 liters/tank water capacity. Water temperature was maintained at 28 ^{o}C to 32 ^{o}C at density of 10 fish/tank. Fish juvenile were kept for acclimatization for two weeks. Before starting the feeding, they were bath treatment with NaCl (5mg/L) to prevent of fungal infection to the fish juvenile, following the protocol established by Rowland and Ingram [8]. During the period of acclimatization, juvenile were provided with a basal diet once a day. The tanks were provided with artificial aeration system and photoperiod of 12 hours light, 12 hours dark; Fish juvenile were fed daily with water hyacinth leaf meal incorporated feed with concentration of 10%, 20% and 30% for tanks T1, T2 and T3 respectively.

2.3 Preparation and Feed Formulation of Ingredients

The iso-nitrogenous feed was prepared by balancing the protein level by using Pearson's square method. The required quantities (Table 1) of the various feed components (except vitamins, minerals, and fish oil) were dried well, water hyacinth leaf (WHLM) powder and mixed all feed ingredients. It was mixed with an adequate quantity of water to form soft dough that was then it was cooked properly in steam with the help of pressure cooker. The dough was then allowed to cool without the lid being removed, and it was subsequently mixed with a sufficient amount of vitamins, minerals, and fish oil. Furthermore, the dough was pressed through a pelletizer that had a perforated disc, and the noodles were dried and broken into pieces. Care was taken to ensure that the pellet feeds were moisture-free, and the dried feed was stored for daily use in an airtight container. The water hyacinth leaf meal was procured from a commercial feed mill and underwent chemical composition analysis as per by the following Association of Official Analytical Chemists (AOAC) [9] before crafting the test diets. A foundational diet containing the necessary nutrients for the typical growth of fish was prepared.

2.4 Experimental Design

A total number of 120 juvenile fish were taken for present study and divided into four experimental group namely Control, T1, T2 and T3 having 30 fish in each group including three replicates (10) fish were sampled for each treatment. By following completely randomized block design. Water hyacinth leaf meal served as a test component, and the test diets were created with different levels of WHLM. Fish meal was gradually substituted with WHLM meal @ of 0%, 10%, 20%, and 30% concentration for Control group, T1, T2 and T3 groups respectively in the diet formulations. The duration for feeding trail was of 45 day and there after evaluated for the growth and survivability of pangasius catfish.

2.5 Feeding Procedure

Pangasius juvenile were provided their designated diets, amounting to 5% of their live wet weight, and were fed twice daily. Every 15th days throughout the experiment, the fish in each tank were weighed to assess the growth of pangasius juvenile.

Table 1. Ingredients and composition of iso-nitrogenous experimental diets

Ingredients	C (0%)	T1 (10%)	T2 (20%)	T3 (30%)
WHLM	_	2.82	5.64	8.46
Fish Meal	28.23	25.41	23.1	20.2
Mustard Oil Cake	26.8	27.7	27.4	28.23
Rice bran	19.27	18.3	18.16	17.64
Wheat Bran	15.7	15.7	15.7	15.47
Fish Oil	5	5	5	5
Vitamin premix	2	2	2	2
Mineral premix	3	3	3	3
Total	100	100	100	100
Crude Protein (%)	30	30	30	30

2.6 Growth Analysis

Throughout the experiment, all the fish in each tank were collectively weighed using weighing machine every 15 days to assess the growth performance of pangasius juvenile. Growth was evaluated by calculating Weight Gain, SGR and FCR, PER, Survival rate using established formulas:

- The mean weight gain = Mean final weight gain - Mean initial weight gain,
- Specific Growth Rate (SGR) = (final weight)- (initial weight)/ Culture period (Days)x100
- Food conversion ratio (FCR) = Feed fed in dry weight /Live weight gain

$$PER = \frac{Gain\ in\ body\ weight\ (g)}{Gain\ in\ body\ weight\ (g)}$$

$$Survival\ rate\ (\%) = \frac{Initial\ surviving\ fishes\ x\ 100}{Final\ surviving\ fishes}$$

2.7 Statistical Method

Each treatment had three replicates, a total of 10 fish were sampled for each treatment. A sample size of 3 (n = 10) was used as true statistical replicate for the purpose of statistical analysis. R statistical program (v. 4.0.2) was used for all statistical analysis R Core Team, [10]. Microsoft Excel and R statistical program were used to prepare graphs. The data were subjected to One-way Analysis of variance (ANOVA) after testing for normalcy and equality of variance of the data by Sheoran et al. [11]. O.P. Stat was used to compare the means of all the treatments and find if the statistically significant difference between them. The data are represented as mean ± SD, and a $p < 0.05$ was considered statistically significant.

3. RESULTS AND DISCUSSION

Growth performance of pangasius juvenile fed with the four iso-nitrogenous experimental diets are shown in (Table 2).

The mean body weight (BW) of control group was recorded from 15.12 ± 1.16 g to 30.82 ± 2.24 g. The mean body weight (BW) of treatment group 1 (T1) was recorded between as 15.04± 1.54 g to 30.98 ± 1.67 g. The mean body weight (BW) values in group T2 was recorded as 15.10 ± 1.9 g to 33.52 ± 2.13 g (Fig. 1). The T3 group revealed higher body weight ranged from 15.63 ± 2.06 g to 37.26 ± 1.47 g (Table 2). Present study was aligned with the findings of Sadique et al. [12] who recommended that (30%) fermented water hyacinth leaf meal showed greater impact on the growth of fishes at higher level compared to low levels (<20%). The study revealed that Saha and Ray [7]. Who recommended that 40% incorporation level replacing fish meal without any adverse effect on growth of the fish to produce cost effective formulated fish feed.

The Specific Growth Rate was recorded and showed found that group T3 had (Table 2) the maximum average Specific Growth Rate (0.43 ± 0.05%) fed with 30% of water hyacinth leaf meal. Control group (0.31± 0.03) and group T1 (0.32± 0.03) had no significant growth rate when compared to group T2 (39±0.02) and T3 (0.43 ±0.05%) (Fig. 2) group SGR. While similar findings were reported by Otchoumou et al. [13] that water hyacinth leaf meal in diet increased the specific growth rate of treatment group with respect to the control group.

FCR was recorded and the result revealed that group T3 having better / minimum FCR (2.28 ± 0.38) followed by T2 group (2.55 ± 0.53) and T1 group (2.77± 0.47) (Table 2) (Fig. 3). However the FCR results showed statistically significant difference between the treatments and control groups ($P<0.05$). Similar findings reported by Otchoumou et al. [13]. With better FCR and good PER fed with 30% (*Eichhornia crassipes)* and concluded that 30% level is better nutrient of water hyacinth for growth performance.

The survival rate of fishes of different groups were recorded in the maximum survivability in group T3 (Table 2) with 96.67%. The control group recorded lowest survival rate 80.00%. The better FCR, PER and WG found in T3 than the control group (Fig. 4). Were reported by Pratiwi et al. 2021 [14] are similar that he revealed the survival rate of fish fed with water hyacinth leaf meal is better than the other control group. Fouzi et al. [15] reported the better tolerance level with increasing dosage of water hyacinth leaf in fishes. Efawani et al. [16] reported water hyacinth leaf content in the feed increased the survival rate of catfish to (30%) water hyacinth leaf meal compared to no water hyacinth feed treatment.

Table 2. Growth performance of pangasius juvenile varying levels of WHLM basel diets

Growth parameters	Diets			
	Control diet	Treatment 1	Treatment 2	Treatment 3
Mean Initial body weight (g)	$15.12^{a} \pm 1.16$	$15.04^{a} \pm 1.54$	$15.10^{a} \pm 1.99$	$15.63^{a} \pm 2.06$
Mean Final body weight (g)	$30.82^{c} \pm 2.24$	$30.98^{c} \pm 1.67$	$33.52^{b} \pm 2.13$	$37.26^{a} \pm 1.47$
Specific growth rate (%)	$0.31^{c} \pm 0.03$	$0.32^{c} \pm 0.03$	$0.39^{b} \pm 0.02$	$0.43^{a} \pm 0.05$
Feed conversion ratio	$2.81^{a} \pm 0.56$	$2.77^{a} \pm 0.47$	$2.55^{b} \pm 0.53$	$2.28^{c} \pm 0.38$
Protein Efficiency Ratio	$1.32^{c} \pm 0.059$	$1.35^{c} \pm 0.078$	$1.51^{b} \pm 0.29$	$1.66^{a} \pm 0.19$
Survival Rate (%)	80.00	93.33	93.33	96.67

**Values are presented as Mean ± S.D. ($p \leq 0.05$; $n = 10$)*

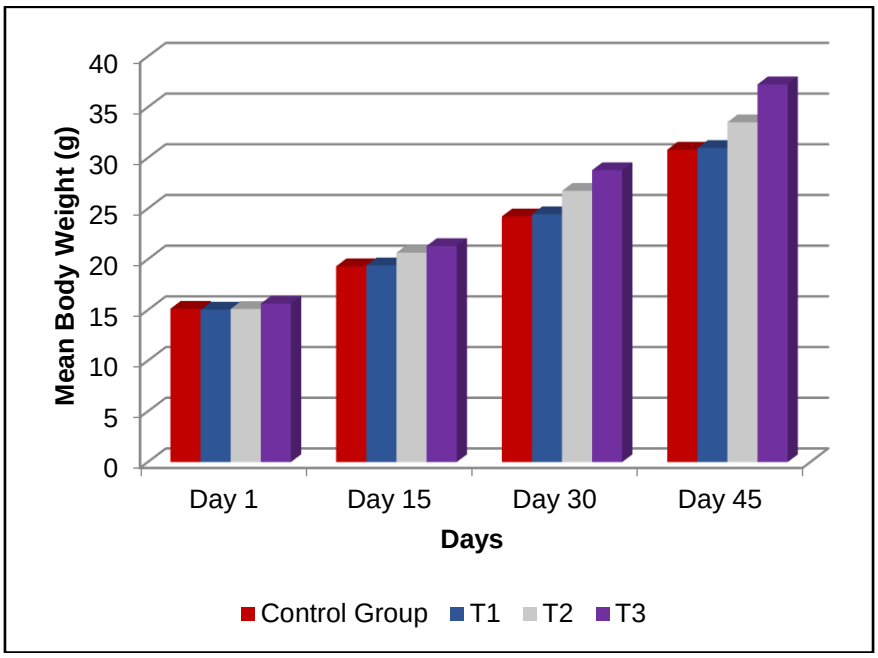

Fig. 1. Mean Body Weight (g) of pangasius Juveniles of different treatment groups

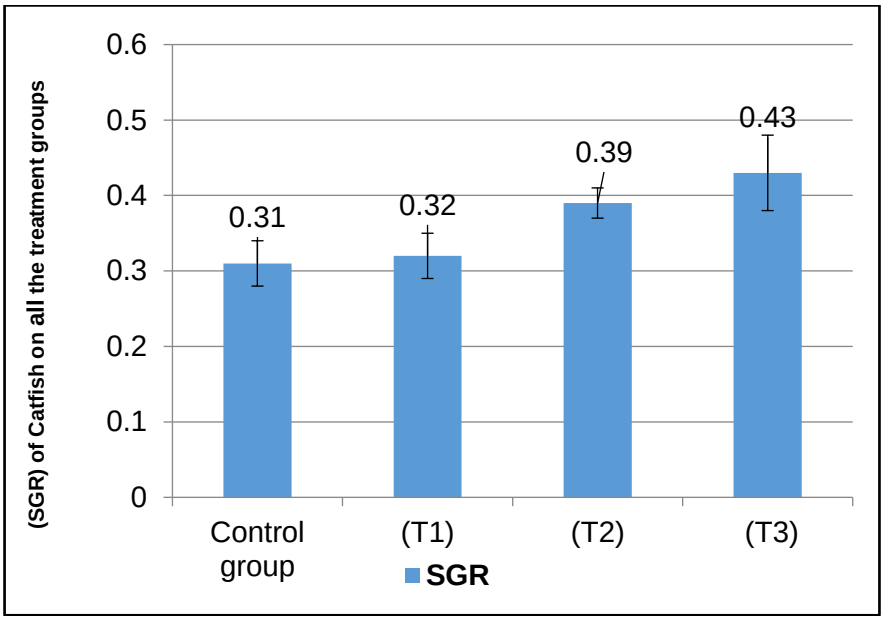

Fig. 2. Specific Growth rate (SGR) of pangasius Catfish on all the treatment groups

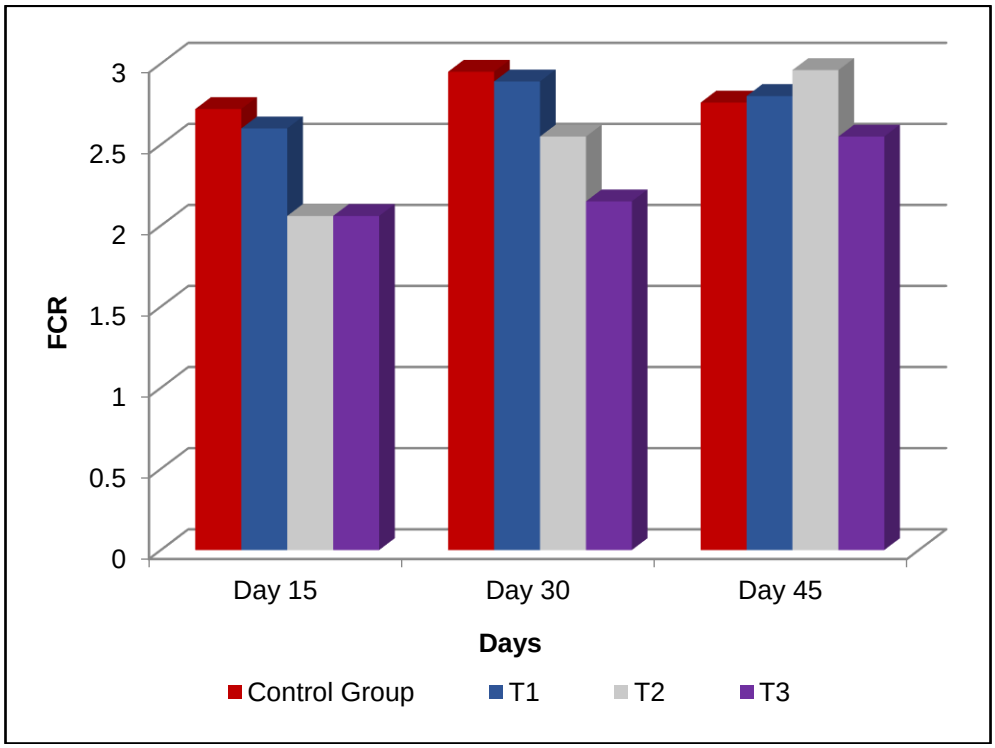

Fig. 3. Effect of water hyacinth leaves on FCR of pangasius catfish at every 15-day interval

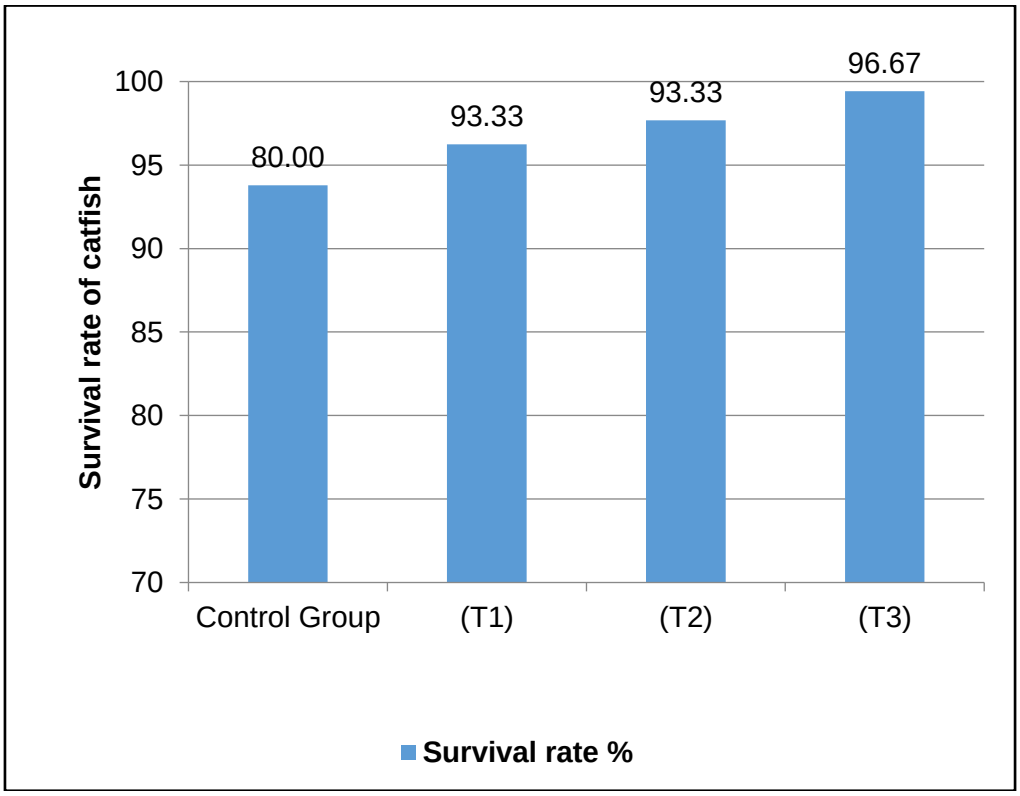

Fig. 4. Effect of water hyacinth leaves on Survival rate of pangasius catfish

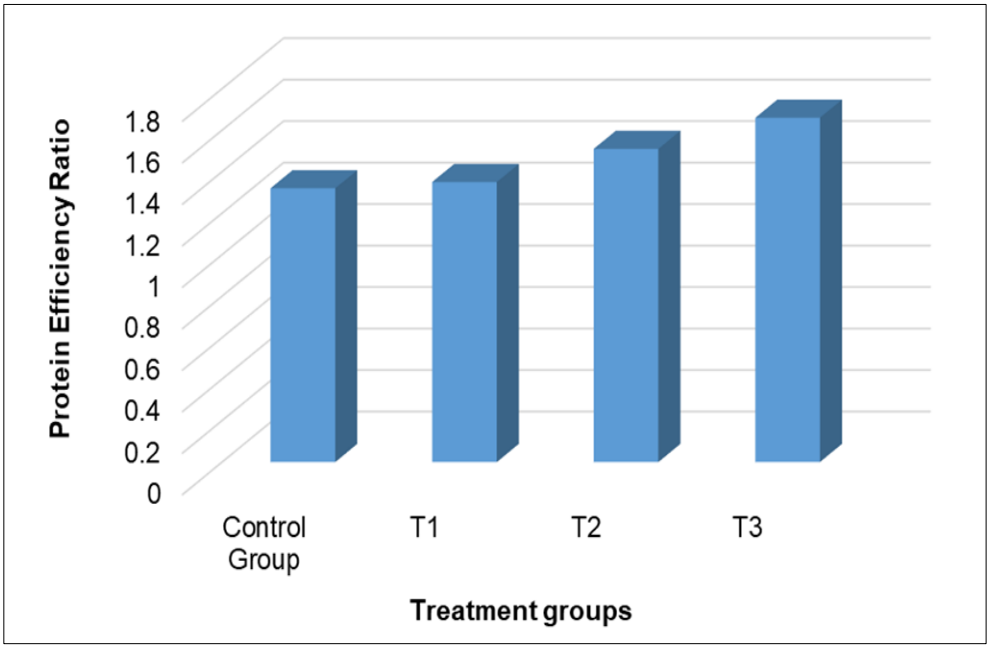

Fig. 5. Effect of water hyacinth leaves on Protein Efficiency Ratio (PER) of pangasius catfish *at* every 15-day interval

The mean PER was recorded and results reveled as group T3 have showed best result (Table 2) with maximum PER had (1.66 ± 0.19) followed by T2 group (1.51± 0.29) and T1 group showed PER as (1.35 ± 0.078). The control group showed minimum PER as 1.32 ± 0 .059 on 15th, 30th, and 45th day interval, respectively (Fig. 5). Similar results were reported by Konyeme et al. [17] who found improved PER of treatment groups treated with *Clarias gariepinus* than the control group.

4. CONCLUSION

The present work suggesting that 30% substitution with water hyacinth leaf meal in diet of pangasius catfish has better growth performance and may include in diet of catfish as a good source of protein than other available feeds.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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