**How to Cite**:
Naji, M. H., & Alzurfi, S. K. L. (2022). Can aquatic plant (Eichhornia crassipes) be used as a partial substitute for carp fish feed?. *International Journal of Health Sciences*, *6*(S5), 8125–8135.
https://doi.org/10.53730/ijhs.v6nS5.10843

# Can aquatic plant (*Eichhornia crassipes*) be used as a partial substitute for carp fish feed?

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***Abstract*---**This study was conducted to evaluate the possibility of using *Eichhornia crassipes* as a partial substitute for vegetarian meals to reduce the cost of feeding fish. *Eichhornia crassipes* powder was included in fish feed at different levels (0%, 25%, 50%, 75% and 100%), and it was fed in *Cyprinus carpio* L. farms using plastic container for 45 days. The obtained results showed that the final weight gain and specific growth rate (SGR) was (15.83; 9.8) gm respectively in the first treatment during the 45$^{th}$ day, highest percentage compared to the control treatment. Non-Significant differences were observed between treatments and days in feeding fish at $p>0.05$ compared with the control treatment. The average intestines length of fish shows the highest increase in the first treatment compare to control, and it may be the best criterion for growth with this concentration. We conclude that the *E. crassipes* (25%) can be replaced as a partial substitute for meals. Therefore, experiments at other concentrations of lower than 25% are recommended to reach the best growth standards.

***Keywords*---**Eichhornia crassipes, Cyprinus carpio, Fish meal, Rate growth, SGR.

## Introduction

Common carp (*Cyprinus carpio*) is one of the most important farmed freshwater fish species globally (Pauly & Froese, 2012). Fish is an important source of food and protein. Humans obtain 14% of animal protein from fish. They also constitute an important source of national income for many countries. Moreover, fish contribute to achieving food security (Ali, 2020). The increasing demand for fish meat consumption in recent times is a major factor of decreasing the productivity of the interior water surfaces and hence causing a nutritional gap. This led to


*Manuscript submitted: 9 April 2022, Manuscript revised: 18 June 2022, Accepted for publication: 27 July 2022*

attention to breeding fish because for its great advantages compared to other animals since its meat is healthy food with good quality protein , essential amino acids, reaching its strong value at 94%, unsaturated fatty acids, vitamins, minerals and salts (Al-Shakhrit, 2009; Hassan and Hashem, 2016). Fish feeding in any fish farming project constitutes about 50-60% of the production cost (Craig and Helfrich, 2017). Therefore, there was an urgent need to find feed alternatives or ingredients to replace the basic elements to reduce the cost. The main problem in aquaculture is the cost of forage, especially protein sources such as soybeans, which are highly costly. Hence, an alternative cost-effective, eco-friendly and convenient ingredient is required (Sithara & Kamalaveni, 2008). The right feed ingredients can be extracted from aquatic plants, thus, the use of aquatic plants as an alternative feed can facilitate the development of a new type of fish production system. Water hyacinth (*Eichhornia crassipes*) is an aquatic plant found in rivers, lakes, or ponds. (DiTomaso and Healy, 2003). It is one of the floating perennial aquatic plants, the most widespread and harmful in the freshwater environment due to its rapid growth in Iraq (Getty, 2021; Center *et al.*,2005). However, this plant still has much potential that humans can utilize. Water hyacinth can be used as fish feed because it contains various nutrients such as proteins, lipids, carbohydrates, vitamins and secondary metabolites. Feed is an important component in fish farming because the nutritional content of the feed influences the growth rate of fish. In addition, about 60% of production costs are dependent on feed costs (Wardono and Prabakusuma, 2016). The current study investigates the possibility finding partially natural alternatives to use *Eichhornia crassipes* as a cheaper feed and more abundant for fish.

## Materials and Methods

### A- Sample collection

*Eichhornia crassipes* samples were collected and bagged from the Haidari stream, a branch of the Euphrates River, and taken to the laboratory. They were washed with running warm water several times to clear from insects, roots and some suspended algae. Then the samples were washed with distilled water. The plants were dried by constant stirring for several days to dry completely by placing them with ventilation away from sunlight.

### B- Preparing *E. crassipes* meal

Four kgs *of Eichhornia crassipes* plant was mixed with 4 kg of local fodder in certain proportions with 400 g of flour and kneaded by adding distilled water until it became lumpy and coherent. The percentages were from four treatments (75% feed and 25% plants, 50% feed and 50% plant, 75% plant and 25% feed and 100% plant), and the fifth treatment is control (feed only). An electric machine was then used to shape the meal.

### C- Experiment design

The experiment was conducted at the Research and Field Experiments at the University of Kufa / College of Science in the Department of Environment and Pollution. The experiment lasted for eight weeks, including the acclimatization period, from 29/1/2022 to 5/4/2022. The fish farming system was prepared using five treatments and three repetitions with 15 plastic containers. The open system was adopted where water entry to all containers is from the top using taps distributed to all basins called input, water exits from the bottom of the inlets. The capacity of each container is 100 litres, and those containers were provided with aerators. Pebbles were placed at the bottom of the containers to provide natural conditions for the fish and clear off microbes by friction. The plastic basins were arranged in a single row, covered with plastic nets to keep the fish in. The experiment was designed in five treatments explain in Table (1).The food percentage for each one fish is 3% of the fish weight.

Table 1
Experiment Design

| | |
|---|---|
| T1 | *Eichhornia crassipes* powder 25%+ 75% industrial meal |
| T2 | *Eichhornia crassipes* powder 50% + 50% industrial meal |
| T3 | *Eichhornia crassipes* powder 75% + 25% industrial meal |
| T4 | 100 % *Eichhornia crassipes* powder |
| T5 | (Control) Industrial meal%100 |

Carp fish of an average weight of 83 g and an average length of 17 cm were brought from the fish hatchery in Al-Mahaweel in Babylon Governorate. Upon reaching the experiment site, the bags were placed in plastic containers for half an hour to adjust and balance the temperature between the water of the bags and that of the containers. Fish were weighed and distributed to the rest of the containers. Fish were placed in plastic containers for the acclimatization period of 14 days. Their weights were measured at the beginning of the experiment twice a month using a sensitive balance. The lengths were also measured using a ruler at the beginning of the experiment and twice a month. After the end of the experiment, the fish were dissected, and the length of the intestines was measured for all treatments.

**Studied Traits**

**Weight gain:** It can be extracted from the following equation (Schmalhausen, 1926):

$$\text{Weight gain} = \text{Final body weight} - \text{initial body weight}$$

**Daily growth rate**: It can be extracted from the following law(Schmalhausen, 1926):

$$\text{Daily growth rate (DGR)} = \frac{\text{final body weight}(\frac{gm}{day}) - \text{initial body weight}\frac{gm}{day}}{\text{Expermint period}}$$

**Relative Growth Rate:** It can be extracted from the following law(Utne, 1978):

$$\text{Relative growth rate (RGR) \%} = \frac{\text{final body weight}(\frac{gm}{day}) - \text{initial body weight}\frac{gm}{day}}{\text{Experiment period}} \times 100$$

**Specific growth rate (SGR)**: It can be extracted from the following law(Brown, 1957):

$$\text{Specific growth rate(SGR)\%} = \frac{\text{(Ln (final body weight)} \, {}^{gm}/_{fish} - \text{Ln (initial body weight)} \, {}^{gm}/_{fish}}{\text{Experiment period}} \times 100$$

**Food Conversion Efficiency (FCE):** It can be extracted from the following equation (Utne, 1978):

$$\text{Food Conversion Efficiency(FCE) \%} = \frac{\text{gain weight}(\frac{gm}{fish})}{\text{Food eaten}} \times 100$$

## Statically analysis

Normality and homogeneity were analyzed, then all data were analyzed by one-way ANOVA test. The probability level of 5% ($P < 0.05$) was selected to show the statistical difference. Statistical analysis was carried out to rank the five groups using the SPSS 26.0(IBM, Chicago, IL, USA) (Al-Hadraawy et al., 2022; Medhat and Aljanabay, 2022; Aljanaby et al., 2022).

## Results and Discussion

### A-Weight gain and daily growth rate

The results of the current study show that the highest average values of weight of fish recorded (15.83) gm in the first treatment during the forty-fifth day and the lowest average values was (0.55) gm in the second treatment during the fourteenth day from the beginning of the experiment. The statistical analysis shows significant differences between treatments (P value < 0.05) but no significant differences were found (P value> 0.05) between days and treatments (Figure 1 and Table 2). The highest average values of weight gain of fish was (15.83) gm in the first treatment and the lowest average values was (0.1) gm in the fourth treatment. The statistical analysis did not show any significant differences (P value > 0.05) (Table 3). Meanwhile, the highest average values of daily growth weight in fish was (0.35) gm in the first treatment and the lowest average values was (0.002) gm in the fourth treatment. The statistical analysis did not show any significant differences (P value > 0.05) (Table 3). The results of the current study show superiority of the first treatment in both the quantitative weight gain and daily growth rate. It may be due to the effect of plant components, which lead to the tearing of the plant cell wall and the dissolution of the lignocellulose bond between the lignin, cellulose and hemicellulose, and make the food item more digestible. Also, the *E. crassipes* plant may contain a useful protein source supported by amino acids and good protein supplements in the fish diet (Hontiveros and Serrano, 2015). The results of the current study agree with those of (Lee et al., 2016).

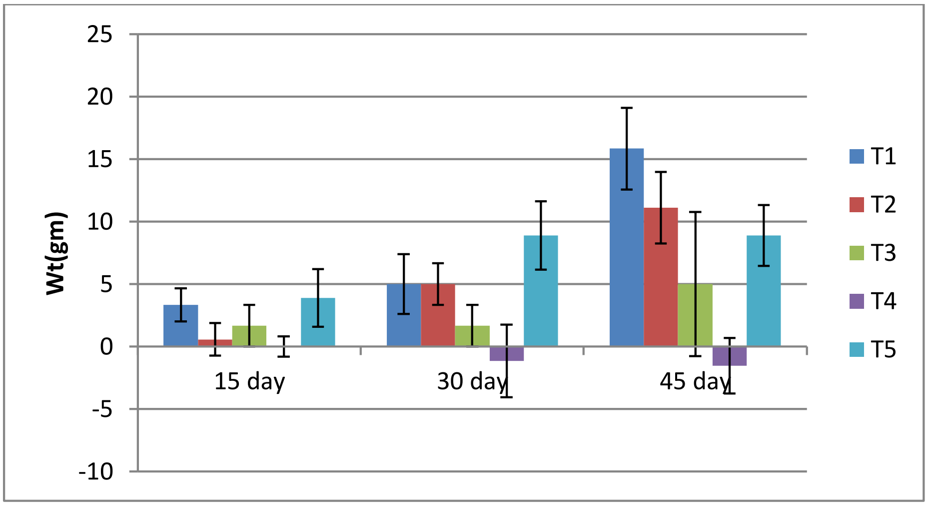


Figure 1. Mean weight of carp fish after being treated with different concentrations of *Eichhornia crassipes* meal with SE

Table 2
ANOVA test for weight of fish during experiment period( P-value >0.05 =0.054 for interference treatment and days, P-value >0.05 =0.085 for days and P-value <0.05 =0.007 for treatment)

| Tests of Between-Subjects Effects | | | | | |
|---|---|---|---|---|---|
| Dependent Variable: Weight gain | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 951.807[a] | 14 | 67.986 | 2.904 | .007 |
| Intercept | 841.422 | 1 | 841.422 | 35.940 | .000 |
| T | 410.258 | 4 | 102.564 | 4.381 | .007 |
| D | 125.465 | 2 | 62.732 | 2.680 | .085 |
| T * D | 416.084 | 8 | 52.011 | 2.222 | .054 |
| Error | 702.351 | 30 | 23.412 | | |
| Total | 2495.579 | 45 | | | |
| Corrected Total | 1654.158 | 44 | | | |
| a. R Squared = .575 (Adjusted R Squared = .377) | | | | | |

**A- Specific growth rate (SGR) and (RGR)**

The results of the current study show that the highest average values of SGR of fish recorded (9.8) % in the first treatment and the lowest average values was (8) % in the third treatment. The highest average values of RGR of fish recorded (22.34) % in the first treatment and the lowest average values was (0.22) % in the fourth treatment. The statistical analysis did not show any significant differences (P value> 0.05) between treatments, (Table 3). The highest average values of Food Conversion Efficiency was (8.79) % in the first treatment and the lowest average values was (0.05) % in the fourth treatment (Table 3). The reason for the increase in the relative and qualitative growth in the first treatment compared to the rest of the treatments may be due to the presence of a balanced proportion of the nutritional value, especially the nitrogen compounds and amino acids in the plant, thus increasing the utilization of them as food for animals (Hassan, 2004).

Table 3
Mean of Daily growth rate, Weight gain, Relative growth%, Efficiency feed and SGR of Carp fish that feed to *Eichhornia crassipes* meal

| Treatment | Pretest | after 15 day | after 30 day | after 45 day | Daily growth rate | Weight gain | Relative growth% | Food Conversion Efficiency | SGR |
|---|---|---|---|---|---|---|---|---|---|
| T1 | 70.8 | 74.1 | 75.83 | 86.6 | 0.35 | 15.83 | 22.34 | 8.79 | 9.8 |
| T2 | 51.6 | 49.4 | 55 | 60 | 0.18 | 8.36 | 16.2 | 4.64 | 8.9 |
| T3 | 35 | 36.6 | 36.6 | 40 | 0.11 | 5 | 14.28 | 2.7 | 8 |
| T4 | 47.3 | 47.8 | 47.01 | 47.4 | 0.002 | 0.1 | 0.22 | 0.05 | 8.3 |
| T5 | 61.6 | 64.8 | 71.01 | 70 | 0.18 | 8.36 | 13.5 | 4.64 | 9.3 |
| P.value0.05 | | | | | 0.13 | 0.13 | | | |

**A- Length of Fish**

The length-weight relationship is significant for measuring fish average weight and assessing the relative well-being of fish population (BilikisIyabo and John, 2021) .The results of the current study showed increment in the length of carp fish similar to the weight gain. The highest values of length gain was (0.96) cm, recorded in the first treatment during 45 days, and the lowest values recorded (0.01) in the fourth treatment during 15th days (Figure 2). The statistical analysis did not show any significant differences (P value > 0.05) between days and treatment but significant differences were found in days only (Table 4). In previous studies, it was indicated that the fish increases faster in length than in weight (BilikisIyabo and John, 2021). The results of the current study agree with (Miranda et al., 2006; Abowei et al., 2009)

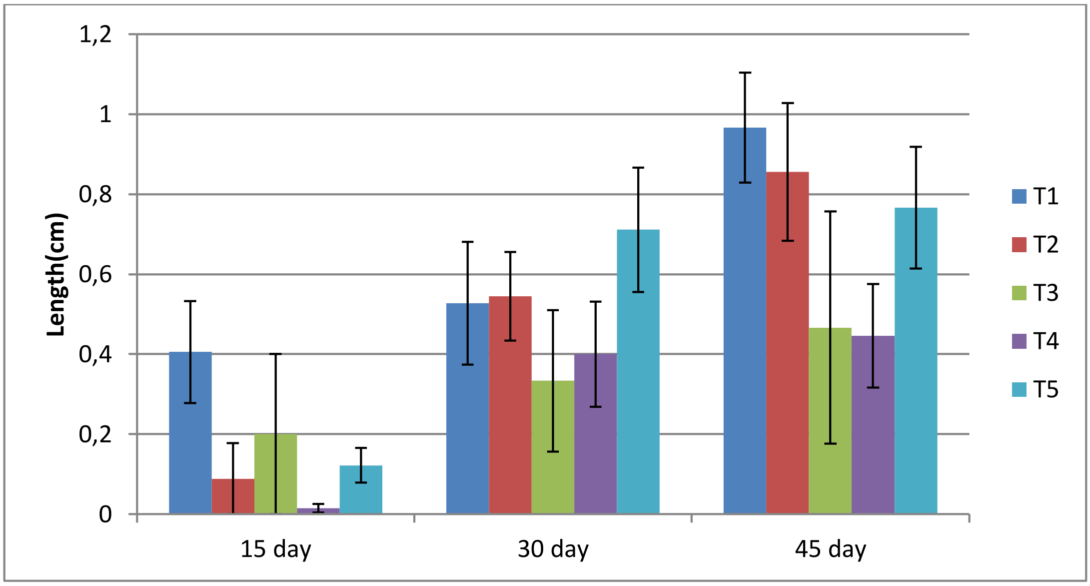


Figure 2. Mean Length of carp fish after being treated with different concentrations of *Eichhornia crassipes meal with SE.*

Table 4
ANOVA test for length of fish during experiment period ( P.value >0.05 =0.8 for interference treatment and days , P.value <0.05 =0.00 for days and P.value >0.05 =0.11 for treatment)

| Tests of Between-Subjects Effects | | | | | |
|---|---|---|---|---|---|
| Dependent Variable: length gain | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 3.090[a] | 14 | .221 | 2.579 | .014 |
| Intercept | 8.760 | 1 | 8.760 | 102.373 | .000 |
| T | .690 | 4 | .172 | 2.016 | .118 |
| D | 2.019 | 2 | 1.010 | 11.798 | .000 |
| T * D | .381 | 8 | .048 | .556 | .805 |
| Error | 2.567 | 30 | .086 | | |
| Total | 14.417 | 45 | | | |
| Corrected Total | 5.657 | 44 | | | |
| a. R Squared = .546 (Adjusted R Squared = .334) | | | | | |

**A- The rate length of intestine**

The results of the current study show that the intestines length of carp fish with the highest rate value was (33.3 cm) in the first treatment and the lowest rate value recorded was (26.06 cm) in the control treatment. The statistical analysis did not record any significant differences between treatment (P value > 0.05), (Figure 3). A strong relationship was found between intestine length (GL) and total length (TL) of fish (significant relationships (P < 0.05) (r=0.80) (Figure 4). Herbivores have longer digestive tracts than higher-trophic-level animals, a trend that is assumed to reflect a trade-off between digestive efficiency and tissue maintenance costs (Wagner et al., 2009). The overall quality of an animal's diet is influenced by the nutritional content, energy content, and digestibility of food resources; however, their relative influences on intestinal length are difficult to distinguish (Wagner et al., 2009). Differential digestibility of food resources may have played a role in intestinal length variation. Plant-eating fishes appear to have longer intestines than fish that eat industrial feed and are in nearly the same trophic level (Figure 3).

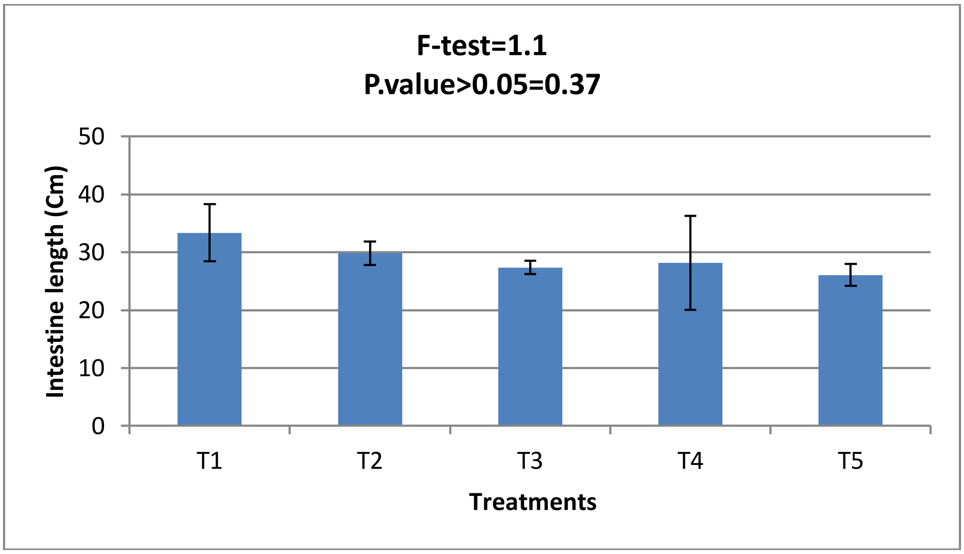


Figure 3. Mean intestine length of carp fish that feed on *Eichhornia crassipes* meal with SD±

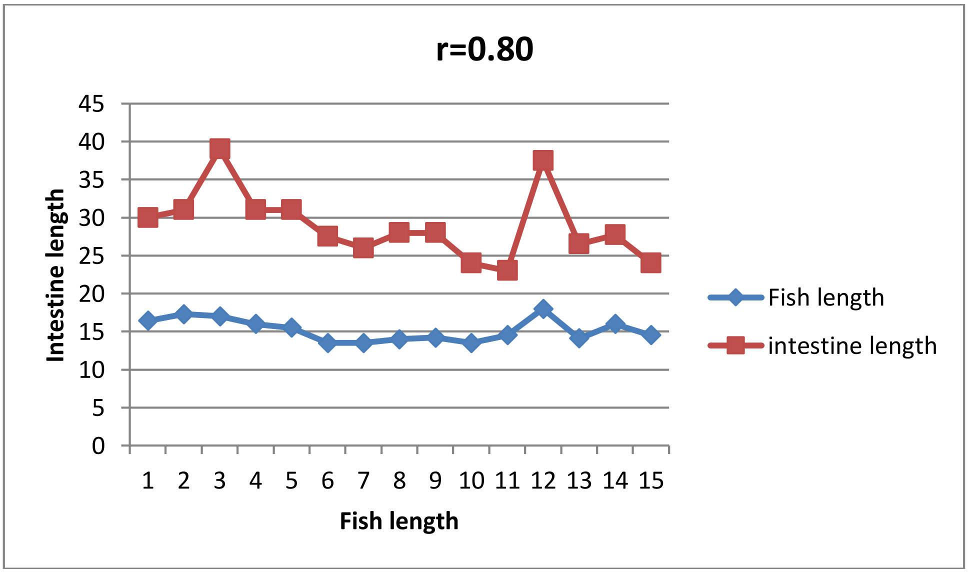


Figure 4. Mean intestine length and length of carp fish that feed on *Eichhornia crassipes* meal

## Conclusions

The results of the current study indicate that the best concentration for partial replacement of *Eichhornia crassipes* powder at 25%. Therefore, it is recommended to use proportions of less than 25% of fish meal with *Eichhornia crassipes* flour to obtain the best nutritional value when manufacturing.

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