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# Incorporation of Water Hyacinth (*Eichhornia crassipes)* in Feed for Developing Eco-friendly Low Cost Feed of Mirror Carp, *Cyprinus carpio* var. *specularis* (Linnaeus, 1758)

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**Abstract—***This study was conducted to develop low cost eco-friendly feed incorporation with water hyacinth, Eichhornia crassipes meal, and to evaluate the effects on growth performance and production economy of mirror carp, Cyprinus carpio var. specularis aquaculture. Mirror carp at average weight of 21.34±0.17 g were fed with three different experimental diets with 0% water hyacinth meal (WH0 diet), 15% (WH15 diet) and 25% (WH25 diet) for 12 weeks in six different experimental ponds. Fish were fed two times daily at a rate of 4% of their body weight during the entire experimental period. The water quality parameters of the experimental ponds were monitored every 2 weeks interval. The water quality parameters were found at acceptable limit. The result indicated that growth performance tended to decrease with increase in inclusion level of water hyacinth meal. The weight gain and specific growth rate (SGR %,bwd/day) were significantly higher (P<0.05) in fish groups fed WH0 and WH15 diets than WH25 group. Also, the feed conversion ratio (FCR) was significantly higher in fish group fed WH25 diet than fish groups fed WH0 and WH15 diets. The fish groups fed WH0 and WH15 diets had no significant difference in weight gain (WG), SGR and FCR. The production was found significantly higher in WH0 fish group than other groups. However, the cost benefit ratio (CBR) was found significantly higher in WH15 (15% water hyacinths meal based diet) fish group than other groups. Analysis of proximate composition of the whole fish fed with different diets did not show any significant difference (P>0.05). The cost of feed production decreased as the incorporation level of water hyacinth increased. Result indicated that incorporation of 15% water hyacinth meal in a diet was the best as a practical diet of mirror carp for reducing feed cost and increasing profit.*

**Keywords***: Water hyacinth, growth, economics, mirror carp*

## 1. INTRODUCTION

Aquaculture has emerged as a fast-growing enterprise for fish production. A major determinant of successful growth of aquaculture depends on aqua feed. The aqua feed cost is a crucial problem for profitable aquaculture. Fish feed generally constitutes 60–70% of the operational cost in intensive and semi-intensive aquaculture system [1]. The under supply and high cost of conventional pelleted fish feed has severely constrained the development of low-cost aquaculture system. There is a need for the development of eco friendly fish feed which can influence the production quality fish.

The most successful alternatives can be the ingredients of plant origin due to their global availability and favorable price and the fact that their nutritional properties can satisfy the nutritional requirements of the fish. Considering the importance of nutritionally balanced and cost-effective alternative diets for fish, research efforts are essential to evaluate the nutritive value of different non-conventional feed resources, including terrestrial and aquatic macrophytes. Locally available selected macrophytes have been experimented as alternative food sources, which can be used for preparation of feed [2]. Water hyacinth can be used as animal feed as well as fish feed because it is a good source of nutrient. The nutritive value of water hyacinth and its usefulness as animal feed have reported by many workers [3,4]. The water hyacinth (*Eichhornia crassipes*) is a large, free-floating, available tropical aquatic plant. The dry matter contains between 10 and 26 % of crude protein, fiber level about 20% and a good content of vitamin and mineral [5]. Mirror carp (*Cyprinus carpio* var. *specularis*) is a freshwater exotic fish which is found all over the world. Its rapid growth, tasty flesh, good reproductive ability and food habit have lead to the carps becoming the stable fish of warm water fisheries [6]. Some works on using water hyacinth as feed ingredient and its effect on the growth as well as production have been studied [7,8,9]. But, this had not been standardized to be recommended at farmer's level for commercial production. Therefore, this study aims to evaluate modifications in nutrient supply of fish by the incorporation of water hyacinths with

fish feed and minimizing the feed cost as well as increase profitability.

## 2. MATERIALS AND METHODS

### Experiment setup

The experiment was conducted in the experimental ponds under three treatments each with two replications at the Department of Fisheries, University of Rajshahi, Rajshahi, Bangladesh for a period of 12 weeks. A total of six experimental ponds of 1 decimal (deci) were used for the trials.

### Management of experimental pond

All undesirable fish were completely eradicated by drying of the pond. Aquatic weeds were removed manually. Liming was done at a rate of 1 kg/deci. The ponds were fertilized with cow dung 5 kg/deci, urea-150 g/deci. and TSP75 g/deci.

### Experiment fish

*Cyprinus carpio* var. *specularis* (mirror carp) was selected for the present experiment. A total number of 300 fingerlings of weight 21.34g were purchased from Meherchandry Fish Farm, near Rajshahi University area. The fingerlings were starved overnight, then randomly sorted, weighted and stocked into the experimental ponds at the rate of 50 (fifty) fingerlings per ponds. They were acclimatized for one week in that pond fed the control diet. Each experiment treatment was duplicated. The ponds were monitored for fish mortality daily. Dead fish were removed, counted and recorded for determination of survival rate.

### Management of experimental pond

All undesirable fish were completely eradicated by sun drying of the pond. The aquatic weeds were removed manually. Liming was done at a rate of 1 kg/deci. The ponds were fertilized with cow dung 8 kg/decimal, urea-150 g/deci. and TSP 75 g/deci.

### Experimental diets

Three experimental diets were formulated by the incorporation of water hyacinth meal at the level of 0% (WH0) $T_1$, Control diet), 15% (WH15) $T_2$ and 25% (WH25) $T_3$. The ingredient compositions of the experimental diets are shown in Table 1.The experimental diets were formulated based on protein content of the major ingredients. The feeds were formulated using Microsoft Excel software balancing of protein and lipid. The ingredients were thoroughly mixed and pelleted wet using kitchen hand crancker pelletizer. The pelleted dough were collected in flat trays and crushed into crumbs with hand. Then the diets were sun-dried to constant weight after which the feeds were then stored in plastic bags at 4$^{o}$C temperature.

**Table 1: The ingredient compositions of the experimental diets**

| Ingredients | Diets | | |
|---|---|---|---|
| | WH0 ($T_1$) | WH15($T_2$) | WH25($T_3$) |
| Meat and bone meal | 22.0 | 22.0 | 17.0 |
| Mastered oil cake | 20.0 | 20.0 | 25.0 |
| Maize bran | 10.0 | 10.0 | 10.0 |
| Rice bran | 40.0 | 25.0 | 15.0 |
| *Eichhornia* meal | 0.0 | 15.0 | 25.0 |
| NaCl | 3.0 | 2.0 | 2.0 |
| Vitamin premix | 5.0 | 5.0 | 5.0 |
| Vitamin-E | 0.0 | 1.0 | 1.0 |
| **Total** | **100** | **100** | **100** |

### Proximate analysis of the experimental diets and fish carcass

Different chemical compositions of feeds and fish muscle such as crude protein, lipid, carbohydrate, ash Crude fiber and moisture contents were measured according to Association of Official Analytical Chemists (AOAC, 2003). The proximate compositions of experimental diets are shown in Table 2.

**Table 2: Proximate composition of the experimental diets (% dry basis)**

| Parameters | Diets | | |
|---|---|---|---|
| | WH0 ($T_1$) | WH15($T_2$) | WH25($T_3$) |
| Moisture (%) | 13.79 | 15.29 | 15.14 |
| Crude lipid (%) | 6.60 | 8.20 | 7.40 |
| Crude protein (%) | 25.80 | 25.20 | 24.05 |
| Ash (%) | 13.22 | 13.96 | 16.26 |
| Crude fiber (%) | 6.20 | 5.80 | 6.15 |
| Carbohydrate (%) | 34.39 | 31.55 | 31.00 |

### Feeding of fish

The fingerlings were fed twice daily (between 8.30-9.00hr and 16.00-17.00hr). Fish were initially fed at a rate of 5% of their body weight and further reduced at the level 4% (from 5th week). The quantity of feed was adjusted based on the new weekly weight of fish.

### Monitoring of water quality parameter

Water transference, temperature, pH, dissolved oxygen (DO) and total alkalinity were monitored fortnightly as water quality parameters. Water transparency was measured by a secchi disc. Water temperature was recorded by Celsius thermometer. The pH was measured by a direct reading pH meter (HACH). Dissolved oxygen (DO) was determined by the Winkler's titration method (APHA, 1976). Total alkalinity was determined by test kit (HACH kit model FF-2, made in USA).

### Sampling of Fish

Fishes were sampled monthly by using seine net to assess their growth and health condition. At least 10 fish from each pond were taken to make assessment of growth trends. Weight of

the sampled fish was measured using a measuring scale and digital electronic balance (OHAUS, MODEL no.CT-1200-5). Fishes were handled carefully to avoid stress during sampling.

**Analysis of growth performance of fish**

Fishes were harvested manually after pond drying from each pond. To evaluate the growth performance, weight gain, specific growth rate (SGR), food conversion ratio (FCR), survival rate, production of fish were monitored with following formulae.

The mean weight gain = Mean final weight gain - Mean initial weight gain,

Specific Growth Rate (SGR) = $L_n$(final weight)- $L_n$(final weight)/ Culture period (Days)×100

Food conversion ratio (FCR) = **Feed fed in dry weight /Live weight gain**

Survival rate (%) = No of fish harvested /No. of fish stocked× 100

Production of fishes = No. of fish harvested × final weight of fish.

**Economic analysis**

A simple economic analysis was done to estimate the economic return. Data of both fixed and variable cost were recorded to determine the total cost (BDT/ha). Total returns were determined from the market price of fish and expressed as BDT/ha. Net benefit was calculated by deducing the total return from total cost and was expressed as BDT/ha. Cost benefit ratio (CBR) was calculated:

**Statistical analysis**

For the statistical analysis of data, one-way analysis of variance (ANOVA) was performed using a software SPSS (Statistical Package for Social Science, evaluation version-15.0). Significance was assigned at the 0.05% level. The mean values were also compared to see the significance through DMRT (Duncan Multiple Range Test).

## 3. RESULTS AND DISCURSION

**Water quality**

The mean values of water quality in different treatments are presented in Table 3. No significant different was found for the mean values of all the water quality parameter. This statement is agreed with the temperature to be ranged from 20.5-36.5°C [10]. This statement is also more or less agreed with the temperature to be ranged found by other researchers [11,12].

**Table 3: Variations in the mean values of physico-chemical parameters of water**

| Parameters | Treatments | | |
|---|---|---|---|
| | WH0 ($T_1$) | WH15($T_2$) | WH25($T_3$) |
| Temperature (°C) | 32.57±0.68[a] | 32.43±0.72[a] | 32.47±0.81[a] |
| Transparency (cm) | 34.88±3.57[a] | 31.67±3.13[a] | 32.56±3.88[a] |
| DO (mg/l) | 5.05±0.41[a] | 5.07±0.30[a] | 5.18±0.33[a] |
| pH | 7.69±0.06[a] | 7.71±0.07[a] | 7.77±0.08[a] |
| Alkalinity (mg/l) | 132.81±0.49[a] | 129.91±0.13[a] | 132.31±0.32[a] |

*Figures in a row bearing common letters do not differ significantly (P<0.05).

The measured secchi depth readings between 26 to 50 cm[13].The pH values ranging from 6.5 to 9.0 were observed suitable for pond fish culture according to Swingle [14]. This statement is also more or less agreed with pH values to be ranged found by other researchers[11,12]. This statement is agreed with the DO level from 2.2 to 7.1 mg/1 in ponds [13]. The study on pond ecology and stated that the values of total alkalinity from 71 to 175 mg/l is suitable for fish culture [14].

**Growth performance**

The three experimental diets fed to the fingerlings for a period of 12weeks were well accepted and utilized for growth. The diets with water hyacinths meal were also well accepted by the catfish fingerlings[9]. The calculated values of growth parameter are shown in Table 4. The average final weights were 123.63±6.98, 115.10±7.25 and 107.68±5.95 in $T_1$, $T_2$ and $T_3$ respectively. The mean weight gain was 102.48±8.89, 93.63±7.94 and 86.28±6.73 in $T_1$, $T_2$ and $T_3$ respectively. The calculated mean SGR of the fish in $T_1$, $T_2$ and $T_3$ were 2.54±0.29, 2.42±0.26 and 2.30±0.24, respectively which varied significantly among treatments. The mean values of FCR of the fish in $T_1$, $T_2$, and $T_3$ were 1.71±0.01, 1.73±0.01 and 2.03±0.02 respectively. The survival rate of the fish varied between 91.25±0.67 ($T_2$) to 90.00±0.33 ($T_1$ & $T_2$). This study demonstrated that the three incorporation level of water hyacinth meal supported the growth for mirror carp (*Cyprinus carpio* var. *specularis*). Thus, incorporation level up to 25% water hyacinth meal in formulated diet did not exert any adverse effect on growth performance of mirror carp. Growth performance of mirror carp fed with 0%, 15% and 25% water hyacinth shows that there was a decreasing trend with increasing level of water hyacinth meal in the feed from 15% to 25% incorporation. Also no significant difference in growth performance of *Labeo rohita* was noticed with increasing level of raw *Eichhornia* leaf meal[8].

**Table 4: Growth performance of the fish**

| Parameters | Treatments | | |
|---|---|---|---|
| | WH0 ($T_1$) | WH15($T_2$) | WH25($T_3$) |
| Mean initial weight (g) | 21.15±3.7[a] | 21.48±3.8[a] | 21.40±3.5[a] |
| Final weight (g) | 123.63±6.9[a] | 115.10±7.2[b] | 107.68±5.9[c] |

| | | | |
|---|---|---|---|
| Weight gain (g) | 102.48±8.8[a] | 93.63±7.9[b] | 86.28±6.7[c] |
| SGR (%, bwd-1) | 2.54±0.2[a] | 2.42±0.2[b] | 2.30±0.2[c] |
| FCR | 1.71±0.01[b] | 1.73±0.01[b] | 2.03±0.02[a] |
| Survival rate (%) | 90.00±0.33[b] | 91.25±0.67[a] | 90.00±0.1[b] |
| Production (kg/ha/84d) | 2,198.63±12[a] | 2,075.36±11[b] | 1,914±9.5[c] |

The other study found SGR was similar [16]. Also upto 30% use of water hyacinth Meal was not affected in SGR with Red Tilapia [17] and with cat fish (*Clarias gariepinus*) [9]. The lower value of the FCR was better the feed utilization. FCR value of 0% and 15% incorporation of water hyacinth meal respectively do not differ significantly. Higher FCR was found for 25% inclusion of water hyacinth meal. The lower FCR of 0% and 15% incorporation of water hyacinth meal indicates that fish can easily digest the feed and convert these feed into their body mass. The tested value of FCR showed a lower magnitude indicating an encouraging effect on economic involvement in fish farming. It was found 2.35±0.06 FCR by the inclusion of water hyacinth dust at the rate of 47% in the feed for Nile tilapia (*Oreochromis niloticus*) [18]. Also up to 30% inoculation of water hyacinth fed with cat fish (*Clarias gariepinus*) was not affected in FCR[9].

The highest survival rate was found in 15% inclusion of water hyacinth meal (91%). The 100% survival was found with red tilapia[17] and cat fish l[20].. Also 67% survivality of common carp[19].

**Proximate composition**

Proximate composition of whole fish after 84 days rearing were found to be ranged from moisture content 77.19±0.089 ($T_1$) to 78.29±0.28 ($T_3$) %, crude lipid content 4.16±0.37 ($T_3$) to 4.49±0.023 %, ($T_1$), crude protein content 13.41±0.023 ($T_1$) to 13.82±0.035% ($T_2$), ash content 2.94±0.02 ($T_2$) to 3.56±0.029% ($T_1$), carbohydrate content 0.50±0.170 ($T_2$) to 1.34±0.020% ($T_1$). This results followed by study fed cat fish [20].

**Table 6: Proximate composition of fish muscle**

| Parameters | Treatments | | |
|---|---|---|---|
| | WH0 ($T_1$) | WH15($T_2$) | WH25($T_3$) |
| Moisture | 77.19±0.089[c] | 77.79±0.018[b] | 78.29±0.28[a] |
| Crude lipid | 4.49±0.023[a] | 4.39±0.026[b] | 4.16±0.37[c] |
| Crude protein | 13.41±0.023[c] | 13.82±0.035[a] | 13.79±0.020[b] |
| Ash | 3.56±0.029[a] | 2.94±0.02[c] | 3.17±0.017[b] |
| Carbohydrate | 1.34±0.020[a] | 0.50±0.170[c] | 0.75±0.020[b] |

*Figures in a row bearing common letters do not differ significantly (P<0.05).

**Cost benefit ratio (CBR)**

The total cost, net profit and CBR significantly varied among the treatments which are shown in Table 5. CBR of the study were found 0.64±0.04, 0.76±0.03 and 0 .53±0.04 with the treatment WH0, WH15 and WH25 diets respectively. A good result was also found in CBR where the water hyacinth meal based diet fed with cat fish (*Clarias gariepinus*) [9].

**Table 5: Cost (BDT) of inputs and economic returns from the sale of fish (based on 1 ha pond)**

| Parameters | Treatments | | |
|---|---|---|---|
| | WH0 | WH15 | WH25 |
| Pond preparation | 20,000±00[a] | 20,000±00[a] | 20,000±00[a] |
| Cost of fry | 91,291±00[a] | 91,291±00[a] | 91,291±00[a] |
| Feed cost | 86,450±12[a] | 60,515±106[b] | 51,870±88[c] |
| Operational cost | 17,000±00[a] | 17,000±00[a] | 17,000±00[a] |
| Total cost | 2,14,741±41[a] | 1,88,806±35[b] | 1,80,161±25[c] |
| Total income | 3,51,781±47[a] | 3,32,058.±45[b] | 3,06,396±43[c] |
| Net profit | 1,37,040±17[b] | 1,43,252±19[a] | 1,26,235±13[c] |
| CBR | 0.64±0.04[b] | 0.76±0.03 [a] | 0.53±0.04 [c] |

* Figures in a row bearing common letters do not differ significantly (P<0.05).

This aquaculture utilization will promotes sustainable aquaculture in Nigeria and helps in the control of the nuisance water hyacinth report from the wild [21].

## 4. CONCLUSION

The present study revealed that 15% water hyacinth meal feed would be optimum for the maximum growth of *Cyprinus carpio* var. *specularis*. Further, such aquatic weed based feeds are cheaper as compared to the conventional feeds, supplementation of aquatic weeds in carp diets would also prove economically viable.

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