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Utilization of water hyacinth (*Eichhornia crassipes*) meal as partial fish protein Replacement in the diet of *Cyprinus carpio* fry

Sashi Bhushan Mohapatra

Department of Zoology, Banki Autonomous College, Banki, Cuttack, Odisha, India

ABSTRACT

The aim of this work was to determine the possibilities of substituting plant protein ingredients for fish meal in compound artificial diets in rearing of common carp fry, *Cyprinus carpio* L. Inclusion of water hyacinth, *Eichhornia* at different levels (0%, 10%, 20%, 30% and 40%) in place of fish meal were prepared to feed the fry. The acceptable nutritional value of water hyacinth as an ingredient in diets for fry was experimented under aquarium culture system at 5% of the body weight twice daily morning and evening for 70 days. The different inclusion levels of water hyacinth supported the growth of *Cyprinus carpio* fry but growth performance decreases as the level of water hyacinth increases. It was observed that weight gain growth rate was favoured by low inclusion of water hyacinth meal. There was no significant difference ($P \leq 0.05$) between the weights gains recorded for the fish fed all the experimental diets. Although fishmeal is non replaceable but can be supplemented with water hyacinth up to an optimum level to produce cost effective feed for the growth performance of *Cyprinus carpio*. The results showed that a diet consisting of up to 40% content could be used as a replacement for fish meal in diet formulation for common carp fry.

Keywords: Water hyacinth, Feed ingredients, fish meal, growth performance, *Cyprinus carpio*.

INTRODUCTION

In recent decades, global aquaculture has been the fastest growing food production sector. The most common aquaculture products are freshwater, omnivorous fish, most of which come from the cyprinid family. For the past several years, one of the main directions in improving fish feeds has been the search for protein source alternatives to fish meal and determining their nutritional suitability in diets [1]. This trend is, firstly, a response to growing demands for formulated diets, and secondly, a response to limited resources of fish meal that will soon hit the upper threshold of exploitation. Additionally, according to [2] one of methods to develop less expensive and effective formulations is lowering fish meal levels in diets.

The high cost and undersupply of conventional pelleted fish feed has sternly forced the development of low-cost suitable fish feed in aquaculture system for small-scale farmers in the developing world [3, 4]. Water hyacinth (*Eichhornia crassipes*) remains the world's most important aquatic weed. It is spreading at an alarming rate in many tropical and sub-tropical countries and is a major problem in the Indian subcontinent. Water hyacinth is a potential ingredient in farm-mixed feeds for the farming of herbivorous or omnivorous freshwater fish in simple farming

systems where it is available at low cost. Considerable research has been dedicated to investigate the use of water hyacinth in fish feeding [5].

(Hertrampf and Piedad-Pascal 2000[6] suggested inclusion rates for water hyacinth in farm-mixed feeds for the farming of herbivorous or omnivorous freshwater fish in simple farming systems where it is available at low cost. These authors recommended that suitable inclusion levels were either 25-50 percent as a supplementation of basic feed (e.g. rice bran, broken rice, chicken manure) or 5-10 percent as a replacement protein source in formulated feeds (fish meal, vegetable oil meals/cake). The nutritive value of water hyacinth and its usefulness as animal feed weed have been reported [7,8]. Increased of plant protein feedstuffs in fish diets will reduce feed cost and assist in reducing dependence on fish meal as fish protein feedstuff source [9].

The common carp has been one of the oldest domesticated species of fish for food[10]. The choice of *Cyprinus carpio* is necessary in this study because of its remarkable fast growth rate. It is highly esteemed and command very high commercial value in the markets due to its ability to adapt readily to poor conditions, fast growth rate, acceptability and high conversion of artificial feeds, tolerance to crowded conditions and high quality of its flesh. *Cyprinus carpio* has the ability to survive under various climatic conditions and is found to be most suitable for many farming system [11]

This study is aimed at determining the best replacement level, acceptance of cheap feeds meal with water hyacinth meal that will favour the growth of *Cyprinus carpio* and economical viable to the fish farmers.

MATERIALS AND METHODS

Experimental fish:

The rationale of selection of *Cyprinus carpio* for the present experiment was that it has excellent growth rate, easy availability wide distribution, commercial importance etc. It is tolerant and hardy fish for better survival in a wide variety of aquatic habitats. Its seed has been high demand by the aqua-farmers for variety of purposes such as monoculture and polyculture. In view of consistent demand for fry and fingerlings, studies were therefore undertaken in aquaria and ponds.

A total number of 200 common carp fry (weight range 1.20-1.30g) were obtained from government fish feed hatchery and maintained in laboratory under optimum conditions on the feed supplement containing rice bran and groundnut oil cake in order to habituate them for artificial feeding. During the entire 70 days experimental period the fry were fed with a formulated experimental diet @5% of body weight twice daily. Each group of fish were weighed every 10th day and the quantity of feed given was adjusted accordingly.

Experimental diets:

The present experiment was undertaken to utilize the aquatic weeds and trash fish to prepare the experimental diet. The ingredients, i.e. Mustard oil cake, Wheat flour, Soybean, Fish meal and *Eichhornia* were procured from local area and were dried and grinded to powder form. Five diets were formulated in which fish meal was replaced with *Eichhornia* meal at 0%, 10%, 20%, 30% and 40% levels. The diets were fortified with vitamins and salt.

Experimental Procedure:

The feeding trial was conducted in 12 glass aquaria and duplicate tanks were used for dieting treatment. The glass aquaria were properly washed and rinsed with clean water. The working dimension of each aquarium was 60x40x45 cm³. The water was filled with borehole water and aerated using air pumps to ensure proper oxygenation and continual aeration. The common carp fry of average body weight were distributed in to 12 groups of 20 fish each group. Water quality was monitored every 10th day for temperature, pH, dissolved oxygen and total alkalinity through the methods [12]. The study was carried out for 70 days. At the end of the experiment all the fish from different treatments were harvested, weighed individually and yield calculated and measured to assess the performance of fish.

Analytical Procedures and Water Quality Assessment:

The dry matter, protein and ash, content of the diets were analyzed [13] dry matter after drying in an oven at 104°C until constant weight; ash content by incineration in a muffle furnace at 600°C for 24 h; crude protein by the Kjeldahl method. Total lipid content was determined by chloroform/methanol extraction[14]. Growth performance,

feed utilization, was all subjected to ANOVA to determine if significant differences occurred among the dietary treatments. Water temperature and dissolved oxygen were measured daily using a combined digital YSI-52 model oxygen meter, and pH was monitored weekly using an electronic pH meter (Lutron-206 model).

Table: 1 Percentage composition of experimental feed of *Eichhornia*

Ingredients	Percentage inclusion of <i>Eichhornia</i>				
	0%	10%	20%	30%	40%
<i>Eichhornia</i>	0	5.12	10.24	15.36	20.48
Fish meal	42.28	37.16	32.04	26.92	21.80
Mustard oil cake	25.00	25.00	25.00	25.00	25.00
Wheat flour	15.80	15.80	15.80	15.80	15.80
Soybean	15.42	15.42	15.42	15.42	15.42
Vitamin	1.0	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0	100.0

Table: 2 Proximate Composition of Experimental diet of *Eichhornia*

<i>Eichhornia</i> feed	% crude protein	% crude lipid	% Ash	% Moisture	% crude fiber
<i>Eichhornia</i>	16.50	2.2	17.00	3.30	16.54
Fish meal	51.12	8.50	21.30	1.10	1.20
0%	38.78	6.5	8.07	5.82	4.98
10%	37.60	5.82	8.52	6.68	4.54
20%	36.84	5.61	9.08	7.47	4.82
30%	36.14	5.34	10.35	8.58	5.26
40%	35.38	4.87	10.96	9.56	5.86

Table: 3 Growth performance of common carp fry fed *Eichhornia* meal based diet for 70 days.(±SE)

Parameters	0%	10%	20%	30%	40%
Initial mean weight (g/fish)	1.30 ±0.12	1.28 ±0.11	1.20 ±0.09	1.20 ±0.09	1.30 ±0.12
Final mean weight (g/fish)	5.06 ±0.024	4.85 ±0.21	4.75 ±0.21	4.51 ±0.18	4.38 ±0.17
Mean weight gain (g/fish)	3.76 ±0.16	3.57 ±0.15	3.55 ±0.15	3.31 ±0.14	3.08 ±0.14
Relative weight gain %	289.21 ±2.67	278.93 ±2.64	295.82 ±2.74	275.82 ±2.64	236.93 ±2.48
Mean daily weight gain (g/day/fish)	0.054 ±0.001	0.051 ±0.001	0.050 ±0.001	0.047 ±0.001	0.044 ±0.001
Specific growth rate (% fish/day)	0.84 ±0.048	0.64 ±0.046	0.67 ±0.46	0.63 ±0.045	0.54 ±0.044
Feed Conversion Ratio	3.39 ±0.15	3.46 ±0.16	3.30 ±0.15	3.37 ±0.15	3.56 ±0.16
Gross Efficiency Conversion rate%	29.50 ±1.64	28.90 ±1.58	30.30 ±1.66	29.67 ±1.67	28.10 ±1.51
Protein Efficiency Rate	0.80 ±0.047	0.80 ±0.047	0.83 ±0.048	0.76 ±0.046	0.78 ±0.047
Protein productive value	0.438 ±0.028	0.457 ±0.029	0.478 ±0.031	0.499 ±0.032	0.506 ±0.034
Survival %	80.0	85.0	85.0	85.0	85.0

RESULTS

The results pertaining to various feed ingredients of experimental diets at different % level of inclusion include *Eichhornia*, Fishmeal, Mustard oil cake, Wheat flour, Soybean, Vitamin, and Salt are depicted in Table-1. The compound experimental diets were analyzed for proximate composition and the values are recorded in Table-2. The fish meal was replaced by 0%, 10%, 20%, 30% and 40% *Eichhornia*. The percentage of crude protein, crude lipid, ash, moisture and crude fibers in the formulated fish diet were ranged from 35.38-38.78%, 4.87-6.5%, 8.07-10.96%, 5.82-9.56% and 4.98-5.86% respectively. The highest percentage of crude protein (38.78%) was recorded at 0% replacement of *Eichhornia* feed and the least (35.38%) was at 40% replacement. The growth Performance of *Cyprinus carpio* fry, fed with different feed ingredients is represented in Table-3. Weight gain increase was recorded in all the experimental treatments containing different amount of *Eichhornia*. The result showed that the highest mean weight gain of 3.76 g was recorded in fish fed 0% *Eichhornia* supplemented diets followed by 10% (Figure 1). The result also revealed that daily weight gain and specific growth rate were highest in control but subsequently decrease (Figure 2 and 3). The result of the Feed Conversion Rate, Gross Feed Conversion Efficiency and Protein Efficiency Rate ranged between 3.30 – 3.56, 28.10 – 30.30% and 0.76 – 0.83 respectively. In addition, the higher survival rates were obtained in groups that were fed experimental diets contains different level of *Eichhornia* supplemented diets than control.

Fish fry fed actively in all dietary groups of experimental diets. There was no rejection of feed until the end of the experiment. More or less the acceptability of the diets was similar.

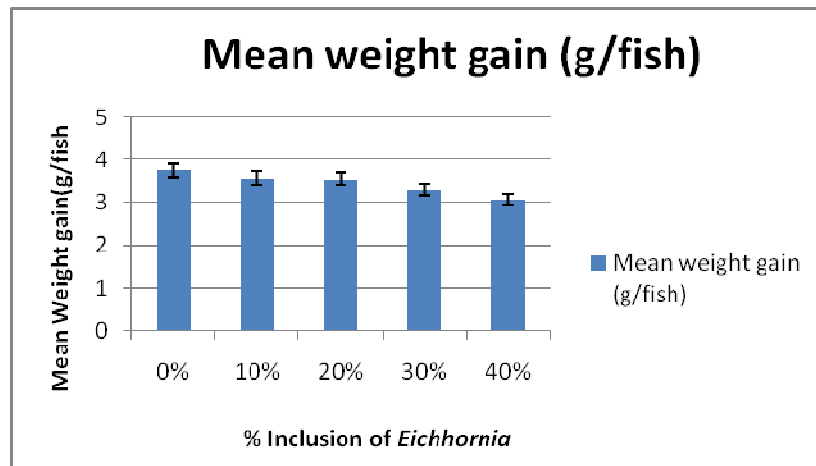


Fig.1 Mean weight gain (g) of carp fry fed with % inclusion of *Eichhornia* based diet (\pm SE)

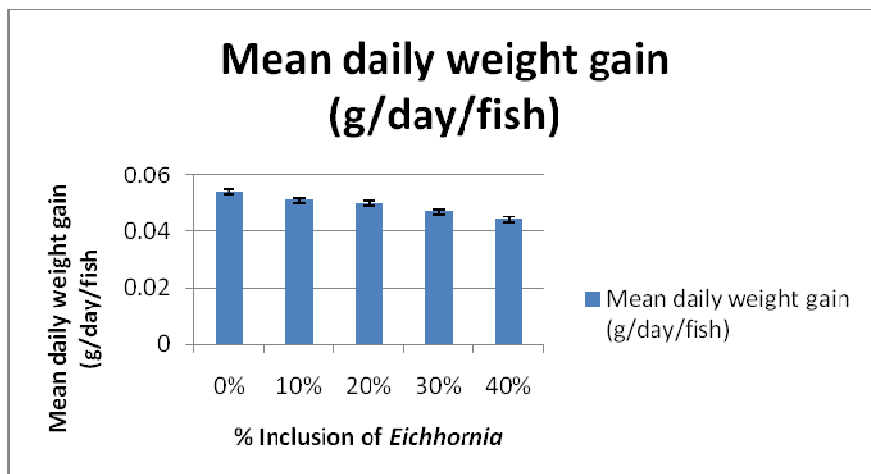


Fig.2 Mean daily weight gain (g) of carp fry fed with % inclusion of *Eichhornia* based diet (\pm SE)

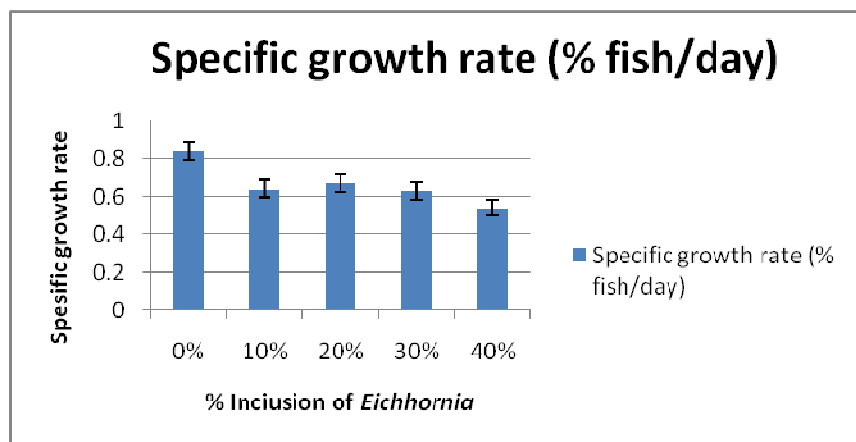


Fig.3 Specific growth rate of carp fry fed with % inclusion of *Eichhornia* based diet (\pm SE)

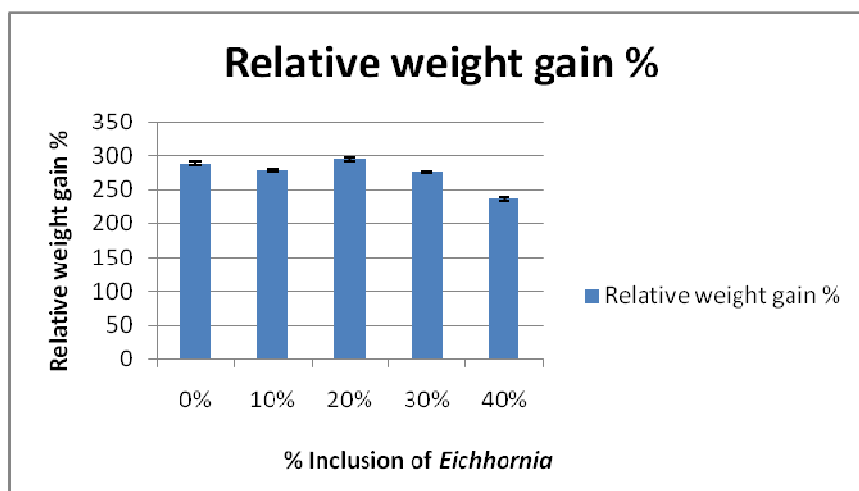


Fig.4 Relative weight gain % of carp fry fed with % inclusion of *Eichhornia* based diet (\pm SE)

DISCUSSION

The present study demonstrated the acceptable nutritional value of *Eichhornia* meal as an ingredient in diets for fry of *Cyprinus carpio*, since this product can replace the most commonly used fish feed ingredient, fish meal up to a certain level. Inclusion of *Eichhornia* meal in compound diets for fry of *Cyprinus carpio* may therefore be a function of diet formulation. An inclusion level up to 40% *Eichhornia* leaf meal in the practical diet for *Cyprinus* did not exert any adverse effect on growth, feed utilization efficiencies. *Eichhornia* significantly increases the crude fibre content of the feeds. This probably affected the food conversion ratio and the feed utilization by the fry. High fibre in feed plays a significant role in digestion of feed [15]. No doubt, animal protein is essential for the growth of carp, plant protein has no less importance for the same cause. There is no significant difference ($P < 0.05$) between the growths of fry fed diets containing 0% - 40% water hyacinth meal. This infers that inclusion of water hyacinth up to 40% significantly improved growth in *Cyprinus carpio*.

In this study, there is a tendency of reduction in growth rate when plant protein fishmeal was increased as a protein source for preparation of artificial feed, but the effects are not significant. Similar results have been reported in the experiment mentioned before [16, 17] where significant effects of replacements were not observed up to a certain level. It is apparent from the results of the present study that fry fed with 0% inclusion of *Eichhornia* meal showed better growth performance which was not significantly different ($P < 0.05$) from the other inclusion of the *Eichhornia* diet. Total replacement of high quality fish protein is difficult for the preparation of artificial diets. However, partial replacement could be possible by inclusion of plant based protein [18, 19, 20 and 21].

From the experiment, this concludes that inclusion of *Eichhornia* up to 40% significantly enhanced growth in *Cyprinus carpio*. The fish fry reared with high % of *Eichhornia* meal show higher feed conversion ratio (FCR) must have been due to the outcome of the negative impact of the anti-nutritional factors there in proteins of plant based ingredients. The factors like anti-nutrients and fibres have poor digestibility properties as a result these impair growth and feed utilization by fish [22, 23]. There is a positive correlation ($r = 0.625$, $P < 0.05$) marked among Protein Efficiency Rate (PER) with total weight gain computed for the experimental diets. It was also observed that fry fed with the water hyacinth supplemented diets showed high survival rate. The findings not only provide optimal growth performance of fry but also suggest partial replacement of animal protein up to 40% in carp may be advantageous and would lead to a reduction in feed costs.

The *Eichhornia* feed at 45% replacement exhibited significant impact on the growth performance of the common carp fry (Mohapatra and Patra, 2013b).

CONCLUSION

Studies have been carried out on the development of new feed formulation for carps in fresh water aquaculture system. Efforts are now being directed in different parts of the globe to find alternate protein sources of good quality

without affecting adverse effect on growth performance of fish. The experiments conclude that the high quality of fishmeal proteins makes substitution difficult. However, partial substitution of *Eichhornia* meal up to 40% can be possible for the maximum growth of *Cyprinus carpio* (L.). 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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