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RESEARCH ARTICLE

EVALUATION OF DUCKWEED (*Lemna minor*) MEAL AS PARTIAL REPLACEMENT FOR FISH MEAL ON THE GROWTH PERFORMANCE OF INDIAN MAJOR CARP, *Cirrhinus mrigala* fry

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ABSTRACT

An experiment was conducted under Laboratory culture conditions for 120days to evaluate the nutritional values and acceptability of *Lemna minor* as component in the diets of *Cirrhinus mrigala* fry. By replacing fish meal with *Lemna minor* at 0%, 15%, 30% and 45% inclusion levels, four different fish feeds comprising of *Lemna*, fish meal, GNOC(Groundnut Oil Cake), rice bran, soybean, salt and vitamin were used to formulate compound diets. The fries were fed twice daily, morning and evening at 5% body weight. The three inclusion levels of duckweed supported the growth of *Cirrhinus mrigala* fry but growth performances weight gain and growth rate was favoured by low inclusion of duckweed meal. However, highest body weight gain (%) was recorded in the group of fish fed diet (0% inclusion of duckweed) which was not significantly different ($P<0.05$) from 15% level inclusion of duckweed. On the basis of the findings, the study revealed that although fish fry fed diet of 15% duckweed dietary inclusion performs best result but fish meal was completely non-replaceable however, can be supplemented with duckweed up to an optimum level to produce cost effective feed.

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INTRODUCTION

The whole nutritional requirements of fish depend mainly on the availability of suitable diets which provide required nutrients for optimum growth. The carrying capacity of culture system is known to be increased by supplementary feeding and thus enhanced fish production by many folds (Mohapatra and Patra, 2013a). *Cirrhinus mrigala* belongs to the family Cyprinidae and is very common in rivers and freshwater lakes of South Asia and South-East Asia (Patra, 2015b). Among all Indian major carps, *Cirrhinus mrigala* is the most popular and delicious food fish and highly rich in protein. On the other hand, duckweeds are the world's smallest angiosperms, faster growing and simplest of flowering plant, usually reproduce by budding and multiply very quickly (Patra, 2015a). Further, duckweed acts as model system for different experiments due to their minute size, ability to rapid growth to form genetically uniform clones, easy handling and high sensitivity to organic and inorganic substance (Faskin *et al.,* 2001, Scherr *et al.,* 2008, Ahamad *et al.,* 2003, Mohapatra and Patra, 2013a). The present study deals with duck weed (*Lemna minor*) as model plant to determine optimum inclusion level of the leaf meal in formulated feed of *Cirrhinus mrigala* and to examine the growth performance of the same in various levels of inclusion and also discussed in terms of different feed ingredients with and without supplemented fish meal.

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MATERIALS AND METHODS

Experimental_Fish: The Indian major carp, *Cirrhinus mrigala (*Hamilton) is one of the oldest cultured species of fish for food. The rational of selection of this fish is that it has excellent growth rate, commercially valued, high survivality and good taste with rich in protein. Healthy fish frys were procured from State Government Fish feed hatchery and were maintained in glass aquaria for 21days acclimatization on the feed supplement of rice bran and groundnut oil cake (GNOC) in order to habituate these fry for artificial feeding under laboratory condition. During experimental period of 120days, the fish frys were fed with formulated artificial diet (5% of body weight/day). The growth of frys were monitored after every 15 days and evaluated the increase in body weight. There ratio was readjusted twice daily. Experimental Diets: An attempt was made to utilize the duckweed and trash fish dried and grinded to fine powder form along with rice bran, GNOC, soybean produced from local area for artificial feed preparation. Four different dry diets were prepared in which only fish meal was replaced with duckweeds at 0%, 15%, 30%, 45% levels. All the diets were fortified with vitamins and salt

(Patra and Ray, 1988, Mohapatra and Patra, 2013 (a, b), Patra, 2015b). Experimental Procedure: The experiment was conducted in 12 fibre glass tanks in triplicate for each dietary treatment. The experimental dimension of each aquarium was 60×40×45 cm. A total of 300 numbers of *Cirrhinus mrigala* frys with mean body weight of 1.80 ± 0.24g were distributed into 30 groups of 10 fries in each group. The experiment was carried out for 120 days (Patra, 2015a). Certain physiochemical parameters such as temperature, pH, DO, total alkalinity etc were analysed as per methods outlined by Jhingran (1991) and APHA (2005 Panda *et al*., 2012) and monitored regularly. Water samples from all the aquaria were also taken on fortnightly basis to record the changes in physiochemical parameters and their mean values were calculated on monthly basis. Statistical analysis: The observed data was programmed by analysis of variance (ANOVA) using Microsoft statistic followed by Duncan's multiple range test (Duncan, 1955 and Mohapatra and Patra, 2013b).

RESULTS AND DISCUSSION

In the past few decades, fish feeds from aquatic plant origin have been found to be successful for Indian major carps due to high performance body growth rate (Mohapatra and Patra, 2014 and Patra, 2015) which is as good as incurred from traditional feed. Incorporation of *Lemna minor* feed (popularly known as duckweed meal) to replace the fish meal in formulated fish feed can be best attributed to achieve the goal for formation of cost-effective fish feed.

In the present experimental set up, mainly the three inclusion levels of duckweed prepared feed supported the growth for *Cirrhinus mrigala* (Table 1 and 2). However, body growth performance was favoured by optimum inclusion levels of duckweed meal in experimental feed (Table 3). The trash fish meal was replaced by 0%, 15%, 30% and 45% *Lemna* feed. The highest percentage of crude protein (40.55%) was recorded at 0% replacement of *Lemna* feed and the least (33.76%) was at 45% replacement. A decreasing trend in growth performance was noticed with increasing level of *Lemna* feed from 15%-45% replacement (Table 3, 4). It had also been observed that the growth performance of Indian major carp, *Cirrhinus mrigala* in 0% replacement was more than 15% replacement of *Lemna* feed so far as protein content in respect of replacement was concerned. It is though evident that animal protein is essential for growth of cultured fish, plant protein has no less importance for the same purpose. Perhaps, because of that reason the *Lemna* feed at 15% replacement showed significantly higher impact($P<0.05$) in comparison to other three treatments on the growth performance of *Cirrhinus mrigala* (Table 3, Fig.1, 2, 3, 4). Feeds from plant origin have an excellent amino acid profile and have been reported to be highly effective and less expensive ingredient for formulation of fish diets (Jackson *et al.,* 1982, Mohapatra and Patra, 2013a, Mohapatra and Patra, 2014). To formulate a low cost feed, ingredients from plant and animal sources are used to fulfil the protein need of the fish meal, fully or partially.

Table 1. Percentage composition of Experimental feed *Lemna minor*

	Percentage Inclusion OF *Lemna minor*			
INGRIDIENTS	0%	15%	30%	45%
Lemna minor	0	3.9	7.8	11.9
Trash Fish Meal	25.4	21.5	17.6	13.5
Soyabean	20.0	20.0	20.0	20.0
Groundnut Oil Cake(GNOC)	30.0	30.0	30.0	30.0
Rice bran	23.0	23.0	23.0	23.0
Vitamins	1.0	1.0	1.0	1.0
Salt	0.6	0.6	0.6	0.6
TOTAL	100.0	100.0	100.0	100.0

Table 2. Proximate Chemical Composition of Experimental feed of *Lemna minor*

Lemna Feed Meal	% Crude Protein	% Crude Lipid	% Ash	% Moisture	% Crude Fibre
0%	40.55	8.7	13.4	2.4	4.6
15%	39.08	6.9	12.6	1.4	4.3
30%	35.76	6.3	11.1	1.1	3.9
45%	33.76	6.1	10.6	1.6	5.2

Table 3. Growth Performance of Major Carp Fry Fed with *Lemna minor* meal based feed for 120 Days (±SE)

PARAMETERS	0%	15%	30%	45%
Initial Weight(gm)	1.74 ± 0.21	1.65 ± 0.17	1.59 ± 0.14	1.50 ± 0.15
Final Weight (gm)	15.41 ± 0.84	14.75 ± 0.51	12.92 ± 0.42	11.11 ± 0.43
Total Weight Gain (gm)	13.67 ± 0.55	13.10 ± 0.34	11.33 ± 0.29	9.61 ± 0.29
Growth Rate (gm/day)	0.106 ± 0.03	0.099 ± 0.01	0.092 ± 0.04	0.078 ± 0.04
% Survival	87	82	69	63

Table 4. Monthly Variations (Mean) of Physicochemical Parameters of Water in Experimental Aquaria

Water Parameters	1st Month	2nd Month	3rd Month	Mean(±SE)
P^H	8.3 ± 0.4	8.1 ± 0.3	8.3 ± 0.2	8.2 ± 0.4
Water Temperature(^{0}c)	27.6 ± 2.4	27.0 ± 2.3	27.1 ± 2.4	27.3 ± 2.4
DO (mgl ^{1})	7.5 ± 0.7	7.4 ± 0.5	7.5 ± 0.6	7.3 ± 0.5
Total Alkalinity (mgl ^{1})	56.3 ± 3.3	54.6 ± 3.5	55.5 ± 3.3	56.3 ± 3.4
Total Hand rest (mgl ^{1})	5.6 ± 0.3	5.3 ± 0.4	5.2 ± 0.1	5.3 ± 0.3
Chloride (mgl ^{1})	0.7 ± 0.02	0.6 ± 0.04	0.6 ± 0.03	0.6 ± 0.05
Sodium (mgl ^{1})	7.5 ± 0.5	7.4 ± 0.03	7.1 ± 0.02	7.2 ± 0.03

The inter-relationship between the dietary energy requirement and the growth of fish and the importance of proper protein nutrition has been well established. Thus, fish nutritionists pay greater attention to reduce the cost of artificial diets by introducing alternative protein sources from plant and animal (Das *et al.,* 1991, Patra, 2015a). This result is similar to the report of several authors who have demonstrated the use of several species of duckweed as partial replacement for fish meal in the routine diet of fish and other animals. Faskin *et al*. (2001) reported the use of duck weed *Spirodella polyrrhiza* in the diet of the Nile Tilapia (*Oreochromis miloticus*) Yilmaz *et al*. (2005) also observed no weight difference when 20% duckweed meal substituted for commercial fish meal in common carp (*Cyprinous carpio*). Guru and Patra, (2007) reported that protein content of *Lemna minor* was estimated to be the highest incomparision to *Eichhornia crassipes* and *Pistia stratiotes*. It is to be noted from the present findings that fingerlings of *Cirrhinus mrigala* fed with formulated *Lemna minor* leaf meal grow more in width than in length, thus incorporating more flesh to the fingerlings. Apart from this, survival rate was found to be 75-80% in this case.

It was also observed by Liang and Lovel (1971), Pattanaik and Patra (2012) and Patra (2015a) that the most favourable use of water hyacinth and duckweed as a supplement to vitamin deficient diet at the rate of 5%-10% increased growth and reduced mortality of the fingerlings of eat fish. The significances of qualitative and quantitative feeds are well recognised by Mohapatra and Patra (2013b) and the level of dietary protein is of fundamental importance because it greatly influences growth, survival and yield of fish (Yilmaz et.al., 2005 and Patra 2015a). The present findings strongly support to the findings of above authors who have reported the successful use of several species of duckweed as partial replacement of fish meal in the diet of fish and other animals for better growth orientation. However, the complete replacement of fish meal with duckweed meal is not favourable for fish production (Faskin *et al*., 2001, Yilmaz *et al*., 2005, Tavares *et al*., 2008, Mohapatra and Patra, 2013b and Patra, 2015a).

Conclusion

This is strongly supported by the present author. Finally, conclusion could be drawn that fish fed diet with 15% duckweed meal performs excellently well compared to other treatments. Further aquatic weed based feeds are cheaper as well as simpler compared to other conventional and commercial available in the market. Furthermore, this *Lemna* based fish feed the most demandable for Indian major carp (*Cirrhinus mrigala*) diet would also prove economically viable.

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