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# Evaluation of the duckweed (*Lemna minor*) meal as partial replacement for fish meal on the growth performance of *Labeo rohita* (Ham.) fry

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**ABSTRACT**

*An experiment of 120 days was conducted to evaluate the nutritional quality and acceptability of Lemna minor meal as component in the diets of Labeo rohita fry under laboratory culture condition. Four different feeds comprising of Lemna, fish meal, GNOC, ricebran, soyabean, salt and vitamin were used to formulate compound diets by replacing fish meal with Lemna at 0%, 15%, 30% and 45% inclusion levels of Lemna minor. The frys were fed at 5% body weight twice daily, morning and evening. The three inclusion levels of duckweed supported the growth of Labeo rohita fry but growth performance, 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 duck weed) which was not significantly different ($p<0.05$) from 15% level inclusion of duckweed. On the basis of the findings, the study showed that fish fry fed diet of 15% duckweed dietary inclusion performs best result and fish meal was completely non-replaceable but can be supplemented with duckweed up to an optimum level to produce cost effective feed.*

**Key words:** Duckweed, feed ingredients, fish meal, growth performance, *Labeo rohita.*

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## INTRODUCTION

Feed represents the single largest input in aquaculture production. At present both protein and energy rich conventional dietary ingredients are of short supply. Therefore, there is a need to incorporate unexplored unconventional locally available cheaper feed stuffs in fish feeds. To reduce the dependence on animal based protein in fish diet, plant based protean food stuffs are used to decrease artificial fish meal cost [1].

*Labeo rohita* belongs to the family cyprinidae and is common in rivers and freshwater lakes of South Asia and South- East Asia [2]. Among all Indian major carps, *L. rohita* is the most popular and delicious food fish in Asia and rich in protein content. On the other hand, duck weeds are the world's smallest angiosperms, faster growing and simplest of flowering plants, usually reproduce by budding and multiply very quickly [3]. Further duck weed acts as model system for different experiments due to their minute sizes, ability to rapid growth to form genetically uniform clones, easy handling and high sensitivity to organic and inorganic substances [4]. *Lemna* sp. are widely used as a model plant both for treatment of waste water [5,6] and for partial replacement of fish meal on the growth performance of Indian major carp [7,8].

In the present study, duckweed (*Lemna minor*) is used as model plant to determine optimum inclusion level of the leaf meal in formulated feed of *Labeo rohita* and 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.

## MATERIALS AND METHODS

### Experimental Fish

The rationale of selection of Indian major carp, *Labeo rohita* (Haml. 1822) was that it has excellent growth rate, commercially important, better survivality and highly tasty and rich in protein as well. In view of consistent demand for fry, fingerlings and young ones, studies were therefore undertaken in aquaria under laboratory condition. Healthy frys were collected from State Govt. fish feed hatchery and were kept in glass aquaria for 21days acclimatization on the feed supplement of rice bran and groundnut oil cake (GNOC) in order to habituate them for artificial feeding. Therefore, during experimental period of 120days, the fish frys were fed with formulated artificial diet (5% of body wt/day). The wt. of frys were monitored after every 15days and based on the increase in body wt. their ration was readjusted twice daily.

### Experimental diets

An attempt has been made to utilize the duck weed (*Lemna minor*) and trash fish for artificial feed preparation along with dried and grinded to fine powder form, rice bran, GNOC, soyabin produced from local area. Four dry diets were prepared in which only fish meal was replaced with duck weeds at 0%, 15%, 30% and 45% levels. The diets were fortified with vitamins and salt [9].

### Experimental Procedure

The experiment was carried out in 12 fiber glass tanks in triplicate for each dietary treatment. The experimental dimension of each aquarium was 60x40x45cm$^3$. A total of 360 nos. of *Labeo rohita* fry with mean body weight of 1.75± 0.23g distributed into 30 groups of 12 fry in each group. The experiment was conducted for 120days. Certain mean water quality parameters such as temperature, pH, DO, total alkalinity etc. were analyzed as per methods outlined by [10] and monitored daily. Water samples from all the aquaria were also taken on fortnightly basis to record the changes in physicochemical factors and their mean values were calculated on monthly basis.

### Statistical analysis

The observed date was programmed by analysis of variance (ANOVA) using microsoft software statistic followed by Duncan's multiple range test [11,12].

## RESULTS

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 [13,14]. 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 [1] which is as good as incurred from traditional feed. In tropical countries, where algal production rates are high, algae have been receiving increasing attention as an alternate protein possessing relatively high protein content (50-65%) which may be incorporated in balanced fish feeds [15].

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 of formation of cost-effective fish feed. In the present study, the three inclusion levels of duck weeds is experimental feed supported the growth for *Labeo rohita* (Ham). However, growth performance was favoured by optimum inclusion levels of duck weed meal in the experimental feed (Table-1).

**Table:- 1 Percentage Composition of Experimental feed *Lemna minor.***

| Ingredients | Percentage Inclusion of *Lemna minor* | | | |
|---|---|---|---|---|
| | 0% | 15% | 30% | 45% |
| *Lemna minor* | 0 | 3.8 | 7.9 | 11.8 |
| Trash fish meal | 25.5 | 22.7 | 18.6 | 14.7 |
| Soybean | 20.0 | 20.0 | 20.0 | 20.0 |
| Groundnunt oil cake (GNOC) | 30.0 | 30.0 | 30.0 | 30.0 |
| Rice bran | 23.0 | 23.0 | 23.0 | 23.0 |
| Vitamin | 1.0 | 1.0 | 1.0 | 1.0 |
| Salt | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

The ingredients of proximate composition of experimental diet includes (i) *Lemna*, (ii) Fish meal, (iii) Soyabean, (iv) Groundnut oil cake, (v) Rice bran, (vi) Vitamin and (vii) Salt at different proportions of *Lemna* meal (Table-2).

**Table: 2 Proximate Composition of Experimental feed of *Lemna minor***

| Lemna feed | % Crude Protein | % Crude Lipid | %Ash | %Moisture | %Crude |
|---|---|---|---|---|---|
| 0% | 40.45 | 8.7 | 13.5 | 2.5 | 4.5 |
| 15% | 39.05 | 6.5 | 12.5 | 1.3 | 4.2 |
| 30% | 35.75 | 6.2 | 11.0 | 1.1 | 4.0 |
| 45% | 33.86 | 6.0 | 10.5 | 1.5 | 5.3 |

The fish meal was replaced by 0%, 15%, 30%, and 45% Lemna feed. The highest percentage of crude protein (40. 45%) was recorded at 0% replacement of *Lemna* feed and the least (33.86%) was at 45% replacement.

A decreasing trend in growth performance was noticed with increasing level of *Lemna* feed from 15% to 45% replacement (Table-3,4).

**Table :3- Growth performance of major carp fry fed *Lemna minor* meal based feed for 120days (±SE)**

| Parameters | 0% | 15% | 30% | 45% |
|---|---|---|---|---|
| Initial weight (g) | 1.75±0.23 | 1.63±0.15 | 1.59±0.13 | 1.51±0.15 |
| Final wt (g) | 15.45±0.81 | 14.65±0.53 | 12.91±0.45 | 11.12±0.42 |
| Total wt. gain (g) | 13.70±0.55 | 13.02±0.41 | 11.32±0.37 | 9.61±0.31 |
| Growth rate (g/day) | 0.105±0.02 | 0.099±0.01 | 0.091±0.03 | 0.079±0.02 |
| % survival | 85 | 80 | 68 | 65 |

It has also been observed that the growth performance of Indian major carp *Labeo rohita* in 0% replacement was more than 15% replacement of *Lemna* feed so far as protein content in respective replacement was concerned. Although, animal protein is essential for growth of major carp, plant protein has no less importance for the same purpose. Perhaps, because of that reason the *Lemna* feed at 15% replacement has proved significantly higher impact ($P<0.05$) in comparision to other three treatments on the growth performance of the Indian major carp (Table-3, Fig,1,2,3,4).

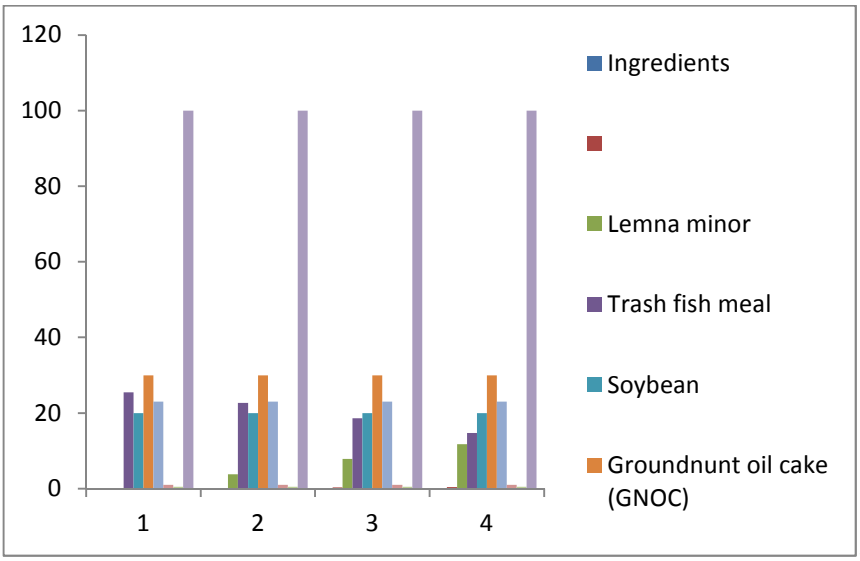



**Fig.1Percentage Composition of Experimental feed *Lemna minor***

**Table 4 Monthly variations (Mean) of physicochemical parameters of experimental aquaria**

| Parameters | 1st month | 2nd month | 3rd month | Mean |
|---|---|---|---|---|
| PH | 8.1±0.5 | 8.0±0.3 | 8.2±0.1 | 8.1±0.3 |
| Water Temp. | 27.5±23 | 27.0±2.5 | 27.1±2.2 | 27.2±2.3 |
| $DO_2$ (Mgl-1) | 7.1±0.8 | 7.0±0.5 | 7.2±0.2 | 7.1±0.5 |
| Total alkalimity (mgl-1) | 56.5±3.5 | 55.6±3.4 | 56.2±3.6 | 56.1±3.5 |
| Total hardness(mgl-1) | 5.5±0.5 | 5.1±0.3 | 5.0±0.1 | 5.2±0.4 |
| Chlorine (mgl-1) | 0.6±0.05 | 0.6±0.05 | 0.6±0.05 | 0.6±0.05 |
| Sodium (mgl-1) | 7.50.6±0.050.8 | 7.30.6±0.050.5 | 7.10.6±0.02 | 7.3±0.5 |
| TDS (mgl-1) | 75±0.3 | 76±0.4 | 77±02 | 76±0.3 |

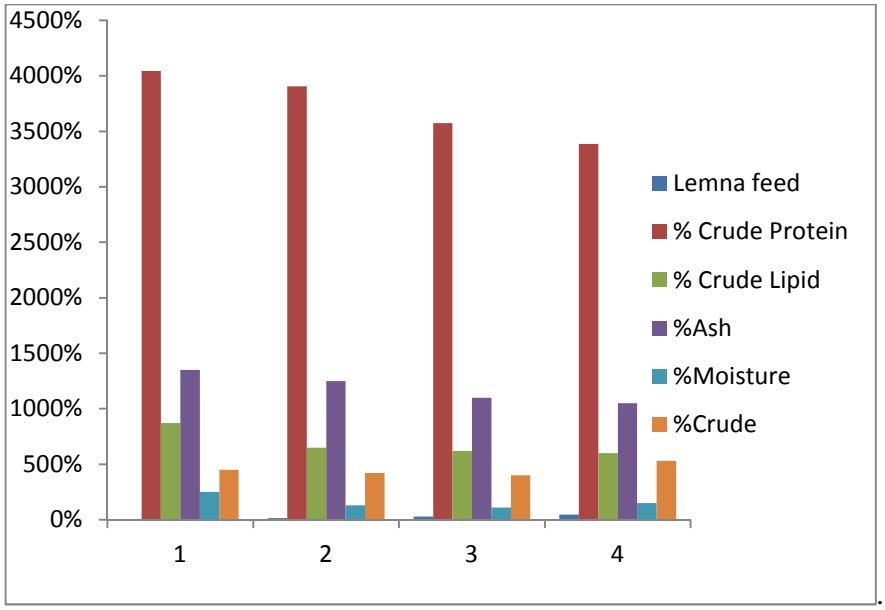
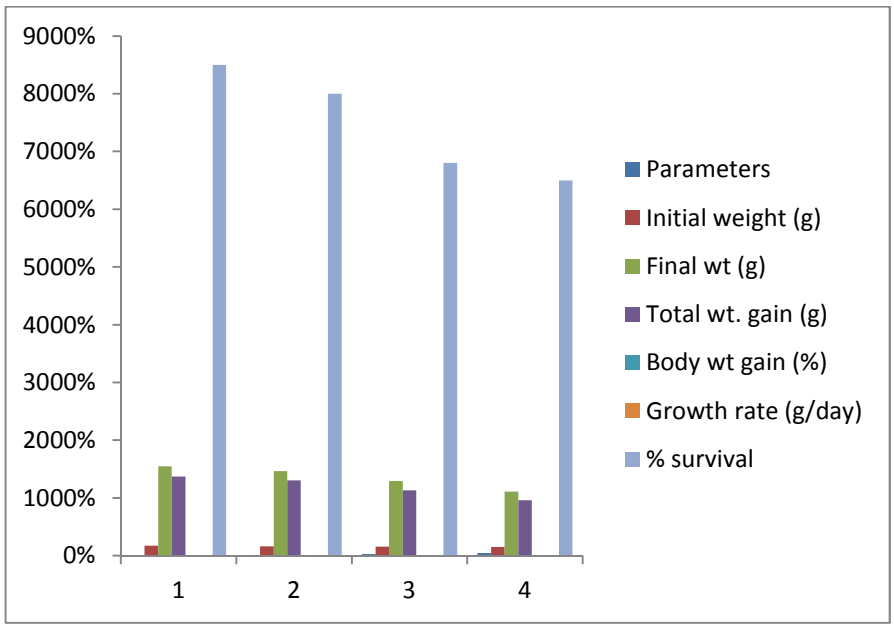



**Fig. 2 Proximate Composition of Experimental feed of *Lemna minor***




Highest gain in body weight (%) was recorded in the group of fish fed diet (0% level of inclusion of *Lemna*) which was not significantly different ($P<0.05$) from the 15% level of inclusion of the same. (Fig.2). The percentage of survival rate was highest (85%) at 0% and lowest at (65%) *Lemna* replacement fish meal.

**Fig. 3- Growth performance of major carp fry fed *Lemna minor* meal based feed for 120days (±SE)**

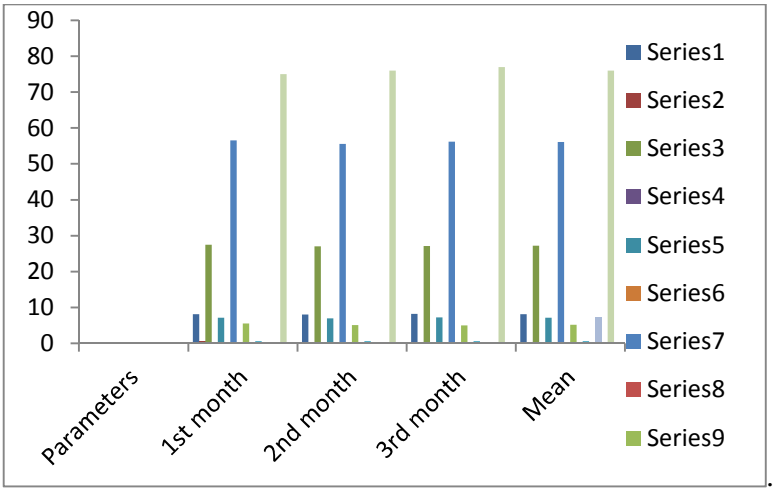



**Fig.4 Monthly variations (Mean) of Physicochemical parameters of experimental aquaria**

*Note : Temp: Temperature, $Do_2$- Dissolved oxygen, TDS-Total dissolved solid*

## DISCUSSION

[16,17] revealed that 30% formulated *Lemna minor* leaf meal incorporated in diet of *Clarias batrachus* fingerlings gave best performance in terms of growth response, food conversion ratio and protein efficiency. In contrast, present observation, 0% to 15% leaf meal diet had the best specific growth rate and food conversion ratio. [7] reported that partial replacement of the costly sesame oil seed by cheaper unconventional duckweed in broiler diet result high profit. Feeds from plant origin have excellent amino acid profile and reported to be effective and less expensive ingredients for formulation of artificial fish diets [13]. For the past several years, one of the main directions in improving fish feeds has been the search of protein source alternative to fish meal and determining their nutrient stability in diets [12]. In the past few decades, feeds from plant origin have been accepted for Indian major carps because the body growth observed has been reported to be as good as that obtained with the traditional feed. In tropical countries, where algal production rates are high, algae have been receiving increasing attention as an alternative protein possessing relatively high protein content (50-60%), which may be regarded as balanced fish feeds [12,18]. The present study demonstrated that the inclusion level of duck weeds experimental feed supported the growth for *L.rohita*. [19] reported that protein content of *Lemna minor* was estimated to be the highest in comparison to *Eichhornia crassipes* and *Pistia stratiotes*. It is to be noted in this study that fingerlings of *Labeo rohita* fed with formulated *Lemna monor* leaf meal grew more in width than in length, thus incorporating more flash to the fingerlings. Apart from this, survival rate was found to be 80-85% in this case. It was also observed by [20] and [21] that the most favorable use of water hyacinth and duck weed as a supplement to vitamin deficient diet at the rate of 5% to 10% increases growth and reduce mortality of the fingerlings of cat fish. The significance of qualitative and quantitative feeds is well recognized by [12] and the level of dietary protein is of fundamental importance, because it significantly influences growth, survival and yield of fish [12,22]. The present findings are similar to the report of above authors who have reported the use of several species of duckweed as partial replacement for fish meal in the diet of fish and other animals.

However, the complete replacement of fish meal with duckweed is detrimental to fish production [12,22,23 and 24]. This is strongly supported by the present author.

## CONCLUSION

The study clearly showed that fish fed diet with 15% duck weed perform excellently well compared to other treatments. Further aquatic weed based feeds are cheaper as well as simpler compared to other conventional feeds of aquatic weeds in major carp (*Labeo rohita*) diets would also prove economically viable.

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