ECRONICON OPEN ACCESS

EC VETERINARY SCIENCE
Research Article

# Effects of Algal Meal on Growth, Body Composition and Survival of Common Carp (*Cyprinus carpio* var. *communis*) Fingerlings

**Ishrat Rather, Oyas Ahmed Asimi*, Ashwani Kumar, Feroz Shah, Irfan Khan, Sajad Baba and Faroz Bhat**

*Division of Fish Nutrition and Biochemistry, Faculty of Fisheries, Rangil, Ganderbal, India*

***Corresponding Author:** Oyas Ahmed Asimi, Division of Fish Nutrition and Biochemistry, Faculty of Fisheries, Rangil, Ganderbal, India.

**Received:** September 16, 2021; **Published:** December 30, 2021

## Abstract

The present study was conducted to evaluate the effects of algal meal on growth, body composition and survival of common Carp (*Cyprinus Carpio* var. *communis*) fingerlings through dietary supplementation. Algal bloom was collected from Dal Lake of Kashmir and after identification *Spirogyra, Oedogonium* and *Ulothrix* were found in the mixture. Proximate analysis of the algae revealed that the *Spirogyra* contains 25% crude protein, *Oedogonium* contains 14% of crude protein and *Uothrix* contains 45% of crude protein. Keeping in view the protein content of algae, an algal meal was prepared and incorporated into the diet of common carp fingerlings at 35% crude protein level. A sixty day feeding trial was carried out to elucidate the effects of algal meal at different inclusion levels (0.0%, 10.0%, 20.0%, 30.0%, 40.0% and 50.0%) respectively. The results revealed that the percentage weight gain, specific growth rate and feed conversion ratio exhibited significantly higher ($p < 0.05$) values in treatment group ($T_4$) fed with 40% algal meal. Lowest feed conversion ratio was observed in treatment group ($T_4$) compared to other treatment groups. Protein efficiency ratio showed significant increase in treatment group ($T_3$) fed with algal meal at 30% inclusion level compared to control(C) group and other treatment groups ($T_1$, $T_2$, $T_4$ and $T_5$). There was no significant difference in survival rate in treatment groups fed with algal meal at different inclusion levels. However, the results suggest that the dietary inclusion of algal meal at 40% augments the growth, body composition and survival of *Cyprinus carpio* fingerlings. The findings of the present study also revealed that the fish meal in the diet of common carp may be replaced upto 40% without affecting growth. It will have direct bearing on reduction of cost of production and making feed cost effective.

***Keywords:*** *Algal Meal; Common Carp; Growth; Fish Meal; Dal Lake*

## Introduction

Union Territory of Jammu and Kashmir has tremendous potential for aquaculture due to large number of cold water resources which are ideal for a number of fish species. The production is already beyond 20 thousand tones with Kashmir province contributing 80 per cent of total production. The main fish species cultured in Kashmir province are trout, mirror carp and common carp. Today, the main problem which Union Territory is facing is the supply-demand gap in fish production. As feed is the major input cost of any aquaculture activity, there is the need to explore cheap and locally available feed ingredients. If we can replace the costlier protein part i.e., fish meal by some cheap and easily available proteins, the variable cost can come down significantly. Use of terrestrial protein sources like algae in place of plant protein has been studied extensively with positive outcomes. Two basic factors which make algae both macroalgae (weeds) and microalgae (phytoplanktons) as good candidates for use as replacements in fish meal are: 1) algae are at the base of aquatic food chains that produce the food which fish readily consume. 2) Immense biochemical diversity. Algae are found to contain all the essential amino acids required for fish growth, taurine: the non-protein sulphonic acid an essential nutrient, polyunsaturated fatty acids other essential growth nutrients.

In the present study, algal meal was used to replace fish meal up to an extent where maximum growth and survival of fish is achieved. The experimental fish selected in the present study viz common carp (*Cyprinus carpio*) is easily available and is having well developed breeding technology in the Union Territory of Jammu and Kashmir. Common carp is a high quality edible fish, deeply appreciated by consumers in Jammu and Kashmir with relatively more economic importance.

## Material and Methods

### Collection and biochemical analysis of algae

The algae were collected from algal bloom of Dal Lake, Srinagar. The algae were brought to Department of Botany, University of Kashmir for identification. After identification *Spirogyra, Oedogonium* and *Ulothrix* were found in the mixture. The algae were washed and then dried at room temperature for one week. Algae were ground into powder in a laboratory grinder and sieved into fine powder. The proximate analysis of algae was carried out in the laboratory of Fish Nutrition and Biochemistry, Faculty of Fisheries, Rangil using methods described by AOAC (Analysis of the Association of Official Analytical Chemists) [2].

### Site of the experiment and fish

The experiment was conducted over a period of 60 days from 26 March 2020 to 24 May 2020 at the wet laboratory of the Faculty of Fisheries, Rangil. The fishes were reared in plastic tubs after acclimatization. Fishes used for experimental purpose were advanced fingerlings of Common carp, *Cyprinus carpio* with an average weight of 4.5 ± 1.1g. The fishes were procured from National Fish Seed Farm, Manasbal, district Ganderbal (Jammu and Kashmir). In order to ameliorate the handling stress the fishes were given a mild salt and $KMnO_4$ treatment on the next day. The stock was acclimatized under aerated condition for one week.

### Experimental design and set-up

One hundred and eighty fingerlings (180) of *Cyprinus carpio* were randomly distributed in six distinct experimental groups, in three replicates, following a completely randomized design. The setup consisted of 18 plastic circular tubs (75L capacity) covered with net. The tubs were initially washed and filled with potassium permanganate solution ($4mgL^{-1}$) that was left overnight. The tubs were flushed out the next day and were thoroughly washed with clean water. One hundred and eighty fishes were randomly distributed in the six distinct experimental groups. Round the clock aeration was provided. Ten fishes of uniform size were kept in each tub. Each tub was covered with a net to prevent the fish from jumping out. The fishes were fed with a control diet for few days before the commencement of the experiment. The body weight was measured at an interval of 15 days to assess the growth. The fishes were starved overnight before taking the bodyweight.

### Formulation and preparation of experimental diets

Six diets (control and five treatment groups) were formulated containing different concentration of algal mix. Diet formulation and proximate composition of experimental diet were performed in Fish nutrition and Biochemistry Laboratory, Faculty of Fisheries, Rangil. The dry ingredients of each diet were thoroughly mixed and then 100ml of distilled water per kg diet was added and the ingredients were blended using kitchen blender to make paste of each diet. In the experimental diets, algal mix was added at 10%, 20%, 30%, 40%, 50% in $Treatment_1$, $Treatment_2$, $Treatment_3$, $Treatment_4$ and $Treatment_5$ respectively. Pelleting of each diet was carried out by passing the blended mixture through hand pelletizer with (1-mm) diameter mesh. The wet pellets were dried in an oven at 60˚C. The diets were stored in plastic bags in a refrigerator (4˚C) for further use.Feeding was done at 5% of the body weight throughout the 60 days feeding trial. The daily ration was divided into two equal parts and fed at 10.00 am in the morning and 6.00 pm in the evening.

### Physico-chemical parameters of water

Water quality parameters *viz*. Temperature, pH, dissolved oxygen, total hardness, ammonia, were recorded during the experimental period as per American Public Health Association (2012) [1].

### Growth parameters

Samplings were done at intervals of 15 days to assess the body weight of the fishes. The weight was taken on an electronic weighing balance. The parameters used in the study to evaluate growth and feed utilization are summarized as below.

### Percentage weight gain

The percentage weight gain was calculated using the following formula:

$$\text{Weight gain (\%)} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

### Specific growth rate (SGR)

The Specific Growth rate was calculated by the following formula

$$\text{SGR (\%)} = \frac{\text{Log}_e \text{ final weight} - \text{Log}_e \text{ initial weight}}{\text{Number of days}} \times 100$$

### Feed conversion ratio (FCR)

The Feed Conversion Ratio was calculated by the following formula

$$\text{FCR} = \frac{\text{Feed given (dry weight)}}{\text{Body weight gain (wet weight)}} \times 100$$

### Protein efficiency ratio (PER)

Protein efficiency ratio was calculated by the following formula.

$$\text{PER} = \frac{\text{Net weight gain (wet weight)}}{\text{Protein fed (g)}} \times 100$$

### Survival rate (SR)

At the end of the experiment, all the experimental tubs were dewatered and the number of the experimental animals in each tub was counted and the survival rate (%) was calculated by the following formula

$$\text{Survival (\%)} = \frac{\text{Total number of fish harvested}}{\text{Total number of fish stocked}} \times 100$$

### Statistical analysis

The data were statistically analyzed by using appropriate statistical tools. To discover where there were significant differences between the levels of the main factor, Least Significant difference was used.

## Result and Discussion

The proximate composition of three different algae namely *Spirogyra spp.*, *Ulothrix spp.* and *Oedogonium spp.,* are presented in table 1. Crude protein, crude lipid, carbohydrate and crude fibre content in percentage were analyzed. On the basis of proximate composition of three algal species, it was found that their nutritive value is good. In the present study algal species were given as meal in the feed of Common carp (*Cyprinus carpiovar. communis*) to ascertain its growth and survival. The algal meal was given at five different concentrations (10%, 20%, 30%, 40% and 50%) respectively and subsequently fish meal was replaced at same concentration to evaluate the effect on growth and survival.

| Algae | Crude protein (%) | Crude lipid (%) | Carbohydrate (%) | Crude fiber (%) |
|---|---|---|---|---|
| Ulothrix | 45.0 | 20.0 | 20.0 | 5.0 |
| Spirogyra | 24.4 | 14.8 | 42.8 | 25.8 |
| Oedogonium | 13.5 | 19.2 | 22.0 | 17.7 |

***Table 1:*** *Proximate composition of (g/100 g of dry weight) three algal species.*

### Physico-chemical parameters of water

The water temperature of the different experimental groups ranged from 16 to 25$^0$C during the experimental period of 60 days. There was not much variation in pH values during the experimental period. The pH values were recorded within the range of 7.2 to 8.2.The dissolved oxygen concentration of all the experimental tubs was recorded within the range of 6.1 to 7.2mg L$^{-1}$during the experimental period of 60 days. The free carbon dioxide in water was found to be negligible during the experimental period of 60 days. The carbonate hardness was found to be 135 to 155mgL$^{-1}$ during the experimental period of 60 days. The total ammonia content of all the experimental tanks was recorded before water exchange. It was found to be in the range of 30 to 70 µg L$^{-1}$ (Table 2 and 3).

| Bi Weekly sampling | Treatments | Temperature (°C) | pH | Dissolved oxygen (mg/l) | Total hardness (mg/l) | Total nitrogen (µg/l) |
|---|---|---|---|---|---|---|
| | | Mean | Mean | Mean | Mean | Mean |
| 1$^{st}$ day | Control | 16.0 | 8.2 | 7.2 | 140 | 30 |
| | Treatment 1 | 16.0 | 8.1 | 7..2 | 140 | 30 |
| | Treatment 2 | 16.0 | 8.0 | 7.0 | 140 | 30 |
| | Treatment 3 | 16.0 | 8.0 | 7.2 | 140 | 30 |
| | Treatment 4 | 16.0 | 8.1 | 7.0 | 140 | 30 |
| | Treatment 5 | 16.0 | 8.0 | 7.2 | 140 | 30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st 15 days | Control | 18 | 7.7 | 6.8 | 145 | 33 |
| | Treatment 1 | 19 | 7.7 | 6.9 | 148 | 35 |
| | Treatment 2 | 18 | 7.7 | 6.8 | 144 | 34 |
| | Treatment 3 | 18 | 7.7 | 7.0 | 145 | 35 |
| | Treatment 4 | 18 | 7.7 | 6.8 | 143 | 33 |
| | Treatment 5 | 18 | 7.7 | 6.6 | 144 | 34 |
| 2nd 15 days | Control | 18 | 7.4 | 6.6 | 148 | 43 |
| | Treatment 1 | 19 | 7.3 | 6.4 | 149 | 47 |
| | Treatment 2 | 17 | 7.3 | 6.3 | 149 | 48 |
| | Treatment 3 | 18 | 7.3 | 6.3 | 148 | 50 |
| | Treatment 4 | 19 | 7.3 | 6.4 | 148 | 41 |
| | Treatment 5 | 20 | 7.3 | 6.5 | 147 | 41 |

***Table 2:*** *Physico-chemical parameters of water during the experimental period for different experimental groups.*

| Of Bi Weekly sampling | Treatments | Temperature (°C) | pH (mg/l) | Dissolved oxygen (mg/l) | Total hardness (mg/l) | Total nitrogen (µg/l) |
|---|---|---|---|---|---|---|
| | | Mean | Mean | Mean | Mean | Mean |
| 3rd 15 days | Control | 18 | 7.3 | 6.5 | 149 | 55 |
| | Treatment 1 | 21 | 7.2 | 6.5 | 150 | 56 |
| | Treatment 2 | 21 | 7.3 | 6.4 | 154 | 49 |
| | Treatment 3 | 19 | 7.2 | 6.4 | 152 | 51 |
| | Treatment 4 | 19 | 7.3 | 6.3 | 152 | 51 |
| | Treatment 5 | 20 | 7.2 | 6.4 | 151 | 58 |
| 4th 15 days | Control | 24 | 7.2 | 6.3 | 153 | 65 |
| | Treatment 1 | 25 | 7.3 | 6.2 | 153 | 70 |
| | Treatment 2 | 23 | 7.2 | 6.2 | 153 | 70 |
| | Treatment 3 | 24 | 7.2 | 6.1 | 154 | 68 |
| | Treatment 4 | 24 | 7.3 | 6.3 | 155 | 65 |
| | Treatment 5 | 23 | 7.2 | 6.1 | 155 | 70 |

***Table 3:*** *Physico-chemical parameters of water during 3rd 15 days, 4th 15 days experimental period for different experimental groups.*

## Proximate composition of the diets

The proximate compositions of the different experimental diets are given in table 4. The per cent dry matter content in the diet ranged from 85.7%to 88.5%. The per cent crude protein content was estimated within the range of 20% to 21.82%. The crude fiber (%) varied from 6.82 to 7.21. The Ash content (%) was estimated within the range of 14.91 to 16.65. The crude lipid content (%) was estimated with the range of 10.23 to 12.64. The gross energy was in the range of 406.20 Kcal/g to 425.95K cal/g (Table 4).

| Chemical composition | Control (0%) | Treatment 1 (10%) | Treatment 2 (20%) | Treatment 3 (30%) | Treatment 4 (40%) | Treatment 5 (50%) |
|---|---|---|---|---|---|---|
| Dry matter (%) | 86.0 | 85.7 | 88.2 | 86.5 | 87.5 | 88.5 |
| Crude protein (%) | 21.82 | 21.42 | 20.67 | 20.00 | 21.50 | 21.09 |
| Crude fibre (%) | 6.82 | 7.03 | 7.07 | 7.21 | 6.94 | 6.99 |
| Ash (%) | 14.91 | 15.79 | 16.21 | 16.65 | 15.01 | 15.10 |
| Lipid (%) | 12.64 | 11.43 | 10.82 | 10.23 | 11.20 | 11.22 |
| Gross energy (Kcal/g) | 425.95 | 412.57 | 406.20 | 409.53 | 420.01 | 422.21 |

***Table 4:*** *Proximate composition of the experimental diets (% dry matter (DM) basis) fed to common carp fingerlings during experimental period.*

## Growth performance and body indices

The growth performance and body indices of the experimental groups at the end of the 60 days of feeding trial are shown in table 5.

| Parameters | Algal meal substitution rate | | | | | |
|---|---|---|---|---|---|---|
| | Control (0%) | Treatment $T_1$ 10% | Treatment $T_2$ (20%) | Treatment $T_3$ (30%) | Treatment $T_4$ (40%) | Treatment $T_5$ (50%) |
| Initial wt. | 32.36 ± 0.26 | 33.06 ± 0.24 | 33.06 ± 0.15 | 32.26 ± 0.01 | 32.63 ± 0.37 | 32.63 ± 0.41 |
| Final wt. | $76.90 \pm 0.18^a$ | $87.13 \pm 0.06^b$ | $87.13 \pm 0.09^b$ | $88.76 \pm 0.91^b$ | $108.86 \pm 0.08^c$ | $90.96 \pm 0.05^b$ |
| Body wt. gain | $44.54 \pm 0.31^a$ | $54.07 \pm 0.03^b$ | $54.07 \pm 0.06^b$ | $56.50 \pm 0.07^b$ | $76.23 \pm 0.04^c$ | $58.33 \pm 0.07^b$ |
| %Body weight gain | $137.63 \pm 0.33^a$ | $163.55 \pm 0.03^b$ | $163.55 \pm 0.01^b$ | $175.13 \pm 0.02^c$ | $233.61 \pm 0.02^d$ | $178.76 \pm 0.03^b$ |
| SGR (%/day) | $1.30 \pm 0.63^a$ | $1.11 \pm 0.01^b$ | $1.10 \pm 0.02^b$ | $1.01 \pm 0.08^c$ | $1.41 \pm 0.07^d$ | $1.11 \pm 0.07^b$ |
| FCR | $2.28 \pm 0.58^a$ | $2.20 \pm 0.06^a$ | $2.23 \pm 0.23^a$ | $2.02 \pm 0.21^b$ | $1.99 \pm 0.01^c$ | $2.11 \pm 0.02^d$ |
| PER | $1.16 \pm 0.29^a$ | $1.26 \pm 0.06^b$ | $1.29 \pm 0.06^c$ | $1.41 \pm 0.05^d$ | $1.32 \pm 0.02^c$ | $1.33 \pm 0.05^c$ |
| SR (%) | 100 ± 00 | 100 ± 00 | 100 ± 00 | 100 ± 00 | 100 ± 00 | 100 ± 00 |

***Table 5:*** *Growth parameters of different experimental groups fed different experimental diets at the end of the experiment. Data were presented as mean ± SE (n = 3). Values within the same column having different superscripts are significantly different (P < 0.05).*
*SGR-Specific growth rate, FCR-Feed conversion ratio, PER-Protein efficiency ratio.*

## Body weight gain

The initial body weight of all experimental groups did not differ significantly (Table 5). The growth performance (final body weight, weight gain, specific growth rate, feed conversion ratio and protein efficiency ratio) of Common carp fingerlings fed diets containing different levels of algal meal are shown in table 5. Highest weight gain was recorded in $T_4$ group (76.23 ± 0, 04 gm) and the lowest weight gain was observed in the control group (44.54 ± 0.31 gm), which was significantly different (P < 0.05).

### Specific growth rate (SGR)

The mean of the Specific growth rate of the $T_4$ group (1.41 ± 0.07%/day) was significantly higher ($P < 0.001$) than the all other groups. The lowest Specific growth rate value was observed in the control group (1.30 ± 0.63%/day), which was significantly different ($P < 0.001$). The Specific Growth Rate of all the treatment groups were significantly ($P < 0.05$) different against the control group (Table 5, Figure 2).

### Feed conversion ratio (FCR)

The Feed Conversion Ratio of different experimental groups varied significantly ($P < 0.001$). The lowest Feed Conversion Ratio (1.99 ± 0.01) was recorded in $T_4$ group. The highest Feed Conversion Ratio of (2.28 ± 0.58) was recorded in the control group (C). Treatment group $T_3$ and $T_4$ are significantly different ($P < 0.05$) from control group (Table 5, Figure 3).

### Protein efficiency ratio (PER)

Highest protein efficiency ratio value was found in group $T_3$ (1.41 ± 0.05) which are significantly different ($P < 0.001$) than the control group (C). The lowest value was recorded in the control group (C) (1.16 ± 0.29) which was significantly different ($P < 0.05$) to other experimental groups.

### Survival rate (SR)

No mortality was observed during the experimental period of 8 weeks. Hundred per cent survival rates were observed in all the experimental groups and in the control group. There was no significant difference ($P < 0.05$) between treatment groups and control group.

The present study was conducted to replace fishmeal with algal meal up to certain maximum level. The results revealed that the algal meal has improved growth and survival of common carp and that the algal meal had a statistically significant impact on the growth performance of *Cyprinus Carpio*, with weight gain (WG), percentage weight gain (WG%) and specific growth rate (SGR) all increasing significantly ($p < 0.05$) at incorporation levels 10%, 20%, 30% and 40% (Table 5) algal meal in the diet compared to the control diet. Feed conversion ratio (FCR) showed the expected downward trend up to incorporation level of 40% (Figure 3). Moreover, the positive impact of algal meal on the growth indicators of Common Carp increased as the proportion of algal meal in the diet increased up to 40%. The fishes in the treatment group $T_4$ exhibited significantly higher growth performance indices than other treatment groups, i.e., C, $T_1$, $T_2$, $T_3$ and $T_5$ respectively. In the treatment group $T_4$ a regressive impact was seen in the growth parameters of fish with the graphs showing the characteristic bell shaped curve (Figure 1). These results showed that algal meal could be incorporated into common carp diets to replace fishmeal up to 40% level beyond which it showed declining trend in the growth performance instead. There is a whole body of literature confirming present hypothesis that algal replacement levels work best up to a certain optimum replacement levels. Also in the present study, no palatability problem was encountered with any of the treatment groups during the experiment. In general there is a great synergy and compatibility between the algal species as replacement and the target fish species.

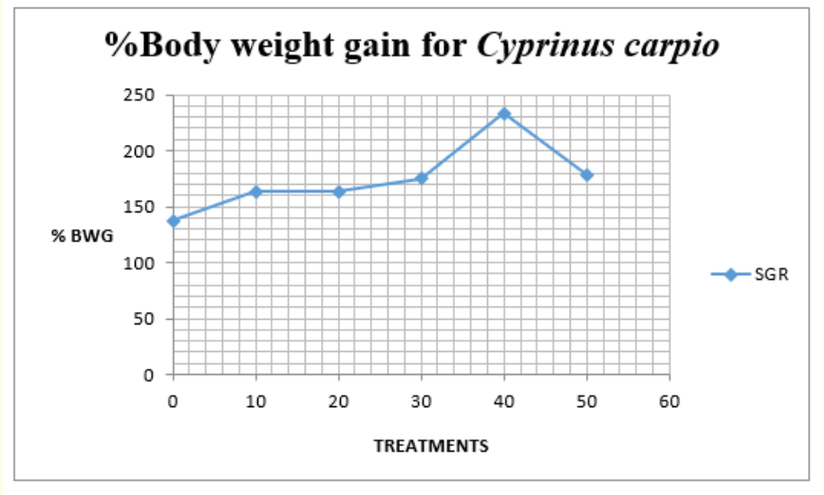


***Figure 1:*** *Weight gain percentage of Cyprinus carpio var. communis fingerlings fed with different experimental diets.*

The reason for the improvement in the growth parameters in the present study with the inclusion of algal meal in the diets of *Cyprinus Carpio* may be due to the high protein content of algae (Table 1) and as for the regressive effects seen beyond the optimum replacement proportions, could be due to the high Nitrogen-free extracts and its possible effects on the digestibility of protein and dry matter. These nitrogen free extracts have been widely studied for their deleterious effects by Xu., *et al.* (2011) [11].

All the water quality parameters were found to vary non-significantly and were within the acceptable ranges during the experimental period. Water temperature plays a significant role in metabolism and growth. *Cyprinus carpio* is a eurythermal fish and can thrive well at temperature range of 10 to 37.8°C. The water temperature varied from 16 to 25°C during the experimental period which is optimum for culture of common carp. As per Jhingran and Pullin (1985) [8] temperature ranging from 10 to 37.8˚C is tolerable by Indian Major Carps.

Body weight gain (BWG) and specific growth rate (SGR) is the basic fundamental parameters that have been analyzed in the present study. In the present study highest weight gain was recorded in the treatment group ($T_4$)76.23 ± 0.04 g (Table 5) and the lowest weight gain was observed in the control group 44.54 ± 0.31 g (Table 5), which was significantly different ($P < 0.05$). The mean of the SGR of the treatment group fed with 40% algal meal 1.41 ± 0.07%/day (Figure 2 and Table 5) was significantly higher ($p < 0.001$) than the all other groups. The lowest SGR value was found in the control group (1.30 ± 0.63%/day), which was significantly different ($p < 0.001$). This is in agreement with the results of Wassef., *et al.* (2001) [10] who reported that striped mullet (*Mugil cephalus L*), fed with *Ulva* meal at 20% inclusion level showed significant weight gain and feed efficiency when *ulva* meal was included in the feed at different inclusion levels i.e., 10, 15, 20 and 25%. Similarly Badwy., *et al.* (2008) [3] investigated the replacement levels of fish meal with dried microalgae (*Chlorella* spp. and *Scenedesmus* spp) in Nile tilapia 0%, 10%, 25%, 50% and 75% inclusion levels. The results indicate that growth parameters *viz* body weight gain (BWG) and specific growth rate (SGR) were significant when substitution level increased up to 40%. Further confirming our proposition, EL-Tawil., *et al.* (2014) [5] evaluated the effects on growth performance, feed utilization and body composition for red tilapia (*Oreochromis sp.*) by the inclusion of green seaweeds (*Ulva sp.*) as a feed supplement in fish diet, he reported that final body weight, weight gain and specific growth rate (SGR) increased considerably with raising *Ulva* level in fish diet up to 15% when *ulva* meal was included in the fish feed at different inclusion levels i.e., 10, 15, 20 and 25%. The results of the above studies are in agreement with the present study which showed that both Body Weight Gain and Specific Growth Rate increased upon replacement of fishmeal by algal meal but only up to 40% inclusion level beyond which the benefits taper off as can be seen from table 5 and figure 1, figure 2.

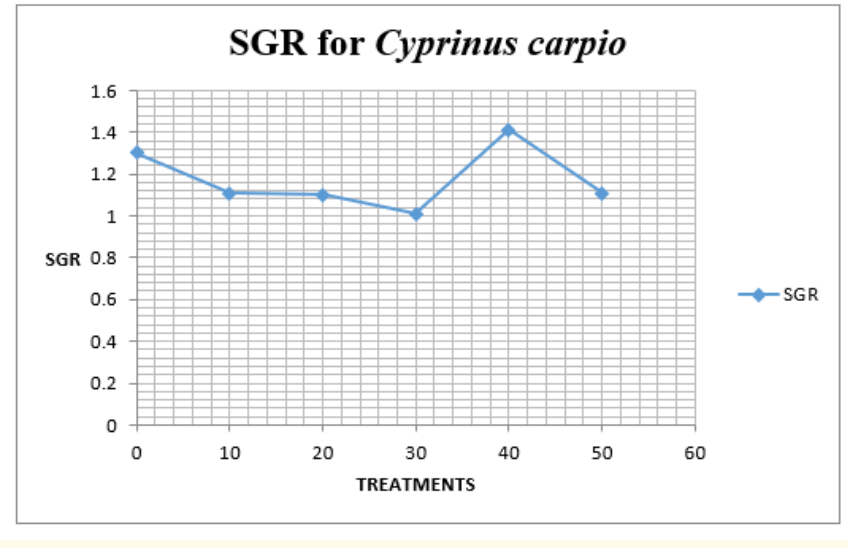


***Figure 2:*** *Specific Growth Rate of Cyprinus carpio fingerlings fed with different experimental diets.*

Feed conversion ratio (FCR) is another important growth parameter widely studied by researchers. It defines the input (feed) per unit of output (body mass). In the present study the lowest FCR (1.99 ± 0.01) was recorded in the treatment group $T_4$ (Table 5 and figure 3). The highest Feed conversion ratio (2.28 ± 0.58) was recorded in the control group. In line with our hypothesis, Guroy., *et al.* (2007) [7] studied the effects of Green macroalgae (*Ulva rigida*) and brown macroalgae (*Cystoseira barbata*) meals as a feed additive on growth performance, feed utilization and body composition of Nile tilapia, *Oreochromis niloticus* for a period of 12 weeks and reported that fish fed with the feed of 15% *Ulva* meal displayed the lowest feed conversion ratio (FCR) when supplemented with various levels of *Ulva* meal (5%, 10%, or 15%) or *Cystoseira* meal (5%, 10%, or 15%). Further Enyidi., *et al.* (2017) [6] studied the utilization of *Chlorella vulgaris* as a protein source in the diets of African catfish (*Clarias gariepinus)* at 0%, 5%, 15% and 25% inclusion levels and reported that African catfish fed with 0% green algal meal showed highest Feed Conversion Ratio. The results of above studies are in agreement with the results of present study wherein Feed Conversion Ratio decreases to a certain optimum replacement concentration point (up to 40%) beyond which it increases as can be seen from table 5 and figure 3.

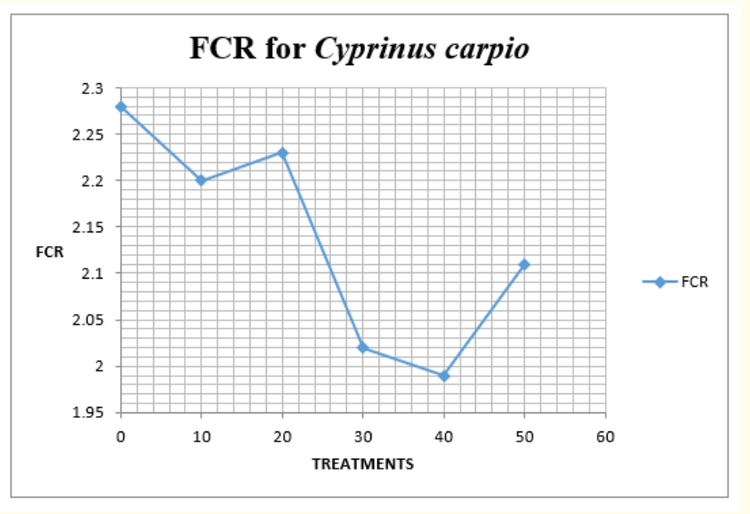


***Figure 3:*** *Feed Conversion Ratio of Cyprinus carpio var. communis fingerlings fed with different experimental diets.*

Protein efficiency ratio (PER) defined as the ratio of weight gain to the food intake is another parameter analysed in the present study. Highest protein efficiency ratio value was found in the treatment group $T_3$ 1.41 ± 0.05 (Table 5) which was significantly different ($p < 0.001$) from the control group. In slight deviation from our present results, Soler-Vila., *et al.* (2009) [9] studied the inclusion of red alga *Porphyra dioica* as a fish-feed ingredient for rainbow trout (*Oncorhynchus mykiss*) and reported that by adding *Porphyra dioica* meal at levels of 5, 10 and 15%, protein efficiency ratio (PER) was not influenced significantly by the addition of seaweed meal for any of the diets. But in the present study Protein efficiency ratio was affected by replacement of fish meal with algal meal with highest Protein Efficiency Ratio obtained for 30% replacement level as can be seen in table 5 and figure 4.

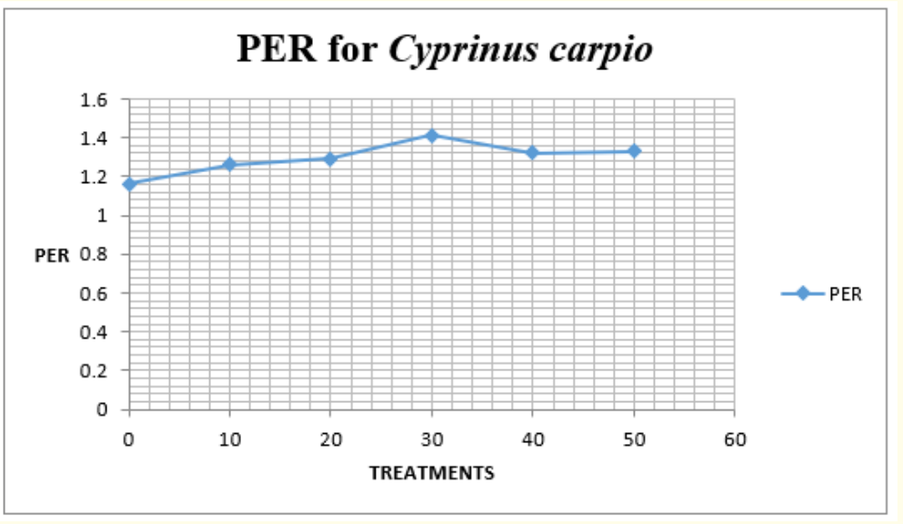


***Figure 4:*** *Protein Efficiency Ratio of Cyprinus carpio var. communis fingerlings fed with different experimental diets.*

Survival rate i.e., the live fish at the end of experimental period is another parameter that has been studied in fishmeal replacement studies. In the present study no mortality was observed during the experimental period of 8 week as no significant difference between treatment groups and control group was observed (table 5). This is in agreement with the results of Guroy., *et al.* 2007 [7] who reported less than 10% of fish mortality while studying *Cystoseira barbata* as a feed supplement for Nile tilapia (*Oreochromis niloticus*). Dallaire (2007) [4] also reported 100% survival rate in all treatment groups in an experimental study of rainbow trout fry (*Oncorhynchus mykiss*) with supplemented diet of algal biomass.

## Conclusion

It has been shown that the algae in general could be incorporated into the diet of *Cyprinus carpio* up to an inclusion level of 40%. Future studies are needed, however, to optimize the level of algal meal in diets of *Cyprinus carpio* to improve growth performance. It would also be interesting to assess the cost benefit analysis to assess whether these inclusion levels could be cost effective at a commercial scale.

## Conflict of Interest

There is no conflict of interest in the present study.

pH is not supposed to have any unit and stands for potential hydrogen.

DO stands for dissolved oxygen as has been mentioned in the previous text only.

## Bibliography

1. American Public Health Association,. Standard methods for examination of water and wastewater. 22nd edition. APHA, Washington (2012): 1360.
2. AOAC.. "Official Method of Analysis of the Association of Official Analytical Chemists". 15th edition". AOAC, Arlington (1990): 2220.
3. Badwy T. M., *et al*. "Partial replacement of fishmeal with dried microalga (Chlorella spp. and Scenedesmus spp.) in Nile tilapia (Oreochromis niloticus) diets". *In 8th International Symposium on Tilapia in Aquaculture* (2008): 801-811.
4. Dallaire V., *et al*. "Effect of algal incorporation on growth, survival and carcass composition of rainbow trout (Oncorhynchus mykiss) fry". *Bioresource Technology* 98.7 (2007): 1433-1439.
5. El-Tawil N E., *et al*. "Effect of replacing dietary fish oil with different plant oils on growth performance of Nile tilapia, Oreochromis niloticus (L.)". *The Journal of Applied Sciences Research* 1.3 (2014): 183-191.
6. Enyidi, U. D. "Chlorella vulgaris as protein source in the diets of African catfish Clarias gariepinus". *Fishes* 2.4 (2017): 17.
7. Güroy B K., *et al*. "Effects of Ulva rigida and Cystoseira barbata meals as a feed additive on growth performance, feed utilization, and body composition of Nile tilapia, Oreochromis niloticus". *Turkish Journal of Veterinary and Animal Sciences* 31.2 (2007): 91-97.
8. Jhingran VG and Pullin RS. "A hatchery manual for the common, Chinese, and Indian major carps". *WorldFish* (1985): 252.
9. Soler-Vila A., *et al*. "The red alga Porphyra dioica as a fish-feed ingredient for rainbow trout (Oncorhynchus mykiss): effects on growth, feed efficiency and carcass composition". *Journal of Applied Phycology* 21.5 (2009): 617-624.
10. Wassef E A., *et al*. "Growth enhancement and muscle structure of striped mullet, Mugil cephalus L., fingerlings by feeding algal meal-based diets". *Aquaculture Research* 32 (2001): 315-322.
11. Xu S., *et al*. "Evaluation of dried seaweed Gracilaria lemaneiformis as an ingredient in diets for teleost fish Siganus candiculatus". *Aquaculture International* 19 (2011): 1007-1018.

**Volume 7 Issue 1 January 2022**