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EFFECT OF DIETARY FISH MEAL REPLACEMENT BY *Gracilaria edulis* ON MORPHOMETRY AND NUTRITIVE INDICES OF *Catla catla*

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ABSTRACT

Fish meal is the primary protein source for aquaculture diets because of its high protein content, well balanced amino acid and fatty acid composition, high digestibility and palatability. Fish meal, on the other hand, is the most expensive ingredient and is in high demand by other animal sectors. Because pelagic fishes are the primary source of fish meal, the demand for it will continue to rise as the aquaculture sector grows. This will have a negative impact on pelagic fishes. Replacement of fish meal with alternative, less expensive animal or plant-protein sources is one way to reduce the use of fish meal. A less expensive protein source should be possible to come by in large enough numbers to meet demand. It should also meet fish's basic amino acid requirements and be sufficiently pleasant to avoid rejection by the fish. In this respect, macro and micro algae have been employed as dietary supplements to help a variety of farmed fish species improve their health and nutritional performance. Many studies have evaluated the inclusion of various algae species in aquafeeds. Hence the study was conducted to evaluate the efficacy of

Gracilaria edulis as feed additives on morphometry and nutritive indices of *Catla catla* for 90 days. The fish were fed with an algae-free control diet and three experimental diets which replaced conventional fish meal with varying levels of dried *G. edulis* (10%, 20% and 30%). The growth parameters of length - weight, Specific Growth Rate, Food Conversion Ratio ,Food Conversion Ratio, survival and metabolic rate was significantly increased($P < 0.05$) at 20 % of *Gracilaria edulis* incorporated diets at 30, 60 and 90 days. The marine algae *Gracilaria edulis* incorporated diets showed very good response in terms of growth and feed utilization of *C. catla.* These results indicate that incorporation of less than 20% red algae, *Gracilaria edulis* could be feasible in the diet of *Catla catla* and further studies are recommended to optimize the level of algae to improve growth performance.

Keywords: *Gracilaria edulis, Catla catla,* Specific Growth Rate, Food Conversion Ratio, Food Conversion Ratio

1. INTRODUCTION

Fisheries and aquaculture is one of the world's fastest-growing businesses, and it has played a significant part in the country's economic growth **[1]**. India has a plethora of fishery resources, both inland and offshore. The country boasts an 8,118-kilometer coastline as well as huge regions beneath estuaries, backwaters, lagoons, and other bodies of water that are ideal for growing catch and culture fisheries **[2]**. Globally, fish production is forecast to be around 54 million tons per year, with annual consumption of 18.5 kg per capita **[3]**. India presently ranks third in the world in fisheries and second in aquaculture production, accounting for 6.3 percent of total worldwide fish production. In 2017-18, India's total fish production was anticipated to be 12.60 million metric tons, with roughly 65 percent coming from the inland sector and about 50 percent coming from cultural fisheries. One of the world's greatest challenges today is providing enough food for a rapidly growing human population. To be more precise, seafood bases contribute significantly in meeting human dietary needs **[4]**. Fish, which is high in protein and many other necessary fatty acids and minerals, performs a unique function in human nutrition by contributing a valuable and nutritious component to a varied and healthy diet. With the ongoing shifts in dietary patterns, which continue to favour a wider range of food options as well as enhanced health, nutritional and diet concerns **[5]**. Fisheries and aquaculture provide not just dietary needs for human

consumption, but also great employment and income generation prospects, particularly in rural areas that are less economically developed **[6]**. Fish meal, on the other hand, is the most expensive ingredient and is in high demand by other animal sectors **[7]**. Because fishes are the primary source of fish meal, the demand for it will continue to rise as the aquaculture sector grows. This will have a negative impact on fishes **[8]**. As a result, using less-expensive protein sources as partial or complete substitutes for fish meal is a top goal for international research. Guroy *et al*. **[9]** employed macro and micro algae as dietary supplements to improve the health and nutritional performance of a variety of fish species. Many previous studies have evaluated the inclusion of various algae species in aquafeeds: *Ulva* **[10]**, *Padina arborescens* **[11]**, *Sargassum siliquastrum* **[12]** *Sargassum spp*. **[13]**, *Gracilaria bursa-pastoris, Gracilaria cornea* and *Ulva rigida* **[14]**, *Hizikia fusiformis* **[15]** and *Porphyra* **[16- 18]**. The preponderance of this research suggests that algae can be used as a partial replacement for fishmeal. Because of their comparatively high protein content and structurally diversified bioactive chemicals with substantial pharmacological and biological potential, red algae appears to be the most suited source of animal nutrition among the many macroalgae species. *Catla catla* is fresh water fish belonging to Class Cypriniformes, Order Cypriniformes, Family Cyprinidae and indigenous fish of India. *Catla catla* is a surface column feeder fish, which feeds on small crustacean, insects, rotifers, algae, and vertebrates. Its growth rate is very fast **[19]**. To test this material as a fish meal alternative and to examine its influence on the growth performance subjected to morphometry and nutritive indices of *Catla catla* under laboratory feeding circumstances, we partially substituted fish meal with *Gracilaria edulis.*

2. MATERIALS AND METHODS

Collection and maintenance of fish

The fingerlings of *Catla catla* purchased from Tamilnadu fish farm near poondi lake. Thiruvallur, Tamilnadu, India and were brought to the laboratory very safely in a plastic bag which was well oxygenated. During the process of acclimatization *Catla catla* given with commercially available feed.

Experimental setup

Catla catla with uniform size chosen for the experiment from acclimatized fishes in the laboratory environment and the initial length and weights were noted. This experiment was planned long for about 0 - 90 days. In this experiment two different feeds

made from *Gracilaria edulis* with general feed substances as a first step of experiment initial weight and length of the fishes of the different groups were measured and noted. Similarly, this process of measuring the length and weight of fishes was done at the end of 90th day which was the final weight and length of the experiment.

Collection and process of algae

Gracilaria edulis was collected around the coastal regions of Tuticorin. *Gracilaria edulis* was washed 3 to 4 times thoroughly with running water in order to reduce the salinity level. Then it was shade dried for few days and then it is powder well.

Feed formulation

Three different proportions (10%, 20% and 30%) of these ingredients where made so that three diet with three levels of *Gracilaria edulis* was obtained to the ingredients Rice bran, groundnut oil cake, fish meals, tapioca powder required amount of water was added and a wet doughis homogenized. This homogeneous wet dough is cooked under steam in pressure cooker and cooled. To this, vitamin mix and algae meal were added. The same process is done for the *Gracilaria edulis* taken separately. This is then made into do small pellets that the fish can easily eat, which are then shade dried until the moisture content reduced. These feed weed stored in airtight containers separately and used for the further analysis **[20]**.

Morphometry of fish

The growth parameters were calculated by using the following equation

Nutritive Indices

Specific Growth Rate (Rate)= Final Weight (g) – Initial weight (g)/ Initial weight (g)x100

Food Conversion Ratio (FCR) = Total feed given (g)/Total weight gain fish (g) x100

Food Conversion Efficiency (%) (FCE)=Biomass (g) / Total feed intake (g) x 100

Survival (%) = No. of survived at the end of the experiment / No. of fishes stocked at the start of the experiment x 100

Metabolic Rate (MR) = Absorption rate (k.cal/g/day) – Conversion rate (k.cal/g/day) + NH_3 excretion rate (k.cal/g/day)

Statistical analysis

The collected data was subjected to statistical analysis using one-way Analysis of Variance (ANOVA).

3. RESULTS AND DISCUSSION

Attempts have been made in this study to develop a good alternative of feed that contains ingredients that are naturally available and cost effective. Despite the fact that algae are a less expensive source of protein, lipids, and other nutrients, they have

yet to be recognised a major fish food. In recent years, industries have produced plant-based feeds, which have proven to be more effective in increasing the growth of Indian major carps. Aquatic and terrestrial macrophytes have been exploited as an unconventional source of plant proteins in the development of fish meals in some circumstances. *Gracilaria edulis* as fish meal alternative was analysed to study on the morphometry and nutritive indices of *Catla catla* were studied. In the present study, the marine algae *Gracilaria edulis* incorporated diets showed very good response in terms of growth and feed utilization of *C. catla*. The highest weight was observed in 20 % and it was found to be 14.72 and 4.60 % was observed in 30 % of *Gracilaria edulis* incorporated diets **(Table 1 and Figure 1)** Similarly, maximum length was also observed in 20 % of *Gracilaria edulis* incorporated diets showed 11.70 %. Likewise, Younis, *et al* **[21]** reported that effect of dietary fish meal replacement by red algae, *Gracilaria arcuata*, on growth performance and body composition of *Oreochromis niloticus.* Yu *et al*. **[22]** also observed that *Gracilaria lemaneiformi*s dry power enhanced the growth performance of Pacific white shrimp (*Litopenaeus vannamei*). Interestingly 30 % of *Gracilaria edulis* incorporated diets showed 4.60% on growth performance. In the present study, highest weight gain was observed in fish fed with 20% of Gracilaria sp., while as inclusion level increased, the lower growth rate was observed. The growth performance of fish in this experiment also support to the finding of Valente *et al*. **[23]**.

In the present study, highest SGR was observed in 20 % of *Gracilaria edulis* incorporated diets in *Catla catla* and it was found to be 3.00 %, 3.09%, and 3.16 % on 30, 60 and 90 days. But declined level og SGR was observed in 30 % of *Gracilaria edulis* incorporated diets in *Catla catla* **(Table 2-4; Figure 2-4)**. There are many contradictory results obtained by scientists who used seaweed incorporated diet in aquatic animal feed. Swain and Padhi **[24]** reported that the specific growth rate of *Labeo rohita* is more with *Gracilaria verrucosa* and *Grateloupia filicina* substituted diet.

Feed utilization in the form of the feed conversion ratio (FCR), food conversion efficiency (FCE), feeding rate (FR), Survival and metabolic rate also studied **(Table 2-4; Fig 2-4)**. A significant difference ($P < 0.05$) was noted on *Gracilaria edulis* incorporated diets on *Catla catla*. A percentage of feed conversion ratio and food conversion

efficiency was increased and it was found to be 3.49 % and 2.77 % at 20 % on 90 days. Whereas in 30 days and 60 days showed 3.12 %, 2.19 % and 3.29%, 2.66% respectively. Maximum levels of feed conversion ratio and food conversion efficiency were observed in 20 % on 90 days. In contrast, 30 % of *Gracilaria edulis* incorporated diets on *Catla catla* showed the declined level of feed conversion ratio and food conversion efficiency when compared to lower level of inclusion. Our results were akin with the Valente *et al*. **[23]**. He used three seaweeds *Gracilaria bursa-pastoris, Ulva rigida* and *Gracilaria cornea* as dietary ingredients in *Dicentrarchus labrax* juveniles and reported best FCR in fish fed with *Gracilaria cornea*. Several researchers have described better food utilization studies for carps when fed with plant meal based diets of land and aquatic origin.

Highest survival was observed in 20 % of *Gracilaria edulis* incorporated diets in *Catla catla* and it was found to be 96 %, 97 % and 97.50 % on 30, 60, and 90 days. Survival rate of control showed 92 % on *Catla catla* **(Table 2-4; Figure 5-7)**. Swain and Padhi **[24]** reported highest survival rate in *Grateloupia filicina, Gracilaria verrucosa, Enteromorpha* and *Polysiphonia sertularioides* in *Labeo rohita*. Feed containing microalgae *P. incisa* increased the survival rate by increasing lysozyme levels in *Poecilia reticulata* **[25]** Survivability of fish could be improved by feeding 20 % of *Gracilaria edulis* incorporated diets.

Metabolic rate of *Catla catla* also significantly increased in 20 % of *Gracilaria edulis* incorporated diets showed that 6.49%, 6.53% and 6.87% was observed in 30, 60 and 90 days respectively **(Table 2-4; Figure 8-10)**. When compared to control and 10 % of *Gracilaria edulis* incorporated diets, maximum level of metabolic rate was observed in 20 % of *Gracilaria edulis* incorporated diets and decreased level was observed in 30 % of *Gracilaria edulis* incorporated diets respectively. Our findings were substantiating with Mukherjee *et al*. **[26]** showed the formulated algal diet increase the metabolic rate of *Labeo rohita*. The overall study revealed that the 20 % of *Gracilaria edulis* incorporated diets contributed better morphometry and nutritive indices of *Catla catla* and as evident from most of the above parameters. The present experiment thus suggested that the efficacy of the *Gracilaria edulis* incorporated diets was higher than the control one in terms of growth performances of *Catla catla*.

Table 1: Morphometry analysis of *Catla catla* fed with *Gracilaria edulis* at different concentrations

S. No.	Parameters	Control	*Gracilaria Edulis*		
			10%	20%	30%
1	Initial Length (Cm)	9.00 ± 0.06	9.50 ± 0.06	9.20 ± 0.06	9.20 ± 0.05
2	Final Length (Cm)	9.50 ± 0.06	11.20 ± 0.05	11.70 ± 0.08	10.00 ± 0.06
3	Initial Weight (G)	10.21 ± 0.11	11.02 ± 0.05	10.53 ± 0.07	10.44 ± 0.06
4	Final Weight (G)	12.81 ± 0.12	20.01 ± 0.12	25.25 ± 0.11	15.04 ± 0.07
5	Weight Gain (G)	2.60 ± 0.01	8.99 ± 0.03	14.72 ± 0.08	4.60 ± 0.01

Table 2: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (10 %)

S. No.	Parameters	Control	10%		
			30 Days	60 Days	90 Days
1	SGR (%)	1.98 ± 0.01	2.12 ± 0.01	2.23 ± 0.01	2.47 ± 0.02
2	FCR (%)	2.15 ± 0.01	2.26 ± 0.01	2.34 ± 0.01	2.68 ± 0.01
3	FCE (%)	1.07 ± 0.01	1.14 ± 0.01	1.26 ± 0.01	1.68 ± 0.01
4	Survival (%)	92 ± 0.35	92.5 ± 0.34	93.00 ± 0.41	93.50 ± 0.38
5	MR (k.cal/g/day)	1.68 ± 0.01	1.98 ± 0.01	2.87 ± 0.01	4.51 ± 0.02

Table 3: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (20 %)

S. No.	Parameters	Control	20%		
			30 Days	60 Days	90 Days
1	SGR (%)	1.98 ± 0.01	3.00 ± 0.02	3.09 ± 0.01	3.16 ± 0.01
2	FCR (%)	2.15 ± 0.02	3.12 ± 0.02	3.29 ± 0.02	3.49 ± 0.02
3	FCE (%)	1.07 ± 0.01	2.49 ± 0.01	2.66 ± 0.01	2.77 ± 0.01
4	Survival (%)	92 ± 0.44	96 ± 0.45	97 ± 0.45	97.50 ± 0.45
5	MR (k.cal/g/day)	1.68 ± 0.01	6.49 ± 0.03	6.53 ± 0.03	6.87 ± 0.03

Table 4: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (30 %)

S. No.	Parameters	Control	30%		
			30 Days	60 Days	90 Days
1	SGR (%)	1.98 ± 0.01	2.02 ± 0.01	2.11 ± 0.01	2.28 ± 0.01
2	FCR (%)	2.15 ± 0.01	2.21 ±0.02	2.30 ± 0.01	2.49 ± 0.01
3	FCE (%)	1.07 ± 0.01	1.12 ± 0.01	1.25 ± 0.01	1.5 ± 0.01
4	Survival (%)	92 ± 0.46	75 ± 0.31	72 ± 0.32	70.00 ± 0.29
5	MR (k.cal/g/day)	1.68 ± 0.01	1.86 ± 0.01	2.03 ± 0.01	2.88 ± 0.01

SGR = Specific Growth Rate

FCR = Food Conversion Ratio

FCE = Food Conversion Efficiency

FR = Feeding Rate

MR = Metabolic Rate

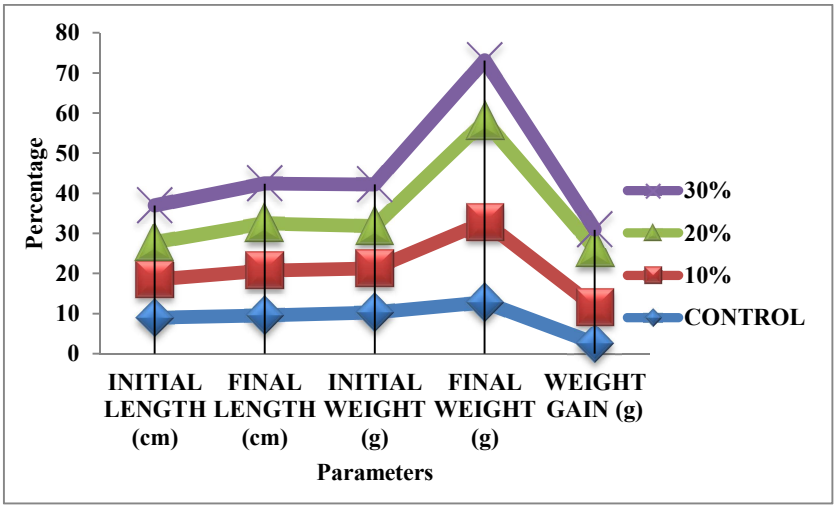

Figure 1: Morphometry analysis of *Catla catla* fed with *Gracilaria edulis* at different concentrations

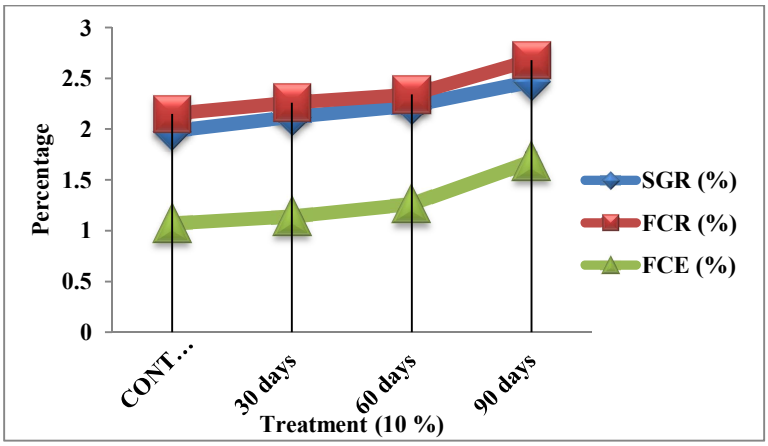

Figure 2: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (10 %)

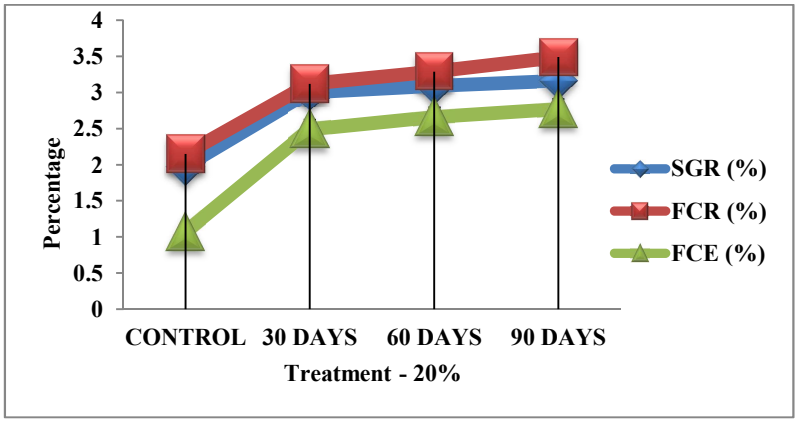

Figure 3: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (20 %)

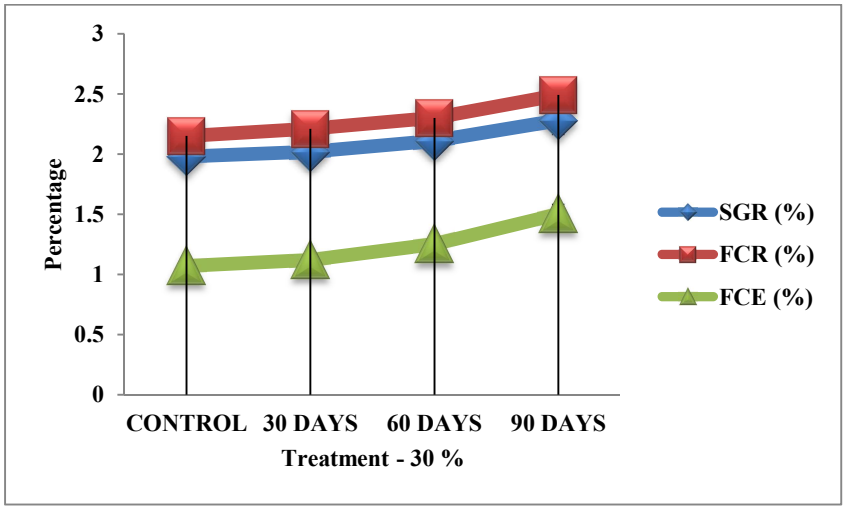

Figure 4: Growth performance and feed utilization parameters of *Catla catla* fed with *Gracilaria edulis* (30 %)

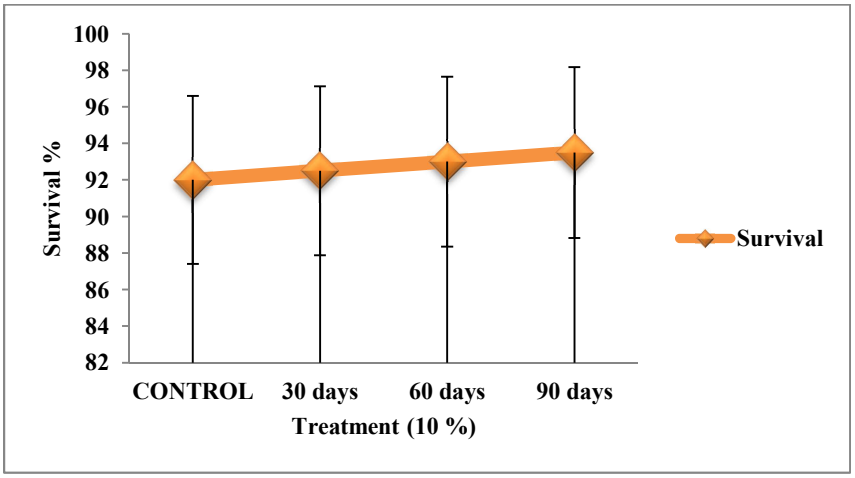

Figure 5: Survival rate of *Catla catla* fed with *Gracilaria edulis* (10 %)

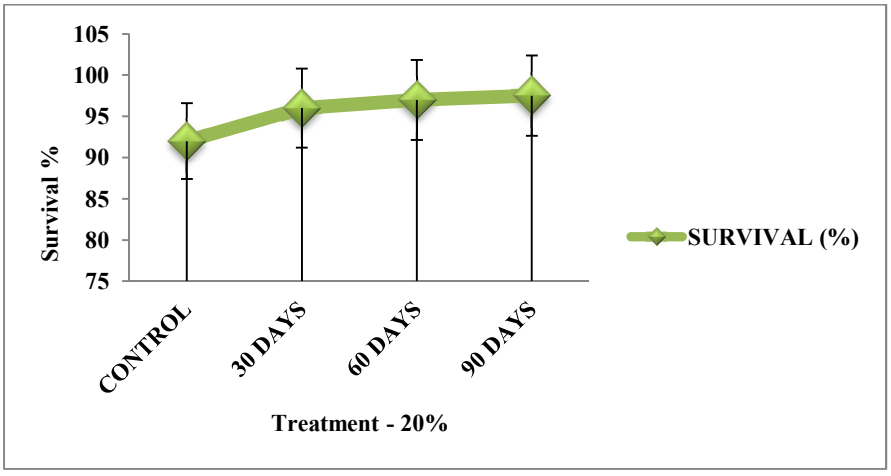

Figure 6: Survival rate of *Catla catla* fed with *Gracilaria edulis* (20 %)

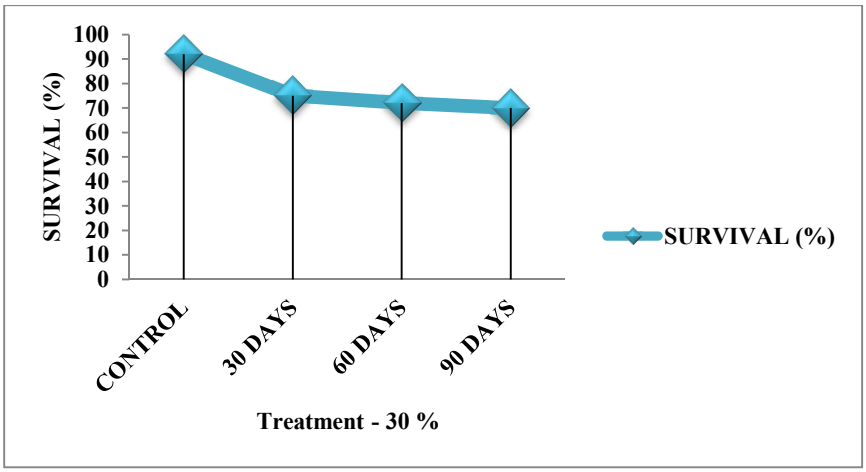

Figure 7: Survival rate of *Catla catla* fed with *Gracilaria edulis* (30 %)

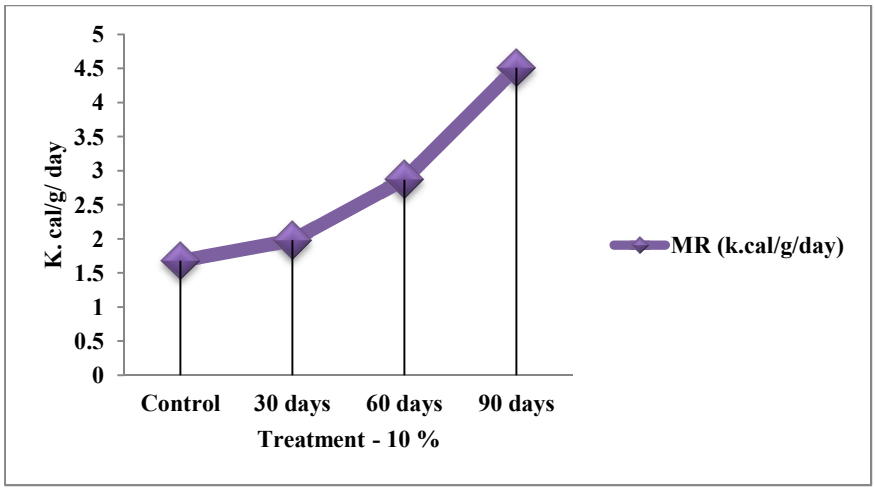

Figure 8: Metabolic rate of *Catla catla* fed with *Gracilaria edulis* (10 %)

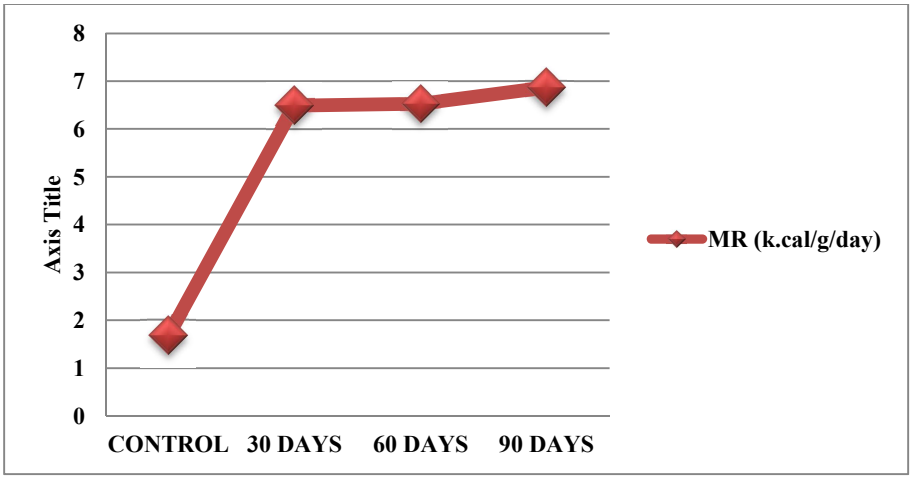

Figure 9: Metabolic rate of *Catla catla* fed with *Gracilaria edulis* (20 %)

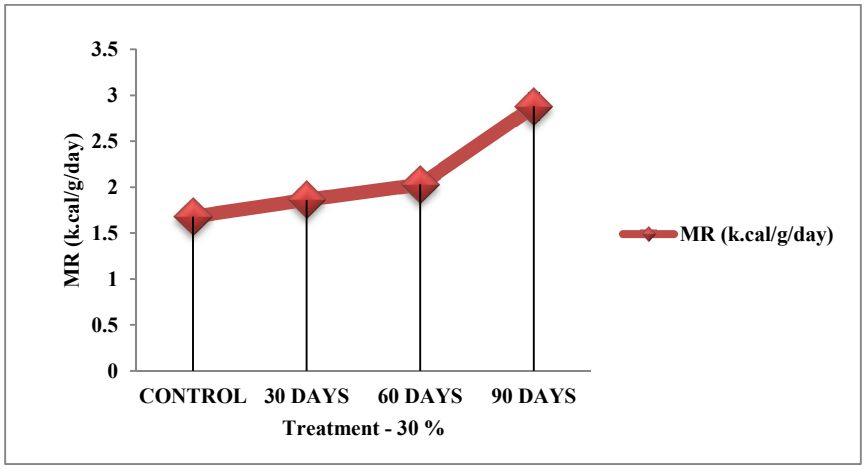

Figure 10: Metabolic rate of *Catla catla* fed with *Gracilaria edulis* (30 %)

4. CONCLUSION

Finally, it was discovered that the red algae, *Gracilaria edulis*, could be substituted for fish meal in *Catla catla* diets by less than 20%. It is needed to adjust the amount of *Gracilaria* meal in *Catla catla* diets in order to increase growth performance. It would also be interesting to compare the cost per kg of algae to fish meal to see if low inclusion levels may be economically viable on a commercial scale. Future research will be needed to assess the efficacy of this seaweed in longer-term feeding trials and to find the optimum dietary inclusion level in fish diets for the best growth performance and final product quality.

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