Scire Science Multidisciplinary Journal

Scire Science Multidisciplinary Journal 2(3), 2018, ISSN 2457-0575
An Open Access Online International Journal Available at http://www.scire.co.in/journal.php
2018, Patel et al.
DOI: https://doi.org/10.25129/2457-0575.SSMJRA2018.163

Research Article

Effect of seaweed (*Ulva* sp.) as a feed additive in the diet on growth and survival of *Labeo rohita* fry

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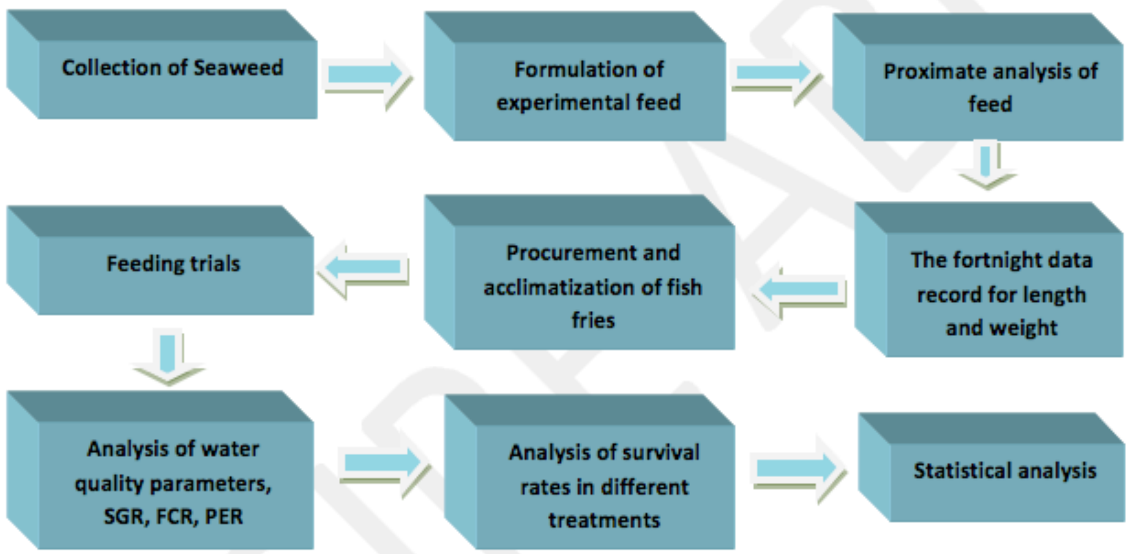
Accepted: July 2018, Available online: August 2018

Objective: To evaluate the effect of Ulva meal on the growth of *Labeo rohita* fry and to compare the rate of survival with different treatments for determining the proper proportion of Ulva meal.

Methodology:



The duration taken for the research: 03 months

Conclusion: Using seaweed Ulva meal at 10% in the diet of *Labeo rohita* is able to replace current fishmeal to make fish culture profitable.

Applicable industries: Fish feed manufacturing industries

Expected outcome: Reduction in operational cost of fish farming and enhancement of farmer's income.

Acknowledgement: The authors are grateful to Honorable Vice Chancellor, Junagadh Agricultural University and Dean, College of Fisheries Science, Junagadh Agricultural University for providing necessary facilities and constant support to carry out research work at Inland Fisheries Research Station, JAU, Junagadh.

Abstract

Research Article

Effect of seaweed (*Ulva* sp.) as a feed additive in the diet on growth and survival of *Labeo rohita* fry

Patel et al.

To evaluate the efficacy of a seaweed *Ulva lactuca* as a feed additive in the diets for *Labeo rohita,* three experimental diets consisting of seaweed *Ulva lactuca* at 10%, 20% and 30% were prepared while control diet without seaweed. The crude protein level in all diets was 30% on a dry weight basis. Total 400 number of *Labeo rohita* fry were randomly distributed into four treatments (control + treatment), each in five replicates. The daily ration was divided into two equal parts and was fed at 09.00 hrs and 17.00 hrs. The water quality parameters were found in the permissible range during the entire experimental period. At the end of the feeding trial, weight gain, feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER) was found to be in the range of 76.43 ± 4.25 to 174.84 ± 4.47 %, 1.21 ± 0.02 to1.99 ± 0.11, 1.28 ± 0.05 to 2.25 ± 0.04 and 0.54 ± 0.05 to 1.29 ± 0.03 respectively. The survival was obtained in the range of 87 ± 1.22 to 90 ± 1 %. Fish fed with 10% Ulva meal showed an increased survival and growth performance ($P < 0.05$) and also a significant increase was found in SGR, PER and FCR ($P < 0.05$)

Keywords: Seaweed, feed additive, FCR, SGR, PER

Introduction

In the last three decades (1990–2010), world aquaculture production has expanded by almost 12 times, at an average annual rate of 8.8 per cent. Global aquaculture production has continued to grow, albeit more slowly than in the 1980s and 1990s (FAO, 2012). While in 2015, global aquaculture production reached 106 million tons 76.6 million tons of aquatic animals and 29.4 million tons of aquatic plants, growing at an average annual rate of 6.6 per cent since 1995 (FAO,2017).

The most essential and significant operational input in successful aquaculture is the feed, and hence, cheap and nutritionally balanced effective artificial feeds need to be developed. Aquafeed accounts for about 50-80 per cent of aquaculture production cost and therefore, its use has to be carefully considered and managed. Nutritionally balanced fish feeds generally contain fishmeal, de-oiled cakes and rice bran. Currently, the search is on for alternative sources of feed ingredients, the main reasons being escalated cost and uncertainty of constant supply of common feed ingredients. The importance of algae as a potential substitute protein source for cultured fish feeding has been documented in recent years. The annual global aquaculture production of marine algae was 14.5x10 tonnes (including brown, green and red seaweeds and different aquatic plants) in 2007 (Yildirim *et al*., 2009). Global production has been dominated by marine macro-algae, or seaweeds, grown in both marine and brackish waters. Seaweeds are receiving consideration for their high protein value, essential amino acid content, vitamins and trace metals in fish feeding. Due to the seasonal availability of seaweeds used for feed, it is necessary to develop a formulated feed to promote the development of an intensive aquaculture industry.

Ulva species have become critical macroalgae, which have been investigated as a dietary ingredient for fish feed in a wide range of fish species. Low-level dietary incorporation of *Ulva* meal has resulted in improved growth, feed utilization, physiological activity, disease resistance, carcass quality, and reduced stress response (Mustafa and Nakagawa, 1995; Wassef *et al*., 2005; Valente *et al*., 2006). *Ulva* species have a good vitamin and mineral profile and are especially rich in ascorbic acid (Ortiz *et al*., 2006; Garcı´a-Casal *et al*., 2007). Vitamin C promotes lipid metabolism, which may result in the alteration of body composition and nutrient deposition in fish, and thus may reduce carcass lipid and increase protein levels (Ji *et al*., 2003).

Valente *et al.,* 2006 this study aimed to evaluate the inclusion of three seaweeds *Gracilaria bursa-pastoris* (GP), *Ulva rigida* (UR) and *Gracilaria cornea* (GC) as dietary ingredients on the performance, nutrient utilisation and body composition of European sea bass juveniles. Six experimental diets were formulated to replace 5% (GP-5, UR-5, and GC-5 Diets) and 10% (GP-10, UR 10 and GC- 10 Diets) fish protein hydrolysate (CPSP) by each of the three seaweeds. The results obtained in this study suggest that the inclusion of *G. bursa-pastoris* (GP) and *U. rigida* (UR), up to 10%, can be considered as new ingredients in diets for sea bass juveniles, as no negative consequences on growth performance, nutrient utilization or body composition were observed. On the other hand, the inclusion of *G. cornea* (GC) should be limited to 5% of the diet.

Yildirim *et al*., 2009 determined the effects of a diet containing two seaweed species, *Ulva lactuca* and *Enteromorpha linza*, on the growth performance, feed utilization and body composition of rainbow trout. Two experimental diets were formulated with the usage of 10% *U. lactuca* meal and 10% *E. linza* meal in feed and control group had no seaweed ingredients. Each experiment was triplicate, and each group had fourteen fish specimens with an average weight of 32.96±0.29 g. Fish were fed three times per day for 60 days. Significant differences were determined in weight gain, specific growth rate, relative growth rate and feed utilization between experimental and control groups ($P<0.05$). The results of the experiment revealed that a diet with *U. lactuca* and *E. linza* inclusion at 10% levels resulted in weaker growth and feed utilization for rainbow trout when compared to those of the control group.

Kotnala *et al.,* 2010 investigated the growth performance of Indian major carp (*Catla catla,* Ham.) over a period through formulated feeds consisting of three seaweeds, namely *Chlorodesmis fastigiata*, *Padina tetrastomatica* and *Stoechospermum marginatum*. The data of the present study demonstrated that seaweeds, such as *C. fastigiata* and *P. tetrastomatica*, could be used in commercially formulated feed to get better growth of the fingerlings of major carps. Shude *et al.,* 2011 evaluated the feasibility of dried seaweed *Gracilaria lemaneiformis* (Bory) as a dietary ingredient for the rabbitfish *Siganus canaliculatus* (Park), juvenile fish (average weight 15.64 ± 0.15 g) were fed with two isonitrogenous (32% crude protein) and isolipid (8% lipid) diets. The survival rate of fish and apparent digestibility coefficient of diets were the same between the two groups. These results indicated that incorporation of Dried *Gracilaria lemaneiformis* in the diet of *S. canaliculatus* is feasible, and further studies are recommended to optimize the level of Dried *Gracilaria lemaneiformis* in the diet of *S. canaliculatus* to improve growth performance. Kotnala *et al.,* 2010 the growth performance of Indian major carp (*Catla catla,* Ham.) was assessed over a period of six months through formulated feeds consisting of three seaweeds, The data of the present study clearly demonstrated that seaweeds, such as *C. fastigiata* and *P. tetrastomatica*, could be used in commercially formulated feed to get better growth of the fingerlings of major carps.

Prasanna *et al.,* 2011, the study was conducted to evaluate the nutritional value of four seaweeds. The four seaweeds were *Enteromorpha intestinalis, Grateloupia filicina, Gracilaria verrucosa* and *Polysiphonia sertularioides* which were added at various induction levels in the diets fed to juvenile Rohu (*Labeo rohita*) and Mrigal (*Cirrihinus mrigala*) fingerlings. The specific growth rate was found to be more in the *Polysiphonia sertularioides* additive algal diets *in Cirrihinus mrigala*. The specific growth rate was found to be more in *Gracilaria verrucosa* additive diets in Rohu (*Labeo rohita*) fingerlings. This difference may be attributed not only to the additional protein content but to the value addition in terms of specific essential amino acid and fatty acids.

Materials and Methods

The experiment was conducted at Inland Fisheries Research Station, Junagadh Agricultural University, Junagadh (Gujarat) to study the effect of seaweed Ulva on growth performance of

Fry of *Labio rohita* (rohu) with a total length of 0.38 ± 0.09 cm (mean ± SE) and weighing 0.62 ± 0.04 g were selected for the experiment. Fry purchased from the Fish Hatchery & brought to Inland Fisheries, Research Station, Junagadh Agricultural University, Junagadh (Gujarat) and were allowed to remain in plastic pools (500 L) for acclimatization with continuous aeration. Fry of *Labio rohita* was randomly selected and distributed in four distinct experimental groups and each with five replications. The experimental design was Factorial Randomized Block Design. The experimental setup consisted of 20 plastic tanks (40 L capacity). Four hundred (400) fish fries were randomly distributed in four distinct experimental groups. Feeding was done at the rate of 10% of body weight initially, and after ten days it was fed *ad libitum* till the end of the experiment. The daily ration was divided into two equal parts and was given at 09.00 and 17.00 hrs.

Experimental Design

The treatments are designated as follows:

- T_0= Control Diets (100% traditional feed)
- T_1= Diet (10% Seaweed 90% traditional feed)
- T_2= Diet (20% Seaweed 80% traditional feed)
- T_3= Diet (30% Seaweed 70% traditional feed)

Design:

- CRD (completely Randomized Design)
- No. of replica: 5

Each group was having five replicates following (CRD). Each tank containing 40L chlorine free water was stocked with 20 fish fries. Water used for the entire experiment was sourced from bore-well (groundwater source). Round the clock aeration was provided through the aerators.

Experimental Diets

The control diet was formulated using the locally available ingredients such as fish meal, GNOC and wheat bran that are mostly used for commercial fish culture. Fish meal was obtained from the local market of Veraval. In three experimental diets, the seaweed *Ulva* Sp. was added at the rate of 10%, 20% and 30% ingredients of control diet. For each diet, the ingredients in the required quantity used to prepare experimental diet by grinding in an electric grinder. The pelleted diet prepared and kept in airtight containers for use in the experiment. The percentage of protein in both control and experimental diet was kept uniform at the 30% level.

Table 3.1: Proximate composition of ingredients used for the preparation of treatments diets

Ingredients	Moisture	CP (%)	Fat	Carbohydrate	Ash
Fish meal	7.30	40	6.07	29.4	23.50
Starch	10.6	0.19	0.10	91.8	0.06
Wheat bran	9.15	12.41	1.01	23.09	1.70
Seaweed	6.90	13.2	2.5	25.56	4.88
GNOC	5.8	45.75	6.07	27.99	7.78

Results and Discussion

Growth of *L. rohita* fry

Based on the data obtained about fish length, fish weight, per cent weight gain and specific growth rate at the end of the experiment, there was a significantly higher growth reported in fish fed with the diet containing 10% seaweed (T1), as compared to all the other experimental diets.

SGR, FCR, and Survival

In the present study, significantly higher SGR (Specific Growth Rate) was observed in all the diet treatments containing seaweed as a protein source as compared to control (T0). The Highest SGR was found in T1 diet treatment (2.25 ± 0.04), whereas the lowest SGR was found in T3 (1.26 ± 0.05). FCR (Food conversion ratio) was found as a feed efficiency parameter, and it was observed that the FCR value of the treatment T1 was lowest as compared to other treatment diet T0, T2, T3. The compiled survival rates of the present study are detailed in Table 4.14. The average survival rates of treatments T0 90 ± 1, T187 ± 1.22 T2 88 ± 1.22and in T3 89 ± 2.44, respectively.

Physico-chemical water parameters:

Temperature, pH, and Dissolved Oxygen (DO), and alkalinity:

In the present study, the temperature remained between 18 to 25 ºC. The experiment was conducted during June to August month. Temperature tolerance limits for Indian major carps and common carp is reported to be 18.3°C and 37.8°C (Jhingran, 1982). The pH value ranged between 7.1-7.6, which was suitable for the rearing of fish. The dissolved oxygen values were found within the optimum range for the entire period ranging between 6.46 to 6.7 mg/L. The data for alkalinity recorded during the experimental period is shown in Fig. 4.12. The alkalinity of water was ranged from 27.5 to 28.3 mg/L during the experiment.

Diets

Proximate composition

The formulation and composition of the control and treatment diets are given in Table 4.1. The level of protein was kept at 30% among all treatment diets.

Table 4.1: Proximate Composition of control and experimental diets

Ingredients (in gm)	Diets			
	T0	T1	T2	T3
Fish meal	28.5	27.5	27	26
GNOC	28.5	27.5	27	27
WB	21	17	12.5	8
Starch	21	17	12.5	8
Ulva	00	10	20	30
Vitamin Mineral Mix	1	1	1	1

Growth of *L. Rohita* fry

Observation on the growth of *L. rohita* advance fry recorded at the end of 45th-day experimental period are summarized below

Total length (cm)

The average length (cm) of *L. rohits* observed at fortnight interval is shown in Table 4.2. The final average length recorded were in T_0 - 1.58 ± 0.02 cm, T_1 - 2.31 ± 0.04 cm, ± 0.1 cm, T_2.02 ± 0.07 cm and T_3 1.64 ± 0.09 cm. The highest length gain was observed in T1 (2.31 ± 0.04 cm) and lowest in T0 (1.58 ± 0.02 cm) treatments. The T1 treatment showed significantly higher ($p<0.05$) length gain as compared to all the other treatments. Average total length gain of fishes fed with different diets is listed in Table 4.3. The highest length gain was found in treatment T1 (183.18 ± 4.50), whereas the lowest was found in T0 diet (103.33 ± 2.04). Significance difference was found between the treatment, interaction for Wet weight of fish ($p<0.05$, Table, 4.4).

Table 4.2: Total length (cm) of *L. rohita* fry recorded in different treatments during fortnight intervals (Mean ± SE) (in cm)

Treatment	Fortnight		
	F1	F2	F3
T0	0.38 ± 0.10	1.19 ± 0.05	1.58 ± 0.02
T1	0.73 ± 0.06	1.56 ± 0.08	2.31 ± 0.04
T2	0.69 ± 0.11	1.42 ± 0.09	2.01 ± 0.07
T3	0.51 ± 0.14	1.10 ± 0.11	1.64 ± 0.09

Table 4.3: Total length gain of *L. rohita* advance fry recorded in different treatments during the culture period (Mean ± S.E.)

Treatment	Fortnight		
	F1	F2	F3
T0	19.39 ± 5.49	70.91 ± 3.97	103.33 ± 2.04
T1	39.24 ± 4.15	101.97 ± 7.33	183.18 ± 4.50
T2	37.15 ± 6.87	89.88 ± 7.46	148.09 ± 7.86
T3	26.64 ± 7.84	64.88 ± 8.00	110.12 ± 8.69

Table 4.4: Analysis of variance of total length gain of *L. rohita* advance fry recorded in different treatments during the culture period

Source of variation	Degree of freedom	Sum of square	Mean	F pr.
fortnight	2	111491.8	55745.9	<.001
treat	3	19457.7	6485.9	<.001
Fortnight treat	6	6766.7	1127.8	<.001
Residual	48	10133.6	211.1	
Total	59	147849.8		

Wet weight (g)

The average wet weight (g) of *L. rohita* observed at periodical intervals is shown in Table 4.5. The final average wet weight recorded was 1.28 ± 0.05 g, 2.25 ± 0.04 g, 1.60 ± 0.10 g, and 1.26 ± 0.05 g in treatment T0, T1, T2, and T3 respectively (Plate 4.-B). The highest final wet weight gain was observed in T1 (2.25 ± 0.04) and lowest in T3 (1.26 ± 0.05) (g) treatments. Significance difference was found between the treatment, fortnight and fortnight treatment interaction for Wet weight of fish ($p<0.05$ Table 4.7).

Percentage weight gain of fishes fed with different diets is listed in Table 4.6. The highest percentage of body weight gain was found in treatment T1 (174.84 ± 4.47 %), whereas the lowest was found in T3 diet (76.43 ± 4.25 %). (Table 4.6)

Table 4.5: Total weight (gm) of *L. rohita* fry recorded in different treatments during the culture period (Mean ± SE)

Treatment	Fortnight		
	F1	F2	F3
T0	0.58 ± 0.06	1.17 ± 0.04	1.28 ± 0.05
T1	1.43 ± 0.02	1.79 ± 0.15	2.25 ± 0.04
T2	0.75 ± 0.05	1.74 ± 0.04	1.60 ± 0.10

T3	0.55 ± 0.06	1.17 ± 0.03	1.26 ± 0.05

Table 4.6: Total weight gain (gm) of *L. rohita* fry recorded in different treatments during the culture period (Mean ± SE)

Treatment	Fortnight		
	F1	**F2**	**F3**
T0	29.88 ± 3.30	69.23 ± 2.88	77.97 ± 4.00
T1	90.70 ± 2.07	125.95 ± 13.65	174.84 ± 4.47
T2	40.47 ± 3.05	119.08 ± 3.43	106.57 ± 9.39
T3	28.30 ± 3.52	69.65 ± 2.38	76.43 ± 4.25

Table 4.7: Analysis of variance of total % wet weight gain of the *L. rohita* fry recorded in different treatments during the culture period

Source of variation	Degree of freedom	Sum of square	Mean square	F pr.
Fortnight	2	42205.3	21102.6	<.001
Treat	3	52158.6	17386.2	<.001
Fortnight .treat	6	6841.9	1140.3	<.001
Residual	48	7820.5	162.9	
Total	59	109026.3		

SGR:

The specific growth rate (SGR) of *L. rohita* fry in different treatments is given in Table 4.8. Highest SGR was found in T1 diet treatment (2.25 ± 0.04) followed by T2 (1.60 ± 0.10), T3 (1.26 ± 0.05) and T1 (1.28 ± 0.05). Thus, the lowest SGR (1.26 ± 0.05) was observed in T3. A significant difference (p>0.05) was observed among the treatment diets, fortnight and fortnight treatment interaction where T1 was found to be higher as compared to the other treatments (Table 4.9). Fig. 4.1 depicts the SGR obtained in respective treatments.

Table 4.8: Specific growth rate (SGR) of *O. mossambicus* advance fry recorded in different treatments during the culture period (Mean ± S.E.)

Treatment	Fortnight		
	F1	**F2**	**F3**
T0	0.58 ± 0.06	1.17 ± 0.04	1.28 ± 0.05
T1	1.43 ± 0.02	1.79 ± 0.15	2.25 ± 0.04
T2	0.75 ± 0.05	1.74 ± 0.04	1.60 ± 0.10
T3	0.55 ± 0.06	1.17 ± 0.03	1.26 ± 0.05

Table 4.9: Analysis of variance of specific growth rate (SGR) of the *L. rohita* fry recorded in different treatments during the culture period

Source of variation	Degree of freedom	Sum of square	Mean square	F pr.
Fortnight	2	6.77030	3.38515	<.001
treat	3	6.86634	2.28878	<.001
Fortnight .treat	6	0.66357	0.11059	<.001
Residual	48	1.03066	0.02147	
Total	59	15.33087		

FCR

Feed conversion ratio was found in T_0 (control) diet followed by 1.94 ± 0.10, T_1 (10% seaweed) diet followed by 0.86 ± 0.02, T_2 (20% seaweed) diet followed by 1.45 ± 0.13, T3 (20% seaweed) diet followed by 1.99 ± 0.11 respectively (Table 4.10). The significant difference found in treatment T_0. The lowest FCR found in treatment T_0 (0.86 ± 0.02) and highest FCR found in treatment T_3 (1.99 ± 0.11). A significant difference (p>0.05) was observed among the treatment diets, fortnight and fortnight treatment interaction where T1 was found to be higher as compared to the other treatments.

Table 4.10: Feed conversion ratio (FCR) of *O. mossambicus* advance fry recorded in different treatments during the culture period (Mean ± S.E.)

Treatment	Fortnight		
	F1	**F2**	**F3**
T0	5.27 ± 0.59	2.18 ± 0.10	1.94 ± 0.10
T1	1.66 ± 0.04	1.27 ± 0.19	**0.86 ± 0.02**
T2	3.81 ± 0.33	1.26 ± 0.04	1.45 ± 0.13
T3	5.65 ± 0.72	2.16 ± 0.07	1.99 ± 0.11

Table 4.11: Analysis of variance of feed conversion ratio (FCR) of the *L. rohita* fry recorded in different treatments during the culture period

Source of variation	Degree of freedom.	Sum of square	Mean square	F pr.
Fortnight	2	80.6743	40.3372	<.001
treat	3	39.2831	13.0944	<.001
Fortnight .treat	6	18.1415	3.0236	<.001

Residual	48	21.3036	0.4438	
Total	59	159.4025		

PER

The results on protein efficiency ratio (PER) of *L. rohita* under different treatments are given in Table 4.12. The lowest PER was found in T1 (0.76 ± 0.04) while the highest PER was found in T4 (0.98 ± 0.13). Concerning PER, all the treatments not significantly differed with each other (p>0.05, Table 4.13), with T4 diet showing highest PER. Protein efficiency ratio (PER) as observed in the respective treatments is shown in Fig. 4.3.

Table 4.12: Protein efficiency ratio of *L. rohita* fry recorded in different treatments during the culture period (Mean ± SE)

Treatment	Fortnight		
	F1	F2	F3
T_0	0.66 ± 0.07	0.53 ± 0.01	0.58 ± 0.03
T_1	2.02 ± 0.05	1.17 ± 0.13	1.29 ± 0.03
T_2	0.90 ± 0.07	1.15 ± 0.02	0.75 ± 0.05
T_3	0.63 ± 0.08	0.83 ± 0.16	0.54 ± 0.05

Table 4.13: Analysis of variance of protein efficiency ratio (PER) of the *L. rohita* fry recorded in different treatments during the culture period

Source of variation	Degree of freedom	Sum of square	Mean square	F pr.
fortnight	2	0.68091	0.34045	<.001
treat	3	7.54588	2.51529	<.001
Fortnight. treat	6	2.07264	0.34544	<.001
Residual	48	1.31222	0.02734	
Total	59	11.61165		

Survival

Data for survivals of *L. rohita* fry in the respective treatments are detailed in Table 4.14. The average survival rates of treatments T0 90 ± 1, T187 ± 1.22 T2 88 ± 1.22and in T3 89 ± 2.44 respectively. However, there was found no significant difference among the treatments (p>0.05, Table 4.15). Fig. 4.5 depicts the survival obtained in the respective treatments.

Table 4.14: Survival of *L.rohita* fry recorded in different treatments during the culture period (Mean ± S.E.)

Treatment	Fortnight		
	F1	F2	F3
T0	94 ± 1	92 ± 1.22	90 ± 1
T1	92 ± 1.22	88 ± 1.22	87 ± 1.22
T2	93 ± 1.22	89 ± 1	88 ± 1.22
T3	93 ± 1.22	90 ± 2.23	89 ± 2.44

Table 4.15: Analysis of variance of survival of the *L. rohita* fry recorded in different treatments during the culture period

Source of variation	Degree of freedom	Sum of square	Mean square	F pr.
fortnight	2	215.833	107.917	<.001
treat	3	71.250	23.750	0.077
Fortnight .treat	6	7.500	1.250	0.992
Residual	48	470.000	9.792	
Total	59	764.583		

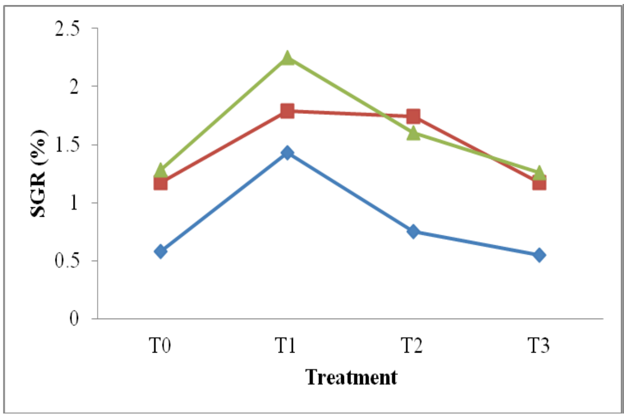


Figure 4.1: Specific growth rate (SGR) of *L. rohita* fry in different treatments during the culture period

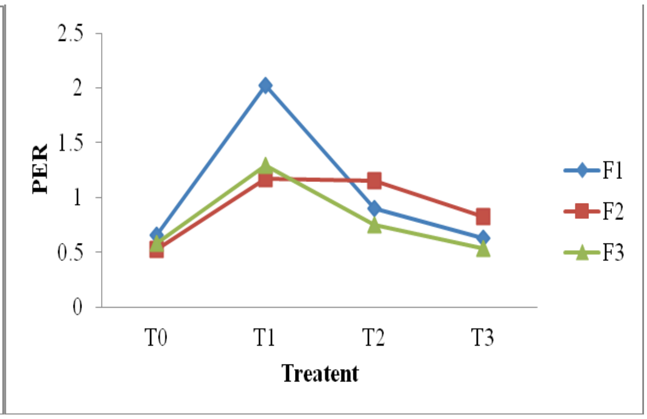


Figure 4.2. Protein efficiency ratio (PER) of *L. rohita* fry in different treatments during the culture period.

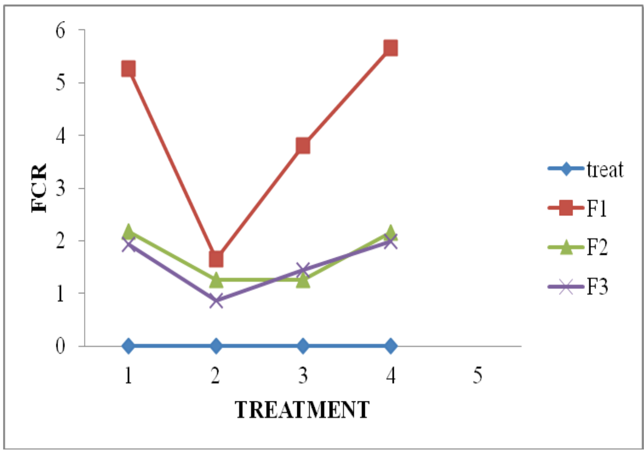


Figure 4.3: Food conversion ratio (FCR) of *L. rohita* fry in different treatments during the culture period.

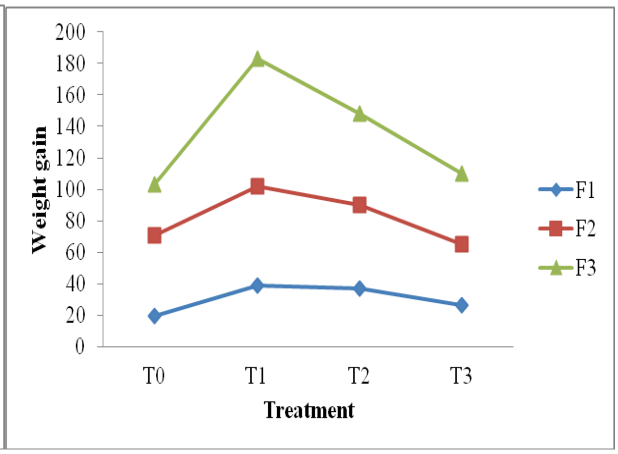


Figure 4.4: Weight gain (%) of *L. rohita* fry in different treatments during the culture period.

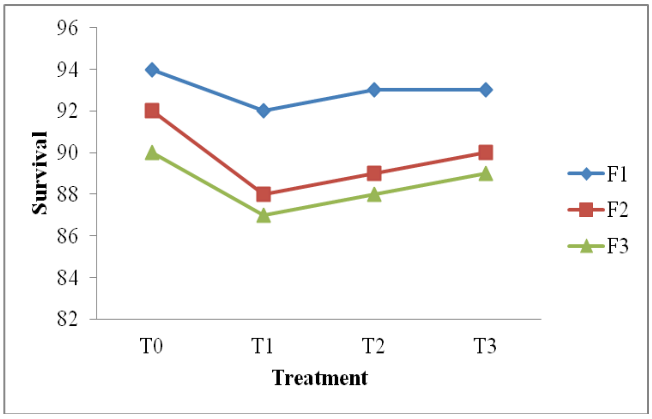


Figure 4.5: Survival of *L. rohita* advance fry in different treatments during the culture period.

Physico-chemical water parameters:

Water temperatures ranged from 18°C to 25°C the experimental period (Fig. 4.6). The pH ranged from 7.3 - 7.4 during the experimental period (Fig. 4.7). The data for dissolved oxygen ranged from 7.6 to 7.7 (Fig. 4.8). The dissolved oxygen content was found within the optimum range during the experimental period. The alkalinity of water ranged from 27.5 to 28.3mg/L (Fig. 4.9).

Most commercial fish feed ingredients are costly and non–availability poses problems for fish farmers to take of aquaculture practices. In the present investigation, attempts have been undertaken to find out the suitable alternative cheaper ingredient of wide availability to boost the culture. Even though algae are a cheaper source of protein, lipid and other nutrients and their culture is easy, they are yet to be considered as a major food item for fish.

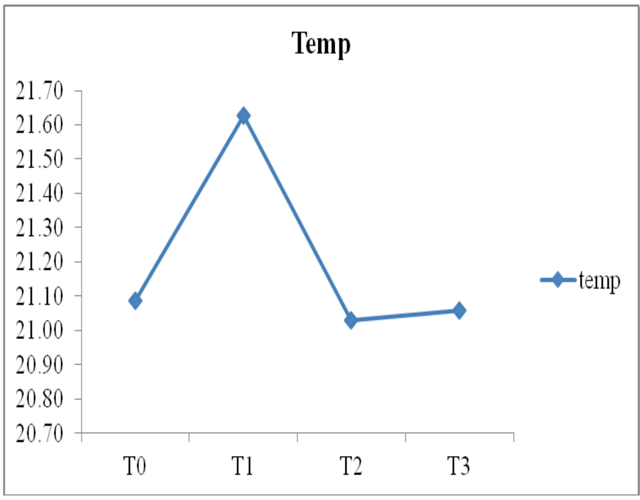


Figure 4.6: Temperature (°C) recorded during different treatments during the experimental period.

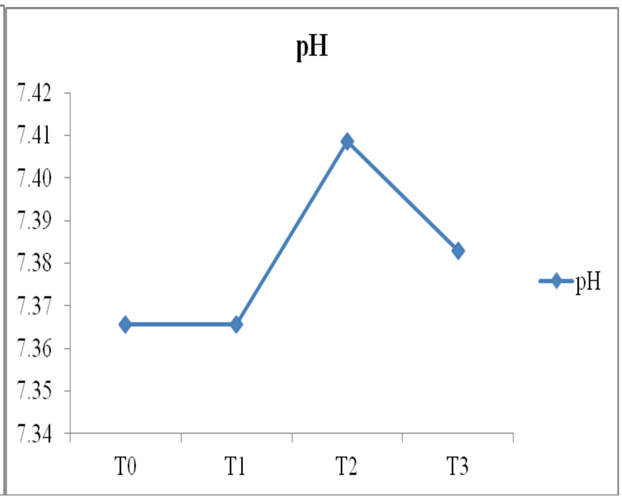


Figure 4.7: pH recorded during different treatments during the experimental period.

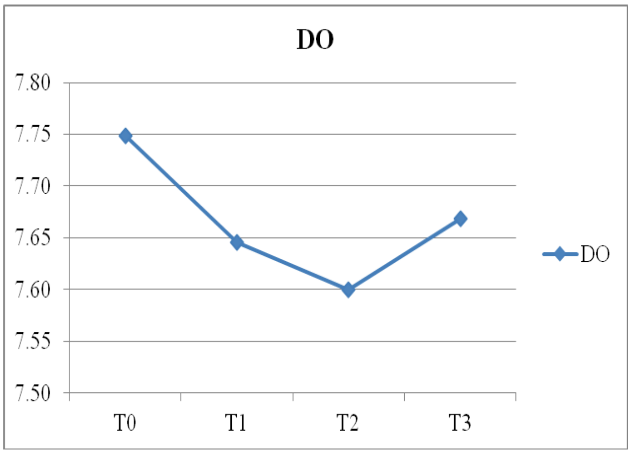


Figure 4.8: Dissolved oxygen (ppm) recorded in different treatment during the experimental period.

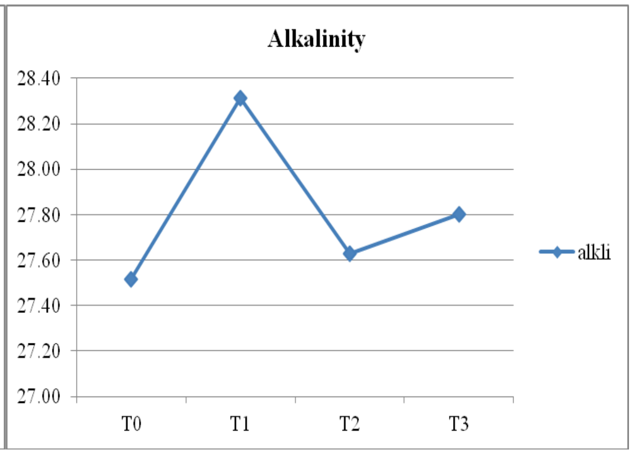


Figure 4.9: Alkalinity (mg/L) recorded in different treatments during the experimental period.

Feeds from plant origin have been reported to be effective and less expensive ingredients to fish diets (Dorsa *et al*., 1982; Robinson *et al*., 1984a, b; Ofojekwu and Ejike, 1984). These feeds are known to have an excellent amino acid profile (Jackson *et al*., 1982). In the recent years, feeds from plant origin have been accepted for Indian major carps as the growth in fishes has been reported to be as good as the traditional feed (Patnaik and Das, 1979). In some cases, aquatic and terrestrial macrophytes have been used as an alternative source of plant proteins to develop suitable fish feeds (Edwards *et al*., 1985; Devaraj *et al*., 1986).

Conclusion

Seaweeds are receiving greater importance for their high protein value, essential amino acid content, vitamins and trace metals in fish feeding. The result of the present experiment is in agreement with the result of Abdel-Aziz MFA, Ragab MA (2017) it is, therefore, recommended to develop a formulated feed to promote the development of an intensive aquaculture industry. Therefore, it is envisaged that, using seaweed *Ulva* meal @ 10% in the diet of *Labeo rohita* to reduce the cost of production and to make fish culture profitable.

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