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Growth assessment of gold fish *Carassius auratus* (Linnaeus 1758) when fed with seaweed incorporated diets

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Abstract
An experiment was conducted to determine the growth and biochemical performance of ornamental fish Carassius *auratus*, for 40 days. In the present study to examine the effects of the three different types of feed namely, Sargassum ilicifolum, Padina tetrastromatica and Gracilaria corticata, at different concentrations in growth and biochemical parameters such as protein, lipid and carbohydrate were studied in C. auratus. The fish fed with S. ilicifolium 20%, 30% 40%, P. tetrastromatica 20%, 30%, 40% and G. corticata 20% 30%, 40% and control (0% seaweed) different experimental diets, in place of fish meal as protein source at 5% of the body weight. The results also clearly showed that C. auratus fed with diet 40% Gracilaria corticata meal dietary inclusion perform the best result among experimental diets. Although fishmeal is non replaceable but can be supplemented with seaweed meal up to an optimum level to produce cost effective fed for *C. auratus*.. There was significant difference ($P<0.05$) in growth and biochemical parameters of fish that were fed with experimental diets.

Keywords: carassius auratus, sargassum ilicifolum, padina tetrastromatica and gracilaria corticata

1. Introduction
Ornamental fish farming is the one of the most valuable in recent years. Ornamental fishes are often referred as living jewels due to their color, shape and behavior. They are peaceful, generally tiny, attractively coloured and could be accommodated in confined spaces. The ornamental fishes are kept as pets in confined space of an aquarium or a garden pool for fun and fancy.

The production and trade of ornamental fish is a profitable alternative in the aquaculture sector. Freshwater and marine species have been used successfully in the aquarium fish trade [27]. Ornamental fishes have traditionally been fed with live feed, which were often nutritionally deficient and can act as the transmitter of diseases (parasitic, bacterial and viral) if not stored properly [18]. The development of manufactured feed could be considered as one of the tremendous growth of this hobby's widespread popularity over the past 50 years [8].The increased acceptability and reliance upon manufactured feed for ornamental fishes has focused the attention the nutritional requirements of these animals. Most information on the quantitative and qualitative nutrient requirements of ornamental fishes in public and home aquaria were derived principally from research carried out by the aquaculture industry since the1970s [21].

The young fishes are fed mainly with *Infusoria*, Artemia, Daphnia, Mosquito larvae, Tubifex and blood worms. For rearing, formulated artificial or prepared feed can be used. The use of artificial feed balanced in protein, lipid, carbohydrate, vitamins, minerals and containing optimum growth/energy ratio is an obvious approach to realize genetic potential for survival, immunity, growth and reproduction. Many authors have studied the replacement of fishmeal by various ingredients of low cost feed intake and growth in cultivable fishes [2, 25, 26].

Seaweeds are marine macro algae and primitive type of plants, growing abundantly in the shallow waters of sea, estuaries and backwater. They flourish wherever rocky, coral or suitable substrata are available for their attachment.

Seaweeds have been used since ancient times as food, fodder, fertilizer and as source of medicinal drugs. Today seaweeds are the raw materials for industrial production of agar, algin and carrageenan but they continue to be widely consumed as food in Asian countries. They are nutritionally valuable as fresh or dried vegetables, or as ingredients in a wide variety of prepared foods. In particular, certain edible seaweeds contain significant quantities of lipids, protein, vitamins and mineral, although nutrient contents vary with species geographical location season and temperature [14].

This study was carried out to determine the nutritive effect of seaweeds when they are used as feed. Their effects on the growth and proximate composition of the gold fish were studied at different concentrations.

2. Materials and methods
In the present investigation the effect of the three different types of feed namely, *Sargassum ilicifolum* (D1), *Padina tetrastromatica* (D2) and *Gracilaria corticata* (D3), at different concentrations on the growth and proximate composition studies of gold fish *Carassius auratus* was studied.

2.1 Collection of seaweeds:
The seaweeds samples, *S.ilicifolum*, *P.tetrastromatica* and *G.corticata* were collected from the littoral and sublittoral zone of Hare island in Tuticorin, Tamil Nadu, India in the early morning. These samples were thoroughly washed with surrounding seawater and were placed in conditional plastic bags until carrying it to the laboratory. Samples were then brought to the lab and washed 3 to 4 times with freshwater to remove the debris, epiphytes and adhered sand/dirt particles. All these samples were dried at room temperature for 10 days. After 10 days these samples were powdered.

2.2 Collection and acclimation

The experimental animal, *C.auratus* was collected from the local fish farm in Thoothukudi, Tamil Nadu, India and immediately transported to the laboratory in a separate plastic buckets with the same water. These fish were acclimatized to the laboratory condition for a month. During acclimatization the animals were fed with dried pellets. The water in the rearing plastic trough was daily changed. After that, they were released into 20 experimental plastic trough which are grouped into two tanks as one set. First group of the fish were fed with control feed and other experimental trough of fishes were fed by *S. ilicifolum* 20%, 30%, 40% as *P.tetrastromatica* 20%, 30%, 40% and *G. corticata* as 20%, 30%, 40% respectively.

2.3 Feed preparation

Feed preparation was done according to Hardy method [10]. 40% protein diet was prepared for experimental use. Test diets were prepared using ingredients like fishmeal, ground nut oil cake, rice bran, cod liver oil and vitamin & mineral mix. The dried and powdered ingredients were blended at first to make a homogenous mixture. Subsequently mixed with suitable level of dried *S. ilicifolum*(20%, 30%, 40%),*P.tetrastromatica* (20%, 30%, 40%*)* and *G.corticata* (20%, 30%, 40%) with an aliquot of boiled water and then steam cooked for 15-20 minutes. After moderate cooking, pellets (2mm) were prepared with a hand operated pelletizer and dried in sunlight. After drying, diets were separately stored in refrigerator for experimental use.

2.4 Feeding

The prepared pelleted feed was fed to the *C. auratus* at the rate of 5% of body weight, twice a day at 8hr and 17hr and after 1 hour of feeding unconsumed feed was collected and dried in a hot air oven at 80˚C for two days.

2.5 Sampling

Sampling was carried at once in 10 days and growth and biochemical parameters of experimental fish were carried out for protein, lipid and carbohydrate [13, 3, 22].

$$\text{FEED CONVERSION RATIO (FCR)} = \frac{\text{Total dry weight of food consumed (g)}}{\text{Total wet weight gain (g)}}$$

$$\text{SPECIFIC GROWTH RATE (SGR)} = \frac{\text{Final wet weight} - \text{Initial wet weight}}{\text{No. of days}} \times 100$$

$$\text{GROWTH CONVERSION EFFICIENCY (GCE)}$$

$$\text{GCE} = \frac{\text{Growth in terms of dry weight gain (production)}}{\text{Total dry weight of food consumed}}$$

$$\text{FEEDING RATE (FR)}$$

$$\text{FR} = \frac{\text{Feed Consumed}}{\text{Initial weight of fish} \times \text{No. of days}}$$

3. Results and Discussion

In the present investigation three different types of food at different concentrations viz. *S. ilicifolium* 20% (D1), 30% (D2), 40% (D3), *P. tetrastromatica* 20% (D4), 30% (D5), 40% (D6) and *G. corticata* 20% (D7), 30% (D8), 40% (D9) were given to the test animals of gold fish for 40 days period. During the feeding trial the fishes accepted the different diet levels but variations were noted in different parameters such as growth, and proximate composition were studies.

Growth performance of *C.aurutus* (gold fish) fed on diets with different types and different concentrations of seaweeds is shown in Table (1).

Table 1: Performance and feed utilization parameters of Carassius auratus fed on the experimental diets. Each value is the mean (x±sd) of three estimations

Parameters	Diets									
	Control	D1	D2	D3	D4	D5	D6	D7	D8	D9
Initial weight (g)	6.06±0.057	6.09± 0.081	5.8 ± 0.102	5.84 ± 0.136	6.05 ± 0.020	6.02 ± 0.020	6.07 ± 0.020	6.01 ± 0.081	6.02 ± 0.065	6.01 ± 0.081
Final weight (g)	7.1±0.080	7.3± 0.124	7.3 ± 0.163	7.6 ± 0.205	7.3 ± 0.163	7.9 ± 0.124	8.2 ± 0.244	7.8 ± 0.124	8.0 ± 0.163	9.0 ± 0.368
Initial length (cm)	7.2±0.20	7.2±0.16	7.3 ± 0.08	7.2 ± 0.12	7.3 ± 0.05	7.2 ± 0.08	7.3 ± 0.08	7.1 ± 0.08	7.3 ± 0.08	7.1 ± 0.08
Final length (cm)	8.6±0.21	9.1±0.12	8.9 ± 0.12	9.1 ± 0.05	8.9 ± 0.05	9.4 ± 0.16	10.03 ± 0.20	9.9 ± 0.08	10.4 ± 0.12	11.3 ± 0.20
Food Conversion Ratio (FCR)	27.95±0.367	24.67±0.869	21.66±0.273	17.75±0.204	23.80±0.608	17.82±0.159	17.78±0.256	19.90±0.489	13.63±0.477	12.75±0.510
Specific Growth Rate(SGR)	2.5±0.047	3.1± 0.117	3.6± 0.051	4.4± 0.047	3.3± 0.151	4.8 ± 0.081	4.9 ± 0.286	4.6± 0.081	7.2 ± 0.081	8.0 ± 0.449
Gross Conversion Efficiency(GCE)	2.63±0.106	3.2± 0.163	3.73 ± 0.028	4.17 ±0.020	3.57± 0.020	3.80 ± 0.016	4.14 ± 0.024	3.62 ± 0.20	4.42 ± 0.024	4.56 ± 0.032
Feeding Rate	0.285±0.004	0.300±0.005	0.333±0.005	0.333±0.002	0.320±0.008	0.356±0.003	0.363±0.005	0.389±0.008	0.463±0.003	0.481±0.009
Survival Rate	95%	100	100	100	100	100	100	100	100	100

The results of the present study have shown that growth performance (final body weight, final length, specific growth rate, cross conversion efficiency, feeding rate, FCR and survival rate increased significantly ($P < 0.05$) with increase of different types of food at different concentrations. (*S.ilicifolium*,*P. tetrastromatica* and *G.corticata*). However,the highest values of FBW (9±0.368), FL (11.3±0.20), SGR (8±0.44), GCE (4.56±0.032), FR (0.481±0.009) and SR (100%) were obtained by fish feed 40% of *G.corticata,* while the lower values of FBW (7.3±0.124), FL (9.1±0.12), SGR (83.1±0.11), GCE (3.20±0.163), FR (0.300±0.005) and SR (100%) were recorded with fish maintained with 10% *S. ilicifolium* and followed by 40% of *P. tetrastromatica* and 40% of *G. corticata.* Obviously, FCR is inversely proportional relationship was obtained in FCR in relation of seaweed diets. The *C. aurutus* consumed 40% *G. corticata* diet elicited the lower level of FCR as compared to other diets.

With respect to body composition of *C.aurutus* resulted in Table (2)

Table 2: Analysis of proximate composition in *Carassius auratus* fed on experimental diets in different concentrations. Each value is the mean (x±std) of three estimations

Days		Protein	Lipid	Carbohydrate
Control	Initial	6.28±1.11	0.3±0.10	1.32±0.02
	Final	7.09±1.73	1.45±0.28	1.61±0.06
D1	Initial	8.80±1.28	1.05±0.30	2.02±0.63
	Final	9.64±0.17	3.55±0.06	2.74±0.07
D2	Initial	8.77±0.30	1.15±0.35	2.05±0.35
	Final	9.90±0.43	3.55±0.06	2.96±0.03
D3	Initial	8.25±0.52	1.19±0.63	2.15±0.09
	Final	9.96±0.43	3.95±0.19	3.19±0.0
D4	Initial	8.01±0.234	1.00±0.24	2.19±0.58
	Final	10.65±0.31	3.12±0.0	3.15±0.04
D5	Initial	8.25±0.76	1.08±0.13	2.12±0.61
	Final	10.86±0.50	3.39±0.02	3.32±0.03
D6	Initial	8.23±0.52	1.02±0.24	2.12±0.61
	Final	11.98±0.52	3.52±0.04	3.58±0.11
D7	Initial	8.37±0.15	0.99±0.14	2.43±0.58
	Final	13.53±0.71	2.69±0.29	4.11±0.03
D8	Initial	8.88±0.72	1.00±0.12	2.15±0.90
	Final	13.87±0.34	2.87±0.04	4.34±0
D9	Initial	8.40±0.88	1.05±0.41	2.23±0.57
	Final	14.35±0.91	2.97±0.14	4.58±0.15

Showed that protein and carbohydrate contents were gradually increased in the seaweed incorporated diets and it was significantly increased ($P< 0.05$) in fish fed with 40% *G.corticata* diet. Generally with the values of 14.35±0.91 and 4.58±0.15 respectively, followed by fish maintained at 30, 40% *G. corticata*, 40, 30, 20% *P.tetrastromatica* and finally lowest values are obtained with 40, 30, 20% of *S. ilicifolium.*

Lipid content in the fish body showed differences among treatements. Fish maintained at 40% *S. ilicifolium* in the diet were significantly ($P< 0.05$) the highest in lipid content than other treatments with the value of 2.97±0.04.

These results are also in agreement with replacement of fish meal with dried microalgae (50%) (*Chlorella spp* and *Scenedesmus spp*) in fish diets significantly increased the Final body weight (30.7g and 31.96g), FCR (2.03 and 1.76), SGR (1.70 and 1.76) [23]. Similarly inclusion of algae in fish diets significantly ($P<0.5$) increased the Live Body Weight (36.69g) and Body Weight Gain (26.46g), Daily Weight Gain (0.29g) and Specific Growth Rate (1.22) [28]. Improvement and growth performance of *Oreochromis niloticus* on feeding with macro bacterial genus *Spirulina* [6] And also the length, weight and FCR were significantly increased in Nile Tilapia fingerlings when fed with 20% brown seaweed meal *Ascophyllum nodosum* [5]. The fish fed with 5% *Ulva sp*. meal showed an increased growth performance compared with non *Ulva sp*. Supplemented diets in Nile Tilapia [9].

The mixed diet consisting of *Gracilaria lemaneiformis* significantly increased shell length, FCE, FR, FCR and SR of abalone [29]. Also increase in body weight as well as SGR percentage in gold fish on treatment with microalgae based feed (12).Several studies have evaluated the feasibility of using red macroalgae of Gracilaria gracilis, G.cornea and G.tenuistipitata in fish diets improve growth rate of abalone [4, 11, 24].

In grey mullet, where the protein content increased significantly with increasing seaweeds level of *Ulva sp*. up to 28% in the fish diet [7]. Similarly protein content increased significantly in the fish fed with 25% of *Ulva sp.* and the lipid content increased in 10% concentration of *Ulva sp* [16].The fish fed with 50% algal biomass showed the protein and lipid content was high when compared with other experimental diets [20]. The dry matter of Tilapia and common carp increased with increasing replacement by aquatic plant less than 20% for tilapia and less than 30% for common carp, whereas fat contents were opposite trend by protein contents [1]. Similarly that brown seaweed of *Ascophyllum nodosum* meal increased muscle protein deposition in red sea bream [15].

4. Conclusion

In conclusion, from the present experiment, it could be concluded that seaweeds (*S.ilicifolium, P.tetrastromatica* and *G. corticata* diet gave best growth performance and proximate composition in *C. aurutus.* Thus we can say as results of our present experiment that fish feed prepared from seaweeds are economically cheap compared to the fish meal.

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