Effect of various feed rations on the growth, survival and body composition of gold spot mullet (*Liza parsia*) fry reared in cages

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Abstract

Liza parsia fry were trained on dry feed, were kept in pond cages and fed with 4, 6, 8 and 10% of their actual body weight. The effect of the daily ration on the growth, survival, condition factor, feed conversion and body composition were observed until fry nursed in cages reached one gram. The appropriate daily ration of 6% of body weight seemed to be advisable for the practices as it achieved the highest average length of 4.46cm, average weight of 1.03g and SGRof 7.03%day^{-1}. There was no significant difference between the conditional factors or survivals of the groups. The best feed conversion (FCR) and protein efficiency ratio (PER) was achieved at the 6% daily ration group and the worst at 10% group in every week of the experiment.

Introduction

Aquaculture of mullets has great potential in brackish waters; its farming is still at infant stage in India compare to rest of world. Mullet culture is a good alternative to direct towards the intensification of production as it has gained the importance in several countries of South East Asia, because these fishes are considered of high quality priced. The mullet usually occur in coastal waters and estuaries throughout the tropical and subtropical belts of the world and sometimes even in temperate zones. They are known to ascend in schools to the shallow littoral areas and connected creeks, channels etc., with the high tide for feeding purposes and this characteristic habit is utilized while collecting them, using almost similar gears throughout the world. Active gears such as scoop nets, skimming nets and beach seines are commonly used to collect wild fry (Sadek and Mires, 2000; Liao, 1994).

Liza parsia is one of the important cultivable species in brackish water fish farming available along the West coast of India. As the culture of gold-spot mullet, *L. parsia* becomes more popular, strategies for supplementary feeding will have to be assessed to reap maximum economic returns. Feeding is one of the most important considerations, because it can affect growth and the efficiency of feed utilization. In this type of farming supplementary feeding has become an integral means of achieving greater productivity.

Supplementary feeding is the single most critical and expensive variable cost in semi-intensive and intensive culture. The economic success of production control in aquaculture depends to a large extent on reasonable feeding costs. One way of reducing feeding costs is to estimate the daily optimal ration and formulate a feeding chart that will best suit local farming conditions. Minimization of the amount of feeding may have the effect not only of reducing the cost of feeding but also the biological loading of recirculation systems and effluent production in flow-through systems (Woods 2005).

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Some studies have been conducted on the effects of manipulating feeding regimes for several cultured brackish water fish species to improve culture efficiency (Chiu et al. 1987; Saether and Jobling 1999; Mihelakakis et al. 2001).

Determination of appropriate feeding rations for cultured fish is important to achieve maximum productivity, because feeding rate affects nutrient requirements in fish, such knowledge is regarded as a pre-requisite for estimation of the amounts of nutrients they should receive (Talbut, 1985). When food intake levels are higher than the optimum, growth increase is negligible (Tsevis et al., 1992) whereas sub-optimum rations may result in reduced growth and increased size variation (Johnston *et al*., 2003).

In any selective culture, a constant supply of nursery reared healthy fingerlings is the most essential prerequisite. The fry of *L. parsia* directly stocked in culture pond leads to high mortality. Therefore, an attempt was made to rear the fry of *L. parsia* in cages as it has advantages as compared to pond.

The aim of the present work was to investigate the effect of daily feeding rations on the growth, survival, body composition, condition, feed conversion and protein efficiency of *L. parsia* fry during nursery rearing in pond cages.

Materials and methods

Fish and experimental procedure

Fry of *L. parsia* were collected during low tide with the help of dragnet from the Kasarveli creek, situated at Sakhartar, Ratnagiri, Maharashtra State, Republic of India (16° 59' 10" N and 73° 16' 25" E). Collected fry was transported to the laboratory in plastic containers (20 litre capacity). Fry of *L. parsia* were identified by using the taxonomic key (Barve, 1987). The cages were installed in a brackish water pond located at College of Fisheries, Shirgaon, Ratnagiri campus. Area of the pond was 450 m^2 (30 m x 15 m). During high tides, the depth of pond water was up to 110 cm while 90 cm at low tides. Rectangular shaped cages were constructed for the fry of *L. parsia* as described by Yu *et al.* (1979). Cage with dimension of 1 m (L) x 1 m (B) x 0.5 m (H) was with volume of 0.5 m^3. Mosquito net cloth of polyamide (PA) with 24 mesh $inch^{-1}$ mesh size was used for preparation of cage bag. Two loops were attached at each corner of the cage bag to fix the bag with the bamboo. Loops were made from the extra mosquito net material; each loop was 6 cm in length. The top cover was connected with the cage bag for opening or closing the cage for feeding and maintenance. The cage was fixed by submerging 3/4^{th} part in water. Fry with average initial length of 1.3 $\pm$ 0.2 mm and average initial weight of 0.07 $\pm$ 0.02 mg were stocked at 50 fry m^{-2} and were fed at 4%, 6%, 8% and 10% of body weight with 5 replicates each. Diet was given twice a day (9:00 h and 17:00 h) directly into cages. No special feeding area was provided in the cage.

Diet Formulation

Diet was formulated containing about 30% protein by using different ingredients as given by Sawant *et al.* (2005). The ingredients and proximate composition of the test diets are given (Table 1). The moisture, crude protein, lipid and ash content in the test diets were analyzed, according to standard procedures of Association of Official Analytical Chemist (AOAC, 1995).

Table 1: Proportion of ingredients and proximate composition of diet used in experiment

Proportion of ingredients	
Ingredients	**Quantity (%)**
Wheat flour	12.18
Rice bran	12.18
Whole poultry egg	37.82
Mustard Oil Cake	37.82
Proximate composition	
Crude Protein (%)	31.57
Crude Fat (%)	9.61
Moisture	8.91
Ash (%)	5.82
Carbohydrate* (%)	44.09
Gross energy (kcal g^{-1})**	450.43

*Carbohydrate (%) = (100 %) – [(% Protein) + (% Fat) + (% Moisture) + (% Ash)] ... (Woods and Aurand, 1977).
**Gross energy (Kcal g^{-1})=(Crude protein x 5.65) + (Crude fat x 9.5)+(Carbohydrate x 4.1) ... (El – Sayed, 2002).

Water parameters

Water parameters such as temperature, pH, salinity, dissolved oxygen, carbon dioxide and alkalinity were ranged from 28.4 to 30.2°C, 7.4 to 8.0, 26 to 29 g L^{-1}, 3.5 to 4.4 mg L^{-1}, 8.2 to 9.4 mg L^{-1} and 120 to 138 mg L^{-1} respectively, were analyzed every week outside and inside the cages according to standard methods APHA (2005).

Statistical Analysis

All data on growth and survival were analysed by one-way ANOVA followed by Least Significant

Difference (LSD) test. Differences were considered significant at $P < 0.05$ according to standard statistical methods by (Snedecor & Cochran 1967; Zar 2004). Quadratic regression analysis (Zeitoun et al. 1976) was used to determine break-points in the growth data. The break-points obtained represented the optimum rations for growth.

Results

Growth and Survival

Different feed rations were found to significantly affect the growth of *L.parsia* (Table 2). After five weeks of the feeding trial the weight gain of fish fed at 6% ration was signiûcantly higher (P<0.05) than those fed the 4, 8 and 10% rations.

Table 2: Effects of feeding ration on the growth and survival of *L. parsia* fry in cages during the experiment.

Feeding ration (%)	Initial weight (g)	Final weight (g)	Weight gain (%)	Survival (%)
4	0.084±0.002	0.53±0.03^{a}	537.95±12.59^{a}	64.0±1.41^{a}
6	0.082±0.003	1.03±0.02^{d}	1167.02±65.06^{d}	76.8±2.41^{c}
8	0.092±0.007	0.85±0.02^{c}	840.73±44.24^{c}	69.2±1.20^{b}
10	0.070±0.002	0.66±0.02^{b}	650.61±23.76^{b}	67.2±1.62^{b}

Data with different letters in the same column means significant differences (P<0.05) between treatments.

Food Conversion Ratio (FCR) and Protein Efficiency Ratio (PER)

Best FCR, and highest specific growth and protein efficiency ratio (PER) where obtained for fish fed 6% and 8% rations. Feed conversion ratio (FCR) decreased with increasing ration up to 6%. No signiûcant (P>0.05) improvement in FCR was evident for fish fed at 6% ration and increasing the ration further resulted in no improvement or even in poor FCR. PER was also found to be significantly higher for the 6% ration than form the 4 and 10% ration, and not significantly different (P>0.05) from that for the 8% ration (Table 3).

Table 3: Effects of feeding ration on the specific growth rate, conditional factor, feed conversion and protein efficiency performance of *L. parsia* fry in cages during the experiment [1].

Feeding ration (%)	SGR[2]	Condition[3] Factor (K_f)	FCR[4]	PER[5]
4	5.14±0.07^{a}	1.13±0.17	0.53±0.03^{a}	0.14±0.01^{a}
6	7.03±0.17^{d}	1.15±0.12	1.03±0.02^{d}	0.30±0.01^{d}
8	6.21±0.16^{c}	1.13±0.23	0.85±0.02^{c}	0.24±0.02^{c}
10	5.59±0.11^{b}	1.15±0.18	0.66±0.02^{b}	0.18±0.01^{b}

[1]Mean values ± SEM from five replicate analyses; [2]SGR = {(In mean final weight) - (In mean initial weight)/No. of days}*100; [3]Kf= weight of fish (g)*100/length^3 (cm); [4]FCR = dry food fed (g)/wet weight gain (g); [5]PER =Weight gain (g,wet weight basis)/Protein intake (g,dry weight basis). Data with different letters in the same column means significant differences (P<0.05) between treatments.

The relationship between FCR (Y) and dietary ration (X) was best described by the second-degree polynomial equation:

$$Y = 0.0084x^2 - 0.1203x + 1.527$$

($r = 0.918$; $P < 0.05$)

The relationship between PER (Y) and dietary ration (X) was best described by the second-degree polynomial equation:

$$Y = -0.0137x^2 + 0.1939x - 0.4046$$

($r = 0.919$; $P < 0.05$)

On the basis of these equations the best values for FCR and PER were obtained for 6.55 and 6.60% rations, respectively.

Body Composition

There were marked differences between whole-body compositions among the fish fed different rations (Table 4). There were no significant differences (P>0.05) between body moisture content for fish fed at different rations except for fish fed under 2% of their body weight (P<0.05) where higher moisture content was evident. Whole-body protein content was found to be significantly higher (P<0.05) for 4% ration compared with fish fed other rations. The whole-body fat content of fish fed different rations gradually increased with the increasing ration and was found to be signiûcantly (P<0.05) higher for 6% and 8% rations. Body ash did not differ among fish fed different rations, except for the 2% ration, for which ash content was significantly higher (P<0.05).

Table 4: Body composition of *L. parsia* fry fed at different rations

Feeding Ration	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Initial	79.57±3.81	10.2±0.43	6.24±0.04	3.99±0.13
2	41.21±4.32	14.23±0.28^{a}	5.58±0.10^{a}	3.42±0.18^{b}
4	35.91±5.25	18.56±0.64^{c}	5.82±0.05^{a}	2.46±0.27^{a}
6	37.82±5.69	16.69±0.88^{b}	6.08±0.07^{c}	2.61±0.32^{a}
8	39.62±5.48	15.96±0.75^{b}	6.16±0.08^{c}	2.85±0.22^{a}

Data with different letters in the same column means significant differences (P<0.05) between treatments.

Discussions

Feeding ration is an important factor governing the growth of fish (Chiu et al. 1987). The relationship between growth rate and ration in fish is very important, because feed accounts for 50% of the cost of the intensive ûsh culture (Tacon and Metian, 2008). Growth rate and ration interact to determine FCR and are used to estimate the daily ration for a particular fish stock. Similar to all animals, fish will lose weight when their nutrient intake rate falls below that required for daily maintenance. As food availability increases, the quantity consumed by the fish will also increase, giving a linear increase in specific growth rate (SGR %) up to the point of maximum voluntary food intake. Growth rate is linearly correlated to food intake (Peres and Oliva-Teles 2005). If fish are fed above their appetite, the extra food will be wasted and a high FCR will result. High FCRs result from both over and under feeding. Beyond a certain level, overfeeding has no effect on growth, and results in a poor growth (De Silva and Andersson 1995) and will also cause water pollution from aquaculture (Storebakken and Austreng 1987).

It is apparent from the results of this study that growth of *L. parsia* fry fed at different rations varied significantly. It was found that, feeding fish in the range of 6% body weight (bw) per day results in maximum utilization of food for growth. On subjecting FCR and PER to second-degree polynomial regression analysis, however, break-points occurred for rations of 6.35 and 6.45%, respectively. These break-points indicate that rations in the range 6.0–6.5% bw per day is optimum for growth of *L. parsia*.

Significantly poor FCR for higher rations can be the result of loss of nutrients and wastage of food, because fish took longer to consume food to reach satiation. Hassan and Jafri (1994) reported a gradual decline in conversion efficiency for Asian catfish, *Clarias batrachus* fed higher rations. In this study a similar trend in feed-conversion efficiency was also noticed for *L. parsia* fed higher rations than the optimum. Poor growth and FCR for fish fed at lower ration of 4% bw per day suggests that, this ration is approximate to maintenance requirements only and that most of the ingested nutrients are used to maintain life and a small portion is available for growth. Present finings for *L. parsia* also seem to be in agreement with the observations of Ahmed (2007) for Rohu, *Labio rohita*. Ration level is an important factor affecting feed utilization and the requirements are affected by fish age and size. Diet composition and numerous other factors (Siddique, 2009) also play a significant role in this regard.

The whole-body composition of fish is often used as an indicator of fish quality. Several factors, including growth and diet are known to affect the body composition of ûsh. Body composition is also significantly affected by feeding rate (Cho et al. 1976; Storebakken and Austreng 1987; Hassan and Jafri 1994; Khan et al. 2004). The whole-body composition of *L. parsia* fed different rations in this study varied substantially. Body moisture content decreased significantly with increasing rations up to 6%; further increasing the rations did not result in any signiûcant difference in moisture content. Body protein content increased with increasing rations levels up to 6%; thereafter a significant fall of body protein was noticed. The fat content of fish fed different rations gradually increased with the increasing rations and was found to be significantly higher for 10% ration. This corresponds with findings for rainbow trout, *Oncorhynchus mykiss* (Storebakken and Austreng 1987). When rations were lower the amount of fat was slightly lower, although at the same time the fish managed to maintain relatively higher and constant amounts of protein in their body tissue over the initial value, suggesting that in this fish body fat is preferred to protein as an energy source. A similar result for body fat was also reported by Hung and Lutes (1987).

The optimum ration recommended in this study for *L. parsia* (6.0%) is similar to that reported for sole, *Solea vulgaris* (7% bw per day; Lagardere 1987) and higher than that reported for other Indian major carp, mrigal, C. mrigala (5.5%; Khan et al. 2004).

In this experiment we did not find a difference between the condition factors of the groups. The feeding rates have not significantly inûuenced the survivals.

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