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THE GROWTH PERFORMANCE OF JUVENILE YELLOW FIN SEABREAM (*ACANTHOPAGRUS ARABICUS)* FED AT DIFFERENT FEEDING RATES WHILE REARED IN FLOATING NET CAGES

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ABSTRACT

This study investigated feeding management of yellowfin seabream, *Acanthopagrus arabicus,* juveniles under different feeding rates and its relationship to growth performance, survival, cannibalism and body composition. Thirty healthy fish (21.87±0.22g initial weight) were stocked in 12 separate net cages 3.4m^3 assigned to four groups: F1, F2, F3, and F4 to receive feed at 3%, 5%, 7% and 9% body weight per day (bw/d). The juveniles were fed twice daily with a diet containing 42% protein for seven weeks. At the end of the feeding trial, group F3, fed at 7% bw/d, had significantly ($P< 0.05$) higher percent weight gain, average daily weight gain and specific growth rate, followed by groups F2 (5% bw/d) and F4 (9% bw/d). The poorest growth performance was recorded in F1 (3% bw/d). Cannibalism was not seen in any treatment group, and survival was recorded 100%. In the whole fish body proximate composition, protein, ash and moisture showed no change while lipid levels in the fish bodies increased with increasing feeding ratio. Based on the results, 7% bw/d was the optimum feeding rate for *A. arabicus* under given experimental conditions.

Keywords: Yellowfin seabream, growth performance, feeding rates, body composition, floating net cages.

INTRODUCTION

For successful aquaculture practice fish nutrition management is needed to minimize cost and maximize growth performance. For example, the optimal feeding rate, the amount of feed consumed by fish per day, is required to manage fish nutrition for best growth performance and fish health. The major part of fish feed is composed of fish meal because fish meal is an acceptable source of essential amino acids, vitamin, mineral and essential fatty acid (Hussain *et al*., 2011). Fish feed share about 30 – 60% of the production cost in floating net cages (Huguenin, 1997; Gomes *et al.,* 2006; Silva, *et al*., 2007). Therefore, the supply of nutritionally balanced feed at an optimal rate would ensure economic returns, better growth performance and enhanced total production of fish (Silva *et al.,* 2007). An appropriate feeding method and optimal feeding rate can avoid overfeeding and/or insufficient feeding both of which may cause fish mortality and raises serious health and growth issues (Masser and Cline, 1990). High and/or insufficient feeding rates may result in high feed conversion ratio (FCR) indicating low growth performance (Chua and Teng, 1978.). In addition, overfeeding causes wastage of feed as well as water pollution, which increases biological oxygen demand (BOD) (Talbot *et al.,* 1999). On the other hand, insufficient feed supply also increases competition and cannibalism (Bureau *et al.,* 2006). Consequently a reduction in total yield and profitability is expected. The optimum feeding rate and feeding frequency generally depend on the fish size and species, as well as water quality (Okorie *et al.,* 2013). For example, high water temperatures tend to increase the feeding and metabolic rate of the fish, while low temperatures cause sluggish rate of digestion (Park *et al.,* 2011).

Sparid fishes are generally considered suitable for aquaculture for their euryhaline characteristics, adaptation to a variety of temperatures, rapid growth and a high market demand (Leu and Chou, 1996). Yellowfin seabream, *Acanthopagrus arabicus* (Sparidae), a recently described species (Iwatsuki, 2013), could be a good candidate for aquaculture. *Acanthopagrus arabicus* is known from Middle East waters, from Qatar to Southern Oman, Duqm, from Trivandrum to off the coast of Kuwait, and the south-western part of India, Iran and Pakistan, except for the Red Sea off the Gulf (Iwatsuki, 2013; Siddiqui *et al.,* 2014). The present research was designed to establish the feeding rate for this commercially important fish species for which no information is available. The objective of the study was to determine the optimum feeding rate for yellowfin seabream, *A. arabicus,* juveniles in floating net cages.

MATERIALS AND METHODS

Feed formulation and preparation: Feed ingredients, such as, fish meal, fish oil, rice bran, wheat bran, wheat flour, starch, vitamins and minerals, were procured from local market. The major protein source used was fish meal and the diet had 42% protein. The ingredients were weighed, mixed thoroughly, blended with water and fish oil to form a dough. Pellets were made (2 mm) from the well mixed dough using pallet-machine, allowed to dry in an oven for 24 hours, packed and stored in freezer until used. The dried feed sample was analyzed for percent dry matter, % crude protein, % crude fat, % crude fibre and % moisture. The feed formulation and percent composition are given in (Table 1).

Design of feeding trial: The juveniles of yellowfin seabream, *A. arabicus,* were collected from the wild near experimental site and stocked initially in the experimental floating net cages for two week acclimatization. During this period juveniles learned to accept formulated diet at a particular time. Thirty healthy juveniles of uniform size (21.87±0.22g average initial weight) were placed into each of the twelve net cages 3.4m^3. Randomized triplicate cages were assigned to four treatment groups: F1, F2, F3 and F4 which received feed at a rate of 3%, 5%, 7% and 9% of wet fish body weight per day, respectively. The cages were cleaned manually every week. Fish counts and individual weight were taken fortnightly and the amount of feed was adjusted accordingly. The initial length and weight data and experimental design are given in (Table 2).

From the initially stocked samples, sixty juveniles were separately euthanized and stored at -20°C for subsequent analysis of initial fish body proximate composition. Water quality parameters of the experimental site were recorded bi-weekly. Temperature, salinity, dissolved oxygen and pH of the water was determined at low, mid and high tide. The water temperature was recorded with a mercury thermometer calibrated in degrees centigrade (˚C). The salinity of the water was determined by a handheld refractometer in part per thousand (‰). Dissolved oxygen of the water was recorded at the different tidal levels using a Jenway oxygen meter in (mg/L). The pH of the installed cages area was determined using a Jenway pH meter

Biochemical analysis and Statistics: At the end of the experimental trial, fish juveniles from each experimental cage were randomly selected and anesthetized for final fish body proximate analysis of fish body crude protein, crude fat, crude fiber and moisture content. The proximate analysis was carried out using the standard methods by the Association of the Official Analytical Chemists (AOAC, 1990). Crude protein was analyzed by a Kjeltec auto analyzer, moisture content was measured by drying the sample at 105°C in an oven to extract the water content of the sample. Crude fat was determined using a petroleum extraction Soxhlet method, ash was calculated by combustion of the sample in a furnace at a 550ºC for six hours.

The data were presented as total mean ± standard deviation of triplicate groups. One way ANOVA (analysis of variance) was used to assess the differences in growth performance between groups receiving different feeding ration. The Tukey HSD test was used to determine the significant differences among the four treatments. The statistical analysis was performed through SPSS ver.18 and Microsoft Excel 2010.

RESULTS

The juveniles remained healthy during the whole trial period and no cannibalism was recorded in any treatment group. Hundred percent survival rates were observed in all the groups. Water quality parameters, such as, the average salinity (26.20±0.73‰), temperature (21.42±0.64ºC), dissolved oxygen (6.20±0.23 mg/L) and pH (7.66±0.63), remained within acceptable range suitable for the cage culture of yellowfin seabream throughout the experimental period.

Table 1. Composition of the experimental diet (g/100 kg^{-1} diet) and percent proximate composition.

Ingredients	Diet
Fish meal	460
Wheat bran	240
Wheat flour	120
Rice bran	80
Fish oil	50
Starch	30
Vitamins & minerals	20
Dry matter %	86
Moisture %	10.6
Crude protein %	42.1
Crude fat %	13.3
Crude fibre %	6.2

CP represents (crude protein): Fish meal (CP-61.2%), wheat flour, (CP-16.2%), wheat bran (CP-12.6%), rice bran (CP-6.1%), starch (CP-9.4%). Vitamins and minerals have the following composition in the diet (g/1000g): Water-soluble vitamins; ascorbic acid (vitamin C) 15, thiamine (vit. B1) 1.1, inositol (vit.B8) 38.5, choline chloride 3.7, pyridoxine (vit.B6) 1.2, folic acid (0.5); cyanocobalamine (vit.B 12) 0.004, nicotinic acid (vit.B3) 4.2, riboflavin (vit.B2) 1.1, pantothenic acid (vit.B5) 1.35 and biotin, 0.4. Fatsoluble vitamins; cholecalciferol (vit.D3) 6.8, retinol (vit. A) 1.1; menadione sodium bisulphite (vit.K3) 0.04, a-tocopherol acetate (vit. E) 5.2. Minerals; calcium 1.3; phosphorus 3.3, zinc 1.1, copper 1.02, magnesium 2.3, phospholipids 3.2, iodine 2.1, manganese 2.04, iron 1.1, sodium 1.02.

The growth performance data like, final body weight gain (FBW), percentage of weight gain (WG %), average daily weight gain (ADG) (g/ind/day), specific growth rate (SGR) and percent survival are depicted in (Table 3). The highest FBW (55.02±0.79 g) was recorded in the experimental group F3 fed at 7% body weight per day. The other groups F2 (5% bw/d; 52.21±2.06 g), F4 (9% bw/d; 51.53±2.19 g) and F1 (3% bw/d; 47.4±0.56 g) had lowered FBW values at the end of the experiment (Figure 1).

The maximum SGR was attained after 49 days in F3 (1.86±0.00), which was significantly higher ($P<0.05$) than the other groups, for example, F2 (1.79±0.07), F4 (1.72±0.00), and F1 (1.59±0.03), which had significantly ($P<0.05$) lower SGR values. Comparatively high significant values for WG and ADG were also recorded in group F3, which declined as the feeding rate was decreased (F1, F2) or increased (F4).

The fish body proximate composition, such as, fish body protein, ash, moisture, appear to have no significant ($P>0.05$) influence of changing the feeding rate. However, lipid concentration of fish body tissues had significantly ($P<0.05$) increased with an increasing feeding rate (Table 4).

Table 2. Initial design of the assessment of the optimum feeding rate for juvenile yellowfin seabream, *A. Arabicus,* in floating net cages.

Treatments	Number of Replicates	Feeding rate %bw/d	Stocking per Cage	Mean initial Weight (g)	Mean initial Length (cm)
F1	3	3%	30	21.73±0.07	12.29±0.77
F2	3	5%	30	21.64±0.67	12.20±0.57
F3	3	7%	30	22.05±0.41	12.62±1.24
F4	3	9%	30	22.09±0.92	12.48±0.59

Table 3. Growth performance of yellowfin seabream, *Acanthophegrus arabicus,* at different feeding levels.

S No	Parameters	F1 (3% bw/d)	F2 (5% bw/d)	F3 (7% bw/d)	F4 (9% bw/d)
1	Average initial weight (g)	21.73±0.07	21.64±0.67	22.05±0.41	22.09±0.92
2	Average final weight gain (g)	47.4±0.56 ^{a}	52.21±2.06^{b}	55.02±0.79^{c}	51.53±2.19^{b}
3	Percentage of weight gain (%)	118.13±2.7^{a}	141.26±0.7^{b}	149.65±1.18^{b}	133.11±0.12^{c}
4	Average daily weight gain (g/ind/day)	0.52±0.01^{a}	0.62±0.02^{b}	0.73±0.07^{c}	0.60±0.02^{b}
5	Specific growth rate (SGR)	1.59±0.03^{a}	1.79±0.07 ^{b}	1.86±0.00^{c}	1.72±0.00 ^{b}
6	Survival rate (%)	100±0.00	100±0.00	100±0.00	100±0.00

Values (mean ± SD of triplicate groups of 30 *A. Arabicus* juveniles$^{a,\,b,\,c,}$significant differences ($P<0.05$) in the same row with different letters

Percentage of weight gain (%) = [(Average final weight–Average initial weight) /Average initial weight] ×100

Average daily weight gain (g/ind/day) = (Average final weight–Average initial weight) /Total cultured day

Specific growth rate = % increase in body weight per day= [(In Total final weight-In Total initial weight) /days)] x 100

Survival rate (%) = (Total final number of fish / Total Initial number of fish) × 100

Table 4. Proximate composition of whole body (kg^{-1} wet weight basis) of juveniles *A. arabicus,* before and after the experiment, fed at different feeding levels.

Parameters	Initial	Diets			
		F1 (3% bw/d)	F2 (5% bw/d)	F3 (7% bw/d)	F4 (9% bw/d)
Whole body					
Moisture ($g\ kg^{-1}$)	732	681±23	674±25	675±36	678±50
Protein ($g\ kg^{-1}$)	168	178±11^{a}	175±23^{a}	174±34^{a}	173±20^{a}
Lipids ($g\ kg^{-1}$)	52	88±1^{a}	89±4^{a}	94±2^{b}	96±5^{b}
Ash ($g\ kg^{-1}$)	48	56±4	53±2	54±1	56±2

Values are the mean ± SD of triplicate groups of 30 *A. arabicus* juveniles; $^{a,\,b,\,c}$ values in the same row with different letters differ significantly (P<0.05).

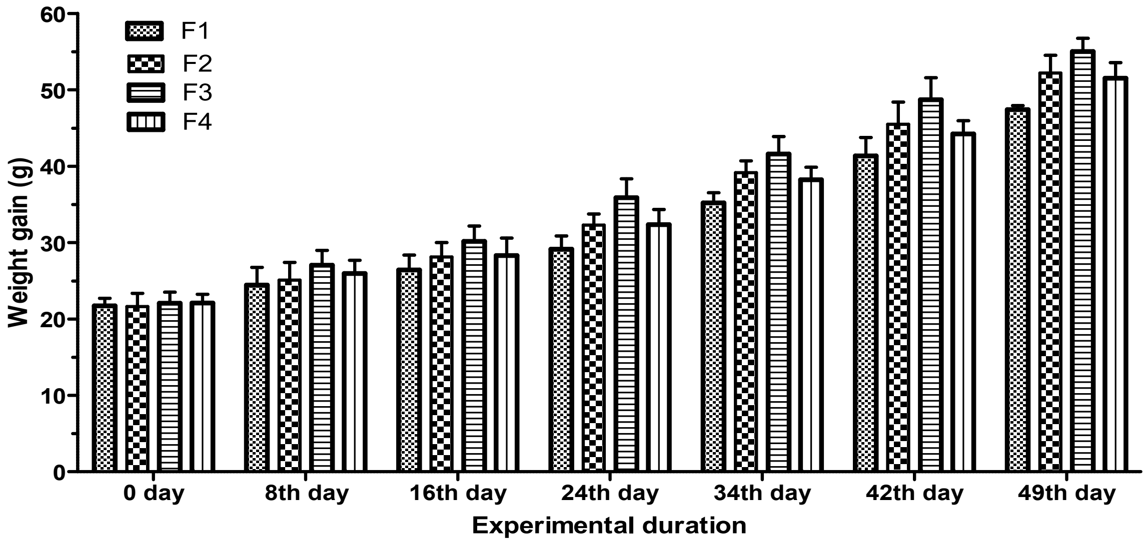

Figure 1. Comparison of final weight gains (g), among the treatment groups at different feeding levels for the duration of the experiment.

DISCUSSION

The finfish aquaculture industry is continuously growing worldwide, and fish feed is considered as one of the greatest challenges in fish cultivation that determines the production cost of cultured fish (Silva *et al.,* 2007)). Fish feed share about 30 – 60% of the production cost in floating net cages (Huguenin, 1997; Gomes *et al.,* 2006). Therefore, from both economic and biological (growth) perspective, the establishment of an appropriate method of feeding (ration) is pivotal to successful fish culture (Silva *et al.,* 2007; Aydin *et al.,* 2011).

The present study reports on optimization of feeding rate for yellowfin seabream, *A. arabicus,* reared in sea water floating net cages. No information on *A. arabicus* or any other sparid fish are available with respect to its optimal requirement for feeding rate in cages under environmental conditions prevailing in coastal waters of Pakistan. Determination of its feeding rate would be useful as it exert a significant effect on growth performance, chemical composition and feed utilization (Juell and Lekang, 2001; Bureau *et al.,* 2006; Yuan *et al.,* 2010; Kaiser *et al.,* 2012; Wang *et al.,* 1998; Van Ham *et al.,* 2003; Cho *et al.,* 2003). An optimum feeding rate and frequency also reduce variation in fish size within groups (Wang, 1998). Both overfeeding and insufficient feeding to fish in culture affects the growth performance and animal health (Ng *et al.,* 2000). In addition, excessive feed supply in cages would cause feed losses and thereby increase the production cost (Silva *et al.,* 2007), sedimentation of high organic feed in natural waters consequently degrades the water quality (Puvanendran *et al.,* 2003) through its decomposition, production of ammonia and depletion of oxygen. The present study was undertaken in the natural environment. The feed loss was minimized by offering feed twice daily with percent body weight of the fishes. The water quality parameters appear to have no impact as depicted through quality parameters (dissolved oxygen, temperature, pH and ammonia concentration) which remained within the range acceptable for fish culture. Similarly, the fish stayed healthy throughout the experiment. No mortality was recorded and no negative competition and/or cannibalism were observed.

We noted that increasing the feeding ratio for *A. arabics* had a remarkable effect on feed utilization and growth performance in fish group fed at 7% bw/d. A further increase in feed ratio reduces feed efficiency indices and growth performance significantly ($P<0.05$). Similar findings were recorded previously (Nadir *et al.,* 2007; Marimuthu *et al.,* 2011).

The optimum feeding rate appears to vary with species and with fish sizes. For example, variability in the feeding rates has been noted for Cobia, *Rachycentron canadum* (7% bw/d; Sun *et al.,* 2006), tambaqui, *Colossoma macropomum* (10% bw/d; Silva *et al.,* 2007), catfish, *Clarias gariepinus* (8% bw/d; Marimuthu *et al.,* 2011), *Clarias fuscus* (6% bw/d; Anderson and Fast, 1991), and *Channa striatus* (5% bw/d; Qin and Fast, 1996). Similarly, feeding ratio of fish is also related to fish size and/or age (Fiogbe *et al.,* 2003). Feed utilization and feeding rates related to fish body weight decreases with fish growth (NRC, 1993). This has been observed, for example, in striped bass (Piper *et al.,* 1982; Hung *et al.,*1993) and gilthead seabream (Eroldogan *et al.,*2004; Kalogeropoulos *et al.,* 1992; Alexis *et al.,* 1999).

The whole body proximate composition of fish fed at different feeding rates generally showed no significant change in proximate composition of fish except for lipid levels which increased with increases in feeding rate. It is generally known that diet composition (Kalogeropoulos *et al*., 1992; Alexis *et al*., 1999; Santinha *et al*., 1999) and feeding rate (Mihelakakis *et al*., 2002; Marimuthu *et al*., 2011) influences growth, body composition, and nutrient utilization of fish. For example, the daily feed allowance has been shown to increase lipid level, but not proteins in Glithead seabream (Mihelakakis *et al*., 2002), African catfish (Marimuthu *et al*., 2011), white sturgeon (Hung and Lutes, 1987), rainbow trout (Storebakken *et al*., 1991), and striped bass (Hung *et al*., 1993).

The optimum value of 7% bw/d for *A. arabicus* is comparatively lower to that of other studies mentioned above (Silva *et al.,* 2007; could be due to the larger initial size and weight of the juveniles. It may also be due to the fact that fish also uses naturally available food as the cages were set out in the natural environment. The experimental fish fed at 7% bw/d remained healthy and no negative competition was noted. Cannibalism in a fish tank/cage occurs for two reasons, such as, insufficient feed provisions (Polis, 1981; Hecht and Pienaar, 1993) and variable fish size in the culture group (Diana and Fast, 1989; Anderson and Fast, 1991). Although, Marimuthu *et al.* (2011) has shown that increasing the feeding ratio does not reduce cannibalism when the fish size is variable and size-dependent mortality occurs (Diana and Fast, 1989; Anderson and Fast, 1991). The fish in the present experiment was uniform in size and it appears that the feed provided to all groups was enough for fish.

Conclusions: It is evident from the present study that the juvenile yellowfin seabream (*A. arabicus*) can be successfully grown in floating net cages. This species can be fed at 7% bw/d to obtain growth under prevailing experimental conditions with no adverse effect in terms of fish health and negative competition among the fish groups.

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