Research Article

Biological Performance in Black Fin Seabream, *Acanthopagrus berda* (Forsskal, 1775) by Using Two Different Protein-Based Diets in Seawater Earthen Ponds

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Abstract | This research focuses on the biological performance in blackfin seabream, *Acanthopagrus berda* (Forsskal, 1775) by using different protein-containing diet i.e., soybean meal and fishmeal. The dietary efficacy was monitored in seawater earthen ponds designated into four nylon meshed hapa (3.7×9.5×9.5 feet) for 60 days. Juveniles (35.75±3.2g) were collected with the help of cast net from Sakro creek and transferred into the earthen fish ponds located at Garho, Thatta, Sindh. Juveniles were acclimatized for more than two weeks (15 days) to the experiment conditions. After acclimatization period, juveniles (n=15) were distributed into each treatment hapa (T1 and T2) with two replicates. Two iso-nitrogenous diets were prepared consisting of Diet-1 soybean meal was used as main source and Diet-2 consist of fishmeal. Feed was given twice daily by 3% of total wet body weight. Results indicated a slightly higher weight gain (WG) in T2 (44.6±0.42g) than T1 (41.6±0.49g). The condition factor was non-significant ($p > 0.05$) among both treatment groups, whereas, food conversion ratio was significantly different ($p<0.05$). No mortality was observed (100% survival ratio) in both treatments. Relative growth of black fin seabream juveniles (*A. berda*) remained significantly different while regression values were found to be non-significant ($P>0.05$; $R2= 0.95$) among both treatments. The physiochemical parameters of seawater ponds were found in the optimum range throughout the trial period. Therefore, it is suggested that soybean meal can be replaced and used as an alternative cost-effective source of fishmeal in the fish diet.

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Introduction

Black fin seabream (*Acanthopagrus berda*) is the commercial fish worldwide (FAO, 2012; Abbas *et al*., 2015; Mourente and Bell, 2006; Rahim *et al*., 2015). The demand of black fin is increasing due to its good taste and meat quality (Sing *et al*., 2014; Zhang *et al*., 2014). The potential culture production for sea bream is now possible in Pakistan because of rapid and high growth rate, resistance to extreme environmental circumstances and large size in a short span (Sa *et al*., 2006; Rigos *et al*., 2011; Sarwat, 2014; Rahim *et al*., 2015). It is noteworthy that sustainable aquaculture depends on the nutritionally balanced feed and the crucial element of fish feed is the protein which is highly important for the growth, digestion, and immunity development (Alvarez-Gonzalez *et al*., 2001; Hecht *et al*., 2003; Ai *et al*., 2004; Ngandzali *et al*., 2011; El-Dahhar *et al*., 2013). Feed is an important component in aquaculture but feeding frequency and feeding rate are also important according to species specific nature of fish (El-Dahhar *et al*., 2013; Abbas *et al*., 2011, 2015). As a result, an appropriate feeding level is critical for successful aquaculture, which will save costs and avoid water damage (Abbas and Siddiqui, 2009).

Fishmeal is one of the vital source of protein in aquaculture and most of the fishmeal is obtained from wild fish stock but this source is not environmentally friendly which further leads to overexploitation and stock depletion (Booman *et al*., 2018). Therefore, the findings of appropriate animal protein substitute are necessary in aquaculture diet. According to fish experts the plant meal can be used as an alternate source of fishmeal and can be replaced by partially or completely. In this context, the soybean meal is considered as the best and cheap protein source in aqua-feed (Krogdahl *et al*., 2000; Romarheim *et al*., 2013; FAO, 2016; Voorhees *et al*., 2019).

Therefore, the purpose of this research is to analyze the substitution of fishmeal by soybean meal and its effects on the biological performance of commercially important black fin seabream species (*A. berda*) reared in seawater ponds.

Materials and Methods

Experimental site, fish collection and diet

Current study was conducted in seawater earthen ponds at Garho, Thatta Sindh (Latitude: 24°18'7.68", Longitude: 67°36'19.3"). The dietary efficacy of black-fin seabream (*Acanthopagrus berda*) was monitored in four nylon meshed hapa (3.7×9.5×9.5 feet) for 60 days. Juveniles (35.75±3.2g) were collected with the help of a cast net from Sakro Creek near Thatta, Sindh, and transported to Garho fish ponds. The total acclimatization period was 2 weeks prior to the experiment. After acclimatization, juveniles (n=15) were distributed into each treatment hapa (T1 and T2) and with two replicates. Two iso-nitrogenous diets were prepared. In Diet-1 soybean meal was included as the main protein source and Diet-2 consist of fishmeal. Compound floating pelleted feed was given at 3% wet body weight twice a day, morning 09:00 am and evening 16:00 pm. Length (cm) and weight (g) of fish were measured fortnightly and the quantity of daily ration was readjusted according to body weight. Experimental diet ingredients for blackfin seabream were labeled in Table 1.

Table 1: *Feed ingredients composition and chemical analysis (%) of the experimental diets supplied to juveniles of blackfin seabream in seawater ponds.*

Ingredients (%)	Diet-1 T1= Soybean meal (%)	Diet-2 T2= Fishmeal (%)
Soybean meal	20	0
Fishmeal	0	20
Mustured oil cake	20	20
Maize Gluten	16	16
Rice bran	21	21
Wheat bran	10	10
Topica	6	6
Vitamin/ mineral premix	2	2
Fish oil	5	5
Total (%)	100 (%)	100 (%)
Chemical analysis (%)		
Moisture	9.4	9.1
Crude protein	39.9	39.8
Crude lipid	4.2	4.6
Crude fiber	9.1	8.9
Ash	11	12.2

Sample and data analysis

After 2 weeks of trial, we were collected juveniles from each treatment and replicate hapa with the help of scoop net and the total length (cm) and weight (g) were recorded with the help of digital weight balance machine and immediately released back into their respective hapas. Growth indices (Abbas *et al*., 2011; Daudpota *et al*., 2016) were used to calculate the overall growth performance of fish.

Following formulas were used for the calculation and analysis of data:

Weight gain = body wt. final – body wt. initial

Average daily wt. gain = fresh body wt. gain/ duration

WG % if initial weight = final weight – initial weight/ initial weight ×100

FCR = diet given/ weight gain (WG)

SGR = Ln final weight – Ln initial weight / time duration × 100

K = Final weight/final length × 100

Water quality assessment

Water quality parameter like temperature, salinity, ammonia, pH and dissolved oxygen were monitored on a daily basis. Temperature was measured by using GH Zeal Ltd-London England digital thermometer, ammonia and dissolve oxygen (DO) were examined by Merck KGaA, 64271, Germany portable test kit, pH was measured by EzDO 6011 Taiwan pH meter and salinity was measured by refractometer (Atago, S/ Mill-E, 0.100‰, Japan).

Biochemical assessment

Three fish juveniles were randomly selected, anesthetize and kept at –20°C for whole body proximate investigation. The moisture, protein, lipid, and ash were calculated according to AOAC (2000). To analyze moisture content, samples were dried into an oven (105°C for 12 hours), crude protein was measured using Kjeldahl method (N × 6.25), and lipid content was analyzed by using the petroleum-ether extraction method, whereas, ash was determined by using muffle furnace (550°C for 18 hours).

Statistical assessment

Data of length weight and other parameters were statistically analyzed by using different statistical methods recommended by Rahim *et al*. (2015). Data was presented as mean values with standard deviation. The probability level was establish as *P<0.05* (Steel *et al*., 1997).

Results and Discussion

Fish growth

The initial mean weight of black fin juveniles was 36.2±2.2 and 36.44±2.9g and the final mean weight was recorded about 76.6±2.6 and 80.2±1.7gin Treatment 1 and 2, respectively. The maximum weight gain was observed in juveniles (T2, 44.6±0.42g) fed D-2 fishmeal based diet than D-1 soybean meal (T1, 41.6±0.49g), but it is found a slight difference (p<0.05) between treatments and considered that soybean meal can be completely replaced by fishmeal. No significant difference (p>0.05) was found in feed conversion ratio and specific growth ratio of T1 and T2 (1.47±0.02, 1.56±0.02% and 1.25±0.01, 1.31±0.02%, respectively). No adverse effects of feed was noticed throughout the study and found high survival ratio (100%) with nil mortality. Although, Figure 1 shows the relative growth of black fin seabream juveniles (*A. berda*) reared in two different treatments for 60 days. In Treatment 2, juveniles showed a higher growth fed fishmeal based diet as compared to Treatment 1. Figure 2 described the regression analysis between length-weight of juveniles and showed no significant difference (*P > 0.05*) among treatments (R^2= 0.95).

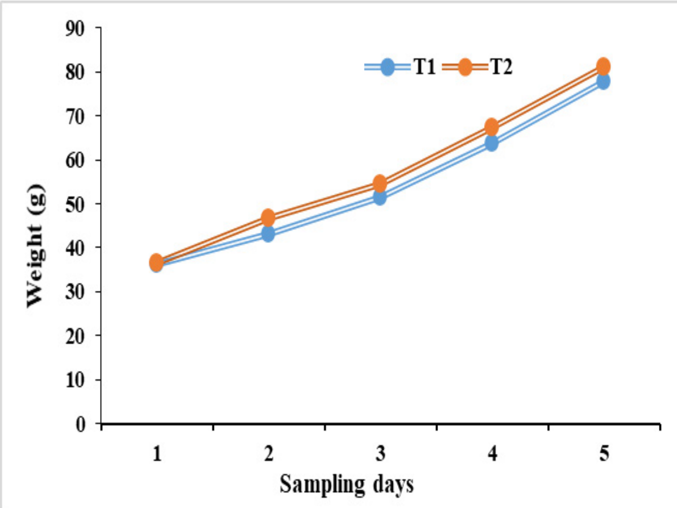

Figure 1: *Comparative growth of black fin seabream juveniles (A. berda) reared on different diets for 60 days.*

Physiochemical parameters

Water quality parameters were assessed throughout the study and found in optimal range. The mean value of temperature (°C) was recorded in T1 (31.35 ± 0.77°C) and in T2 (31.55 ± 0.77°C), salinity recorded in T1 (34.15 ± 0.07‰) and T2 (34.25 ± 0.07‰). Dissolved oxygen (DO, ml/L) in T1= 7.15 ± 0.07 and in T2= 7.2 ± 0.14ml/L, while, pH (7.9 ± 0.28 and 8 ± 0.28) and ammonia (0.025 ± 0.02 and 0.02 ± 0.01mg/L) in T1 and T2, respectively (Table 3). In aquaculture, the optimal value of physicochemical parameters is indispensable for all the aquatic animals specifically to perform their biological processes in the water.

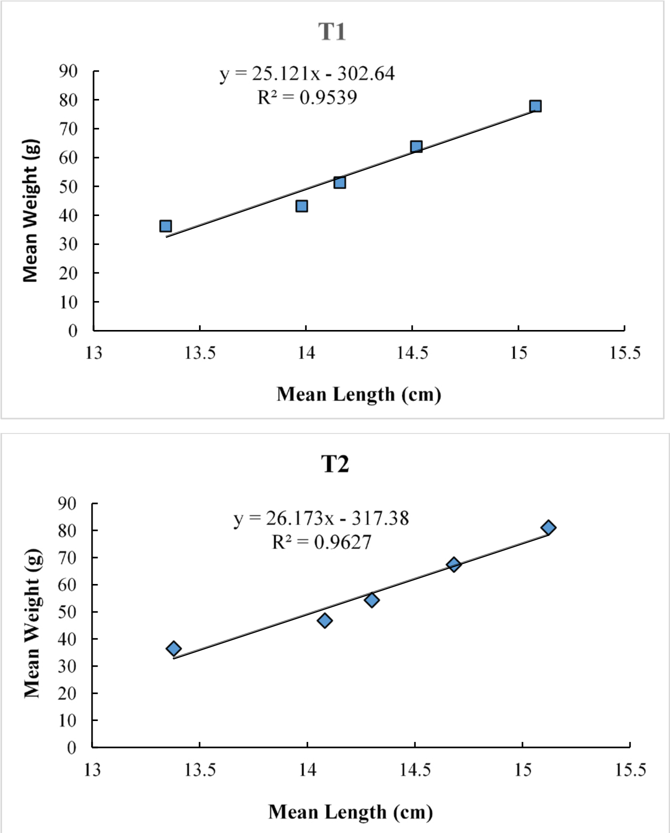

Figure 2: *Regression assessment of black fin seabream juveniles (A. berda) reared under different treatments.*

Meat quality

Table 2 reveals proximate composition of fish. There was no significant (p>0.05) difference in meat quality between fish fed on two different diets for 60 days.

Table 2: *Growth parameters of Acanthopagrus berda reared earthen ponds in hapa for the duration of 60 days.*

Parameters	**(T1) Soybean meal**	**(T2) Fishmeal**
Initial weight (g)	36.2±2.2	36.44±2.9
Initial length (cm)	13.34±0.11	13.38±0.08
Final weight (g)	76.6±2.6	80.2±1.7
Final length (cm)	15.24±0.10	15.36±0.1
Weight gain	41.6±0.49	44.6±0.42
Specific growth rate	1.25±0.01	1.31±0.02
WG, % of initial weight	111.60±0.14	120.1±0.04
Feed conversion ratio	1.56±0.02	1.47±0.02
Condition factor	2.26±0.01	2.34±0.02
Survival rate	100±0.0	100±0.0
Proximate composition (%)		
Moisture	70.61±1.3	71.50±1.5
Protein	40.35±0.3	41.72±0.6[a]
Lipid	7.6±0.3	8.2±0.2[a]
Ash	2.5±0.5	2.8±0.3

**Values are presented as Mean±S.D*

Table 3: *Water quality parameter (temperature, salinity, pH, ammonia and dissolved oxygen) of the ponds for the duration of 60 days.*

Parameters	**Treatment-1**	**Treatment-2**
Salinity (‰)	34.15±0.07	34.25±0.07
Temperature(°C)	31.35±0.77	31.55±0.77
Dissolved Oxygen(ml/L)	7.15±0.07	7.2±0.14
Ammonia(mg/L)	0.025±0.02	0.02±0.01
pH	7.9±0.28	8±0.28

**Values are presented as Mean±S.D*

Balance nutrition in aquaculture is the important necessity to grow and flourish of any aquatic species in captivity. Numerous experiments were conducted to assess the nutritional requirements of demersal fish in aquaculture and protein is the main component of the fish diet (Catacutan *et al*., 2001; Abbas and Siddiqui, 2003; Mourente and Bell, 2006). Fishmeal (animal protein source) have been widely use in aqua diet to fulfil the protein demand globally but overharvesting and less capture fishery production ultimately affect the production and availability of fishmeal. Researchers are constantly finding new available resources of feed stuff which can replace fishmeal in aqua-diet. Another disadvantage of using fishmeal is that a costly product and it has many health hazard effects of accumulated heavy metals which can be transferred by food chain. In comparison of fishmeal with plant meal (i.e., soybean meal), it is environmentally safe, cost effective, easily available and having high production worldwide. Plant protein have now been widely used in aquaculture as a substitute to animal protein (fishmeal) which is obtained from small pelagic fishes (Nordrum *et al*., 2000; Li and Robinson, 2015; Voorhees *et al*., 2019). Uses of plant protein is an appropriate, cheap and profitable substitute protein source for aquaculture industries (FAO, 2016; Voorhees *et al*., 2019). In this study, the amount of fishmeal was completely replaced by soybean meal in the diet of seabream juveniles which was cultured in semi-intensive marine water ponds to analyze the biological performance of fish. Results showed that, WG (41.6±0.49g) obtained by soybean meal diet (T1) was slightly lower than fishmeal diet in T2 (44.6±0.42g). Such finding match with the previous studies by Kader *et al*. (2012b) they replaced 100% soybean meal with fishmeal in the diets of juveniles of red seabream and achieved good results. Regarding replacement of fish meals with soybean meal either partially or completely, many scientists conducted research on different fish species with variable setup such as 20 to 50% replacement of fishmeal with soybean meal in the diet of red seabream (Takagi *et al*., 1999, 2001), gilthead seabream (Kissil *et al*., 2000), turbot (Day and González, 2000) and Japanese flounder (Choi *et al*., 2004; Deng *et al*., 2006). Higher replacements ratio such as 75 to 94% of fishmeal with soybean meal have been discovered by Aragão *et al*. (2003) in Senegalese sole (*Soleasenegalensis*) and juveniles of cobia, *Rachycentroncanadum* (Salze *et al*., 2010). However, the total substitution of fishmeal with soybean proteins was attained by Liang *et al*. (2017) in Japanese seabass (*Lateolabraxjaponicus*), Voorhees *et al*. (2019) in rainbow trout (*Oncorhynchus mykiss*) and obscure puffer (*Takifugu obscurus*) by Ye *et al*. (2019).

Different fish species grow differently by feeding soybean protein and convert efficiently in body meat, that is because soybean meal is deficient in the essential amino acids like methionine and lysine which limits the growth of fish as well as digestibility and acceptability problems (Chatzifotis *et al*., 2008; Kader *et al*., 2010, 2012a). The difference in growth achieved by soybean meal diet may be due to the deficiency in essential amino acid in the diet of black fin sea bream because there was no addition of deficient amino acid takes place. On the other hand, continuous supply of EPA and DHA in the diet to regularize fish growth but complete replacement of fishmeal causes deficiency of these essential fatty acids and this is also proved by earlier studies (Kader *et al*., 2012a). Some studies supported partial substitution of fishmeal to plant protein in fish diet that did not affect the animal's performance reported by (Hansen *et al*., 2007; Suarez *et al*., 2009; Salze *et al*., 2010; Bonaldo *et al*., 2011; Zhang *et al*., 2018). Also, there was no negative effect in physical feature or any other biological parameter other than growth was noted in our study. Similarly, skin color and texture of body was not affected by inclusion of soybean in the diet of sea bream was reported by (De Francesco *et al*., 2007).

FCR and SGR obtained by soybean meal in the current study was non-significant (P>0.05) among treatments. These results show that soybean meal can be substitute for fishmeal which resembles with the study of (Lin and Luo, 2011). Although, high survival rate was obtained on both diets was similar to our study results (Ye *et al*., 2019).

Water quality is the most important factor that contributes in the failure or success of culture and it is also influence on the physiology and health related problems of aquatic species (Piper *et al*., 1982). In our experiment water quality parameters were found in a suitable range.

Conclusions and Recommendations

The current study on plant protein (soybean meal) pointed out the substitution of fishmeal in aqua diet. In conclusion, fishmeal is still preferable diet in aquaculture despite high price feed than soybean meal and gave good results in terms of growth of black fin seabream juveniles (*A. berda*) reared in semi-intensive marine water earthen ponds. But soybean meal is the cost effective and easily available protein source can be used as a substitute to reared *A. berda* juveniles in captivity. However, more research is needed to use soybean meal in the diet as a partially or completely replacement of fishmeal in a long rearing period under captive environment.

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Novelty Statement

The current study investigates the biological performance of black-fin seabream (*Acanthopagrus berda*) juveniles by using two different aqua-diet in seawater earthen ponds.

Author's Contribution

Sajid Ali: Conducted this research in seawater ponds and prepared the manuscript for publication.
Ghulam Abbas: Supervised and helped in experimental setup.
Asma Fatima: Reanalyze the data, revised and finalize the manuscript writing.
Abdul Malik: Helped data analysis, record and help during experimentation.
JabbarMemon: Provided technical assistance during experimentation.
Shahnaz Rashid: Evaluated and revised the final version of manuscript.
Dilawer Ali, Muneer Hussain Bijoro, UshraBatool Hashmi, Rumaisa Abdul Rahim, Shahid Hussain,

Javeria Khourshid and Kashif Ali: Assisted in laboratory work.

Conflict of interest

The authors have declared no conflict of interest.

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