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Effect of Different Dietary Oils on Growth, Feed Conversion and Body Composition of Juvenile Black Fin Sea Bream, *Acanthopagrus berda* (Forsskal, 1775)

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Authors' Contributions
GA conceived and designed the project and wrote the article. AR performed the experimental work. MHR analyzed feed component. AM analyzed fish meat samples. MN and AG statistically analyzed the data. SF and LG helped in preparation of manuscript.

Key words
Sea bream (*Acanthopagrus berda*), Growth, Feed conversion, Body composition, Dietary oils.

ABSTRACT

In this study, effect of varying dietary oils on growth, nutrient utilization and body composition of juvenile black fin sea bream *Acanthopagrus berda* was investigated. Fish juvenile (10.1±0.5 g) were collected from Sonari Channel, Hawksbay, Karachi and were brought to aquaculture laboratory of the Centre for 15 days acclimatization. After acclimatization, they were randomly distributed into the rectangular tanks (3 × 1.5 ×1.5 ft each). In each tank, 10 fish were stocked with three replications for each treatment. Four isonitrogenous diets containing different oils *i.e.*, fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO) were given to the juveniles for 60 days. Best specific growth rate (SGR) and feed conversion ratio (FCR) were noted in the fish fed diet containing FO. Fish fed diet comprising OO and PO showed poor SGR and FCR values than those fed with FO and SO diets. Body composition was not significantly influenced by different lipid sources although low crude lipid was found in fish fed diet containing FO. The hepatosomatic index (HSI) and visrosomatic index (VSI) were greater in the fish fed FO diet than the remaining diets. Finally, it was concluded that fish oil is the best source of energy in fish diet followed by soybean oil for *A. berda* growing from 10.1 g and 69.2 g. Further study is required for optimization of fish oil level and replacement of FO with vegetative oils.

INTRODUCTION

Sea breams are considered as important candidate for aquaculture in the world (Sa *et al*., 2006; Abbas *et al*., 2015). In Pakistan, it has commercial value due to good quality meat (Anonymous, 2012). In order to develop sustainable aquaculture of sea bream, its nutrient requirements must be known. Fish feed is considered as the most important component for such intensive aquaculture and one of the costly components of this feed is oil (Rosenlund *et al*., 2001; Abbas *et al*., 2011, 2015). The dietary oil contains lipids which are used as source of energy (Dong *et al*., 2014). In addition, lipids have high poly unsaturated fatty acids (PUFAs) which contribute well to cell membrane and other organelles (Rosenlund *et al*., 2001; Mateen *et al*., 2016). In marine carnivorous fishes, need of lipid is very impotent because of having little ability to consume carbohydrate (Mourente and Bell, 2006). It is well known that marine finfishes require dietary PUFAs for growth, thus their inclusion must be balanced for maximum progression. In this regard, main oil source is fish oil which can be produced by small pelagic fishes (FAO, 2012). But due to over exploitation of fisheries resources, the landing of fish for oil production is declining. To overcome this alarming situation, alternatives to fish oil for inclusion in diet is necessary (Turchinia *et al*., 2003). In response of high production and low cost of vegetable oils such as soybean oil, palm oil, rapeseed oil, olive oil,

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and corn oil have been investigated to include in diets of salmon, trout, European sea bass and gilthead sea bream (Regost *et al*., 2003; Mourente *et al*., 2005; Mourente and Bell, 2006). According to these studies, replacement fish oil with vegetable oil is important for enhancing fish growth. Since, Pakistan is an agricultural country, having greater production of soybean oil (467-1314kg/hector/ annum), olive oil (500-1000 kg/ hector/ annum) and palm oil (1000 MT /year), these oils can be used as alternate source of fish oil. But, it was observed that vegetable oils have less number of fatty acid and trypsin inhibitors indigestible carbohydrate so can't replace totally (Aberoumand, 2012). Therefore, a study was undertaken to investigate best oil source with optimum concentration for black fin sea bream *A. berda*. The objective of this study was to determine the effects of fish oil, soybean oil, olive oil and palm oil on growth, nutrient utilization, and body composition of juvenile black fin sea bream *A. berda* in captivity.

MATERIALS AND METHODS

Experimental diet

Four isonitrogenous (42% protein) diets were prepared from locally available ingredients on dry matter basis (g/100 g) (Table I). Four different oils *i.e.,* fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO) were used as source of energy in each experimental diet (Table I). Fish meal was added as major source of protein and wheat flour was used as source of carbohydrate. Mixture of minerals and vitamins were also included in the diets. All the ingredients were weighed, grounded and mixed mechanically to realize homogeneity of ingredients. Water (150ml / kg) was added to the mixture and was remixed. Thus soft dough was prepared which was pelleted by using 2mm die. Subsequently, these pellets were dried under shade for 10 h. The experimental diets were then stored at -4°C for further use.

Experimental procedure and feeding trial

Black fin sea bream juveniles, *A. berda* (mean initial body weight 10.1±0.5 g) were collected from Sonari channel, Hawksbay, Karachi. They were acclimatized for 15 days before starting the trial. After acclimatization, they were randomly distributed into the experimental rectangular tanks (3.0 × 1.5 ×1.5 ft each). In each tank, 10 fish were stocked with three replications for each treatment. All the tanks were supplied with sand-filtered seawater continuously. All fishes were placed in similar light with photoperiod of 12L:12D. Fish were fed three times a day (09:00, 13:00 and 17:00) up to 60 days on the ration of 2% wet body weight. Feed was supplied by hand and feed intake was estimated. Each tank was cleaned daily by siphoning. After each 10 days fish body weight and length were noted carefully.

Table I.- Ingredients of experimental diets containing fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO).

Ingredients (g /100g)	Experimental diets			
	FO	SO	OO	PO
Fish meal	37.5	37.5	37.5	37.5
MAB[1]	7.5	7.5	7.5	7.5
Cod liver oil	10	0	0	0
Soybean oil	0	10	0	0
Olive oil	0	0	10	0
Palm oil	0	0	0	10
Corn gluten meal	12.5	12.5	12.5	12.5
Lupine seed meal	4.5	4.5	4.5	4.5
Wheat flour	14	14	14	14
Tapioca flour	6.0	6.0	6.0	6.0
Yeast	6.0	6.0	6.0	6.0
Vitamin-mineral premix[2]	2.0	2.0	2.0	2.0

[1]A mixture of animal by-products (MAB) consisted of 25% cow liver meal, 20% meat and bone meal, 15% blood meal, 10% APC (poultry feather meal), 8% poultry manure dried, 2% choline.
[2]Vitamin and mineral mixture contained the following ingredients (g/100 g diet): Ascorbic acid (vit C), 15.3; thiamin HCl (vit B6), 1.0; inositol, 39.5; calcium, 1.25; zinc, 1.0; retinol (vit A), 1.0; phosphorus, 3.5; choline chloride, 3.5; magnesium, 2.5; copper, 1.0; pyridoxine (vit B6), 1.3; phospholipids, 3.5; α-tocopherol acetate (vit E), 5.5; folic acid, 0.4; cholecalciferol (vit D3), 7.5; cyanocobalamine (vit B12), 0.006; riboflavin (vit B2), 1.5; menadione sodium bisulphite (vit K3), 0.03; manganese, 2.0; iodine, 2.0; sodium, 1.0; iron, 1.0; nicotinic acid, 4.3; biotin, 0.35.

Chemical analysis and measurement

At the end of the experiment, three fishes from each tank were killed and were dissected to calculate the weight of liver and viscera so as to determine their hepatosomatic index (HSI) and visrosomatic index (VSI). The remaining fishes were used for whole body composition analysis. Moisture, crude lipid and crude protein contents were determined by using the standard procedures of AOAC (2000). Moisture was determined with the help of an oven (Labostar-LG122 Tabia Espec, Osaka, Japan), crude lipid was estimated by chloroform / methanol (2:1v/v) extraction procedure (Folch *et al*., 1957). Crude protein was determined by Kjeldahl method (N×6.25) through automatic Kjeldahl system (Buchi 430/323). Ash was calculated by burning in a furnace (Isuzu Seisajusho, Tokyo, Japan). Energy was determined with the help of an automatic bomb-calorimeter (Parr Instruments, model 1265, Moline IL, USA).

Calculations and statistical analysis

The percent weight gain (WG %), condition factor (CF), feed intake (FI), specific growth rate (SGR), feed conversion ratio (FCR), hapatosomatic index (HSI), protein efficiency ratio (PER) and (VSI) visrosomatic index were determined by the following formulae:

WG = % of initial weight =100 × final weight–initial weight / initial weight.
CF = 100 × weight / length^3
FI = diet given as % body weight – remaining diet pellets.
SGR = 100 × (ln final weight – in initial weight/ period).
FCR = diet given / weight gain.
HIS = wet of liver (g) / empty fish weight (g) ×100: total of initial was 1.24%.
PER = wet weight gain / protein (N×6.25) intake.
VSI = 100 × wet weight of visceral organs and associated fat tissue (g) / wet body weight g.

The experimental data was evaluated through one way analysis of variance (ANOVA) to determine growth performance and product quality. Difference among means was calculated by 5% probability level addressing Duncan's multiple range test (Zar, 1996).

RESULTS

Water quality

Water temperature was consistent at 26.5±0.5°C. Dissolved oxygen concentration remained up to 7.0±0.2 ml/l and pH was generally alkaline with slight variation among the tanks; pH values were around 6.5±0.2 throughout the study period. Ammonia and nitrites were not more than 0.01±0.001 ml/l. Salinity was usually between 18-20 %.

Chemical composition of diets

Four experimental diets containing different oils such as FO, SO, OO and PO were chemically analyzed. The composition reveals that each diet has lipid 10.9–11%, protein 42.1–42.3%, moister 6.5–8.3%, ash 12.8–13.8%, fiber 3.3–3.4 %, calcium 2.2–2.5%, NFE 27.6–29.5% and energy 3875.2–3889.2 kJ/100g (Table II).

Growth, feed efficiency and condition indices

No adverse effects were found on health and no mortality was observed during the entire study period. The specific growth rate (SGR) of fish fed diet containing FO showed highest value following the same of fish fed SO, OO and PO (Table III). However, SGR of the reaming three diets were not significantly different (P>0.05; Table III). Higher weight gain (585.14%) was noted in fish fed with FO in contrast with SO, OO and PO diets (Table III; Fig. 1). Lower FCR (0.046) was observed in fish fed diet containing FO (Table III). Feed intake was not significantly affected by the dietary oil inclusion in the trail. The PER value (1.47) of fish fed FO diets was considerably higher, although the PER of the OO and PO diets were same and SO diet has intermediate value (Table III). Higher hepatosomatic index (HSI) was observed in fish fed with FO and lower HSI were noted in fish fed with diets containing OO and PO (Table III). Lower VSI was noted in the fish fed with olive oil and higher VSI was observed in fish fed fish oil diets. However, VSI of fish fed with SO and PO were intermediate (Table III). No significant difference was noted in the values of conditions factor (2.7%) among all treatments.

Table II.- Chemical analysis (% DM) of the experimental diets containing fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO).

Constituents[1]	Experimental diets			
	FO	SO	OO	PO
Moisture	8.3±0.11	6.5±0.14	7.1±0.30	7.1±0.33
Protein[2]	42.1±1.20	42.2±1.11	42.3±1.22	42.3±1.21
Lipid	11.2±0.12	12.1±0.13	12.3±0.27	12.3±0.26
Ash	12.8±0.23	13.1±0.10	13.5±0.20	13.5±0.16
Fiber	4.4±0.31	4.3±0.11	4.3±0.24	4.3±0.20
NFE[3]	29.5±1.21	28.3±0.19	27.6±0.21	27.6±0.18
Calcium	2.5±0.11	2.2±0.13	2.3±0.23	2.5±0.24
Phosphorus	1.6±0.10	1.4±0.21	1.6±0.26	1.6±0.10
Gross energy (kJ/100g)	3876.2± 2.31	3889.2± 2.21	3880.1± 2.44	3880.5± 2.11

[1]Dry matter basis (%); mean ± SE, number of determination = 5.
[2]Measured as nitrogen × 6.25.
[3]Nitrogen-free extract = 100 – [(% protein + % fat + % ash + % fiber)].
Similar superscripts indicate no statistical difference among treatments; initial fish weight is 10.1±0.5 g.

Body composition

Crude lipid was higher in fish fed diets containing PO and OO but lower in the fish given FO diets. Moreover, crude lipid of fish fed with SO was intermediate (Table IV). No significant difference was observed in crude protein of fish with different oil as energy source. Moister content of fish fed with SO was significantly higher than FO, OO and PO (Table IV). Crude fiber of fish fed with fish oil (FO) was slightly greater than SO, OO and PO. Ash content was not significantly affected by the oil source. No differences in the gross energy contents were observed among all treatments (Table IV).

Table III.- Growth performance of black fin sea bream, *A. berda* fed diets containing fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO).

Parameters	Experimental diets			
	FO	SO	OO	PO
Final weight (g)	69.21± 1.21[a]	65.41± 1.37[a]	65.11± 1.25[a]	65.21± 1.24[a]
WG[1]	585.14± 2.31[b]	547.52± 2.21[a]	444.55± 2.26[a]	445.54± 2.20[a]
SGR[2]	3.21± 0.11[b]	2.83± 0.13[a]	2.82± 0.21[a]	2.82±0. 14[a]
Feed intake[3]	27.30± 1.21[a]	31.11± 1.20[b]	32.20± 1.30[b]	32.40± 1.25[b]
FCR[4]	0.046± 0.001[a]	0.056± 0.001[b]	0.072± 0.002[b]	0.072± 0.001[b]
PER[5]	1.47± 0.11[b]	1.38± 0.10[a]	1.36± 0.12[a]	1.36± 0.20[a]
HSI[6]	2.11± 0.01[b]	1.61± 0.01[a]	1.21± 0.02[a]	1.40± 0.01[a]
VSI[7]	3.31± 0.01[b]	2.51± 0.02[a]	2.11± 0.01[a]	2.51± 0.02[a]
CF[8]	2.78± 0.21[a]	2.74± 0.20[a]	2.74± 0.19[a]	2.75± 0.18[a]
Survival %	100	100	100	100

[1]Weight gain, % of initial weight =100 × final weight – initial weight / initial weight. [2]SGR =100 × (ln final weight – ln initial weight / period). [3]FI = diet given as % body weight – remaining diet pellets. [4]FCR = diet given / weight gain). [5]PER = wet weight gain / N×6.25 intake. [6]HSI = wet of liver (g) / empty fish weight (g) ×100: total of initial was 1.24%. [7]VSI = 100 × [wet weight of visceral organs and associated fat tissue (g) / wet body weight g]. [8]CF =100 × weight / length[3].

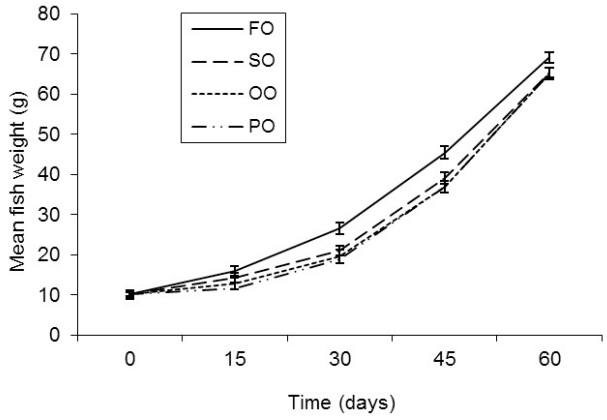

Fig. 1. Mean body weight of juvenile black fin sea bream, *A. berda* fed diets containing fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO).

Table IV.- Whole body composition of *A. berda* fed diets containing fish oil (FO), soybean oil (SO), olive oil (OO) and palm oil (PO).

Constituents[1]	Experimental diets			
	FO	SO	OO	PO
Crud lipid (%)	6.72± 0.12[a]	6.51± 0.11[a]	6.81± 0.09[a]	6.90± 0.11[a]
Crud protein[1] (%)	16.81± 1.11[a]	16.40± 1.21[a]	16.10± 1.20[a]	16.21± 1.13[a]
Moister (%)	73.50± 1.21[a]	73.81± 1.41[a]	73.11± 1.21[a]	73.32± 1.30[a]
Crude fiber (%)	1.54± 0.10[a]	1.42± 0.11[a]	1.31± 0.10[a]	1.30± 0.09[a]
Ash (%)	3.12± 0.10[a]	3.51± 0.21[a]	3.73± 0.23[a]	3.42± 0.20[a]
Gross energy kJ/g (%)	32.52± 1.20[a]	32.90± 1.21[a]	32.61± 1.31[a]	32.52± 1.26[a]

Similar superscripts indicate no statistical difference among treatments. Chemical composition of stocking fish: moisture = 71 %, protein = 52.3 %, lipid = 34.1 %, ash = 11.3 %. [1]Measured as nitrogen ×6.25.

DISCUSSION

In the present study, juvenile black fin sea bream, *A. berda* were shown to have higher WG and SGR at diets encompassing FO as energy source. This higher growth might have been due to the fact that FO has good profile of fatty acids that enhanced growth performance of the fish. Evidence to support this is available from the finding of El-Husseiny *et al*. (2013) and Bahurmiz and Ng (2007). In addition, Peng *et al*. (2008) and Francis *et al*. (2006) studied the effects of replacing dietary fish oil with soybean oil for black sea bream *(Acanthopagrus schlegeli*) and achieved higher growth with fish oil diets. Similar observations were reported by Bahurmiz and Ng (2007). In the present study, WG and SGR of the fish fed diets containing soybean oil, olive oil and palm oil were slightly less than those of the fish fed with fish oil. It may be due to the shortage of arachidonic acid which is only found in fish and other sea animals. Similar conclusions were found by Peng *et al*. (2008) and Bahurmiz and Ng, 2007). These authors stated that complete substitution of fish oil with soybean oil reduced growth efficiency parallel with the findings of our study. In the present study, FCR and PER were affected by the dietary oils source. The high FCR and PER of the fish fed diet including FO indicated that diets with fish oil as energy source are helpful to protein conversion than SO, OO and PO, agreeing with the results of Regost *et al*. (2003) while working on the effect of different oils as source of energy in fish diet. According to

them, fish oil enhances growth as well as fatty acid profile of the fish. Since FO is considered as costly component of fish diet, its alternatives like vegetable oil (soybean oil, olive oil, palm oil *etc.*) should be incorporated in diets as energy source (Rahim *et al*., 2015).

In this study, soybean oil was found to be the second best source of energy in the diets similar to the finding of Figueiredo-Silva *et al*. (2005), Cabral *et al*. (2013), Regost *et al*. (2003) and Mourente *et al*. (2005). But, FCR value of the fish fed soybean oil based diet was somewhat less than that of the fish fed diet having FO. This indicates that total replacement of fish oil with soybean oil slightly decreases the growth but this issue could be resolved by determining the level of replacing fish oil with soybean oil. The limit of replacement depends on the need of fatty acid for species used in culture system, agreeing with Mourente *et al*. (2005) and Regost *et al*. (2003). No significant difference in WG and FCR were observed in the fish fed with PO and OO based diet as energy source. Similar results were reported by Ng *et al*. (2000) while studying on catfish. He revealed that palm oil can successfully be used in feed of catfish to enhance the growth. In addition, Bahurmiz and Ng (2007) confirmed that palm oil can be totally substituted in tilapia diet instead of fish oil throughout their growth period without affecting growth until harvesting with little deficit in fatty acid profile. Number of studies (Lim *et al*., 2001; Mourente and Bell, 2006; Bahurmiz and Ng, 2007) showed that palm oil are feasible alternative in fish diet as described in the present study. Since dietary fatty acid profile play significant role for enhancing meat quality of fish and fatty acid profile with regard to human health as well. Therefore, further studies are required for the assessment of fatty acid composition in case of palm oil as source of lipid. Olive oil in the present trail also gives moderate performance regarding growth similar to the finding of Mourente *et al*. (2005). According to him, olive oil can potentially be used in diet of European sea bass without compromising its growth. This performance can be improve by adding fish oil in diet even in little amount. Positive correlation between hapatosomatic index and growth rate was observed in the present study which is parallel to the results of Bransdena *et al*. (2003).

In case of whole body composition, crude protein was not significantly influenced by the dietary oils. This indicates that lipid source has no effect on body protein due to protein sparing effects (Bransdena *et al*., 2003; Bendiksen *et al*., 2003; Ovie *et al*., 2005; Li *et al*., 2012). Inverse relation between moister and crude lipid was found in the present study agreeing with the findings of Abbas *et al*. (2015) and Rahim *et al*. (2015) who noted negative correlation of fats with moister content. In the present study, ash was not influenced by the dietary lipid sources. These results were advocated by Mourente *et al*. (2005). He concluded that dietary lipid sources have no effect on ash content of the fish. Gross energy was noted same among all treatments in this study.

Finally, it was concluded that the best source of energy for maximum growth of sea bream *A. berda* was fish oil and second best oil source to enhance the growth was soybean oil. After that, palm oil and olive oil can be used in fish diet successfully. But, further study is required to optimize fish oil in diets of sea bream in captivity.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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