International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 2, Issue 6, pp: 399-404, 2017 **http://www.ijzab.com**
https://doi.org/10.5281/zenodo.1312964
Research Article

EFFECT OF ALTERNATE PROTEIN SOURCE SOYBEAN MEAL AND SESAME OIL CAKE ON GROWTH PERFORMANCE AND BODY COMPOSITION OF FRESH WATER FISH *CIRRHINUS MRIGALA*

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Article History: Received 27th October 2017; Accepted 1st December 2017; Published 20th December 2017

ABSTRACT

A 60 days experiment was carried out under laboratory conditions where *Cirrhinus mrigala*, mrigal fries (0.55±1g) were maintained in glass aquaria filled with fresh water. Three main protein sources fish meal (protein from animal source), sesame oil cake and soybean meal (protein from plant source) were used in diets. Further, soybean was taken in two forms raw and processed. Eight diets were formulated with equal proportion of raw soybean in 1-4 diets, and hydrothermically processed soybean in 5-8 diets following inclusion levels (65, 130, 195, 260 g kg^{-1} diet). While sesame oil cake was incorporated in all diets in equal amount. 100% fish meal based diet was used as control in this experiment. Fishes were randomly distributed @ 15 fish per aquarium with duplicates for each dietary treatment. Results showed that where mrigala fry fed on processed soybean based diet Growth % gain and SGR % significantly ($P < 0.02$) increased. Protein efficiency ratio recorded maximum in diet 5. Maximum values were increase in these parameters were observed in diet 6th, where fish meal and processed soybean meal were applied in equal amount in diet in comparison to fish fed on control diet. Feed intake was also declined with the increase in inclusion level of soybean meal, but the feed conversion ratio (FCR) and protein efficiency ratio (PER) maximum in diet 3 and reference were followed by other diets. Our results suggest that soybean meal can be a suitable source without compromising weight gain or feed efficiency in fry of *C. mrigala.*

Keywords: Soybean, Fish meal, Growth performance, Proximate composition, Mrigala fish.

INTRODUCTION

Now a day's aquaculture production included nearly 88.8% by quantity, where fresh water fishes were continued to lead (54.7%) the total fish production by quantity (FAO, 2010). Feed production along with its management is major outlay in aquaculture as it accounts for at least 40-60% of the cost of fish production. Presently Fish Meal is widely used in aqua feeds because of its nutrient quality. However supply of fish meal not sufficient to fulfill the requirement. Further the cost of fish meal is increasing day by day. Therefore, scientists are done so many experiments on plant protein to be used in aqua feeds. Hence this alternative protein source must be found to fulfill the shortage of fish meal. There are many plant proteins source by which fish meal can be replaced by corn, soybean, lupin seed meal, faba bean meal, pea seed meal, rapeseed, cassava leaf meal, barley and alfalfa and soybean. Among plant protein sources used in diets fed to aquatic animal soybean is considered to be cheap and nutritionally rich protein ingredient for partial or total replacement of Fish meal. Further to achieve full nutritional value of plant protein its necessary to inactivate the anti nutritional factors eg- in soybean, protease inhibitors and trypsin inhibitors are present, which are inactivated by processing soybean. It's very important to select ingredients for the formulation of fish feed and it should be cheap and easily available in local market (Zamal *et al.*, 2009). Many scientists used Sesame oil cake as a main dietary protein source at level the experiment ranging from 4.0% to 70% in different carp species (Hossain and Jauncey, 1989; Hasan *et al.*, 1997; Mohanty and Dash, 1995). The advantage of sesame oil cake is its relatively high protein content (420 g kg^{-1}), similar to that of soybean meal, protein and its low crude

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fibre content in comparison to rapeseed and linseed meal (60–70 g kg^{-1} versus 130 g kg^{-1} and 110 g kg^{-1}, respectively (Johnson *et al.,* 1979; Sauvant *et al.,* 2002; Reigh, 2008). Therefore present study reports on nutritional value of soybean meal and sesame oil cake in diets and its effect on fish (*Cirrhinus mrigala*).

MATERIAL AND METHODS

Experimental diets

Nine diets were prepared having the same formula composition (Table 1) and proximate composition (Table 2) using standard methods of AOAC (1995). Soybean was used in preparing the experimental diets were purchased from Grain market, Rohtak. Dry seeds were processed for 15 minutes in autoclave. Both raw and heat processed soybean seeds were separately ground into fine powder, using electric blender to obtain soybean meal. Each meal was mixed with sesame oil cake, wheat flour as binder, fish meal as supplementary animal protein, cod liver oil as fatty acids, and chromic oxide as indicator for digestibility analysis and vitamin / mineral premix. Diets were prepared in laboratory after thoroughly blending all the dietary ingredients in feed pelletizer. Pellets were dried in oven at 60˚C, packed and stored in refrigerator at -4˚C until used.

Table 1. Ingredient contents (g kg-1) incorporated in diets.

Ingredients	Reference diet	Diets							
		Raw soybean based				Processed soybean based			
	(R)	1 (r)	2(r)	3(r)	4(r)	5(p)	6(p)	7(p)	8(p)
Sesame oil cake	650	650	650	650	650	650	650	650	650
Rice bran	26.23	28.35	30.62	32.84	35.00	28.35	30.62	32.84	35.00
Wheat flour	26.23	28.35	30.62	32.84	35.00	28.35	30.62	32.84	35.00
Fish meal	260	195	130	65	-	195	130	65	-
Raw soybean	-	65	130	195	260	-	-	-	-
Processed full fat soybean	-	-	-	-	-	65	130	195	260
Cod liver oil	17.54	13.30	8.76	4.32	-	13.30	8.76	4.32	-
Mineral premix with amino acid	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Cr_2O_3	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

(R- Reference diet, r- raw soybean based, p- processed soybean based). Processed soybean: soybean was hydrothermically processed in an autoclave at 121˚C for 15 minutes to remove anti-nutritional factors (ANFs). Trypsin inhibitor concentration was 83.23±5.44 mgg^{-1} in raw soybean and 8.4±0.49 mgg^{-1} in hydrothermically processed soybean. Each diet included DL-methionine- 1.920g, L-lysine mono hydrochloride 4.4g.

Table 2. Proximate analysis % of diets.

Parameters	Reference	Diet- 1	Diet-2	Diet-3	Diet-4	Diet-5	Diet-6	Diet-7	Diet-8
Dry matter	98.60	97.00	96.60	96.20	98.20	95.00	96.60	92.80	98.00
Crude protein	40.10	40.02	40.00	40.06	40.05	40.09	40.10	40.15	40.00
Crude fat	9.00	7.33	7.66	8.30	7.83	8.03	8.26	8.36	8.66
Crude fibre	4.50	4.00	5.00	4.20	4.40	4.15	4.10	3.50	4.32
Ash	26.20	21.80	17.00	12.60	8.20	20.80	16.80	13.40	8.20

Rearing and sampling

The study was conducted at Research Laboratory, Department of Zoology, Maharshi Dayanand University, Rohtak, and Haryana. Two hundred and seventy fries of *Cirrhinus mrigala* (mean body weight: 0.55±1g) were obtained from Govt. fish seed farm Jhajjar and acclimated to laboratory conditions for minimum period of fifteen days and fed daily on a formulated diet at 5% body weight. After acclimation period the fish were randomly distributed @ 15 fish per aquarium with two replicates for each treatment. Each aquarium was supplied with 30-35 liters of dechlorinated water and aerated continuously by aerators. All groups of fish were fed daily twice between 9am and

5pm at feeding rate of 5% BWd^{-1} for the whole experimental duration of 60 days on different diets depending upon the treatment. Fishes were weighed every 15^{th} day and feeding rate was adjusted accordingly. To maintain the water quality, aquaria water was replenished daily with previously stored water at 25-26˚C. Fish fry were fed with respective diets and thereafter, the uneaten feed was siphoned out and stored separately for calculating the feed conversion ratio (FCR). Feacal matter was collected by siphoning out at every morning. The feacal samples were dried in an oven maintained at 60˚C for subsequent analysis. Individual weight and length of fish fry was recorded at the beginning and at the end of experiment.

Analytical techniques

The feed ingredients, experimental diets, feacal samples and fish carcass (initial and final) were analyzed following the procedure of AOAC (1995). Chromic oxide levels in diets as well as in the fecal samples were estimated spectrophotometrically following the method of Furukawa and Tsukahara (1966). Proximate analysis of fish as well as diet was studied following the procedure of AOAC, 1995.

Dry matter

= 100 - % Moisture

Percentage of moisture

$$= \frac{\text{Wet weight of the sample – Dry weight of the sample}}{\text{Wet weight of sample}} \times 100$$

Percentage of Crude protein

$$= \frac{V \times 0.00014 \times D \times 100 \times 6.25}{W \times A}$$

Where,

V = Volume of 0.01NH2SO4 taken- volume of 0.01N NaOH used

D = Dilution factor

W= Weight (g) of sample

A = Aliquot taken

Percentage of fat

$$= \frac{\text{Weight. of fat (g)}}{\text{Wt. of sample (g)}}$$

Percentage of Crude fibre

$$= \frac{(x - y) \times 100}{\text{Sample}}$$

Where,

X= Dry residue

Y= Dry residue after ignition

Percentage of Ash

$$= \frac{\text{Ash weight}}{\text{Sample wt.}} \times 100$$

Growth parameters were studied.

Live weight gain (g)

= W2- W1

Where,

W2= Final weight

W1= Initial weight

Growth per cent gain in body weight

= W2 – W1 /W1 ×100

Specific growth rate (SGR % g d-1)

= ln W2 – ln W1/t × 100

Where,

W2 = final weight (g)

W1 = initial weight (g)

t = duration of experiment in days

Feed conversion ratio (FCR)

=Feed given (dry wt. g) / Body weight gain (wet wt. g)

Protein efficiency ratio (PER)

= W2- W1 / feed × feed protein

Where,

Feed = Total feed given

Feed protein (%) = 40%

Viscero somatic index (VSI)

$$= \frac{\text{Viscera wt.(g)} \times 100}{A}$$

Where,

A= Weight of empty fish

Hepato somatic index (HSI)

$$= \frac{\text{Liver wt. (g)} \times 100}{A}$$

RESULTS

After duration of 60 days, growth performance and nutrient retention data of *Cirrhinus mrigala* are shown in Table 3. Among the treatments growth % gain, live weight gain and (SGR %) were recorded high in fish fed on Diet-6 and values were also significantly different from remaining diets. FCR ranged from 9.2 to 12.19 and PER varied from 0.20 to 0.27. The values of FCR in reference diet, diet-5 and diet 6 were nearly similar and found to be superior over other diets. All test fishes in different treatments are found to be in good health and very active. Proximate caracass composition of fry *Cirrhinus mrigala* under laboratory conditions shown in Table 5. Crude protein level ranges from 40 to 40.15%. Crude fat and crude fibre % values are

recorded high in reference as compared to diets which are soybean based. Table 4 shows the muscle glycogen and liver glycogen ranges from 0.22 to 0.61 and 1.33 to 6.05. Viscero somatic index (VSI) in diet 6 where the fish shows growth is maximum. Processed soybean based diet 8 shows minimum value of Hepato somatic index (HSI).

Table 3. Effect of replacement of fish meal by soybean on growth performance, nutrient retention and food conversion efficiency in *Cirrhinus mrigala* fry under laboratory conditions.

Parameters	Reference diet*	Diets							
		Raw soybean based				Processed soybean based			
		1	2	3	4	5	6	7	8
Initial weight	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Final weight	1.83	1.45	1.33	1.32	1.09	1.87	1.90	1.59	1.55
Live weight gain	1.29± 0.01	0.91± 0.01	0.79± 0.01	0.78± 0.01	0.55± 0.01	1.33± 0.01	1.36± 0.01	1.05± 0.02	1.01± 0.01
Growth %gain	238.88 ±0.92	168.51 ±0.92	147.22 ±1.39	142.58 ±1.85	102.77 ±0.46	247.22 ±1.39	257.27 ±0.86	194.44 ±0.92	187.03 ±0.92
Specific growth rate % (SGR)	2.033 ±0.004	1.644 ±0.005	1.507 ±0.009	1.483 ±0.008	1.174 ±0.004	2.073 ±0.006	2.099 ±0.006	1.799 ±0.005	1.749 ±0.008
Feed conversion ratio (FCR)	9.25 ±0.010	10.91 ±0.060	12.01 ±0.370	12.19 ±0.080	11.93 ±0.007	9.63 ±0.007	9.87 ±0.005	10.28 ±0.002	10.17 ±0.005
Protein efficiency ratio (PER)	0.270 ±0.002	0.228 ±0.001	0.208 ±0.006	0.204 ±0.001	0.209 ±0.000	0.259 ±0.002	0.253 ±0.000	0.243 ±0.000	0.245 ±0.002

All the values are mean ± S.E.

Table 4. Effect of replacement of fish meal by soybean meal on VSI, HSI, liver and muscle glycogen of *Cirrhinus mrigala.*

Parameters	Reference	Diet-1	Diet-2	Diet-3	Diet-4	Diet-5	Diet-6	Diet-7	Diet-8
Viscero somatic index	8.08± 0.02	5.55± 0.12	4.76± 0.01	6.25± 0.07	8.00± 0.10	6.42± 0.07	8.57± 0.13	6.77± 0.23	4.90± 0.05
Hepato somatic index	8.19± 0.04	6.89± 0.47	7.51± 0.15	11.36± 0.07	4.58± 0.11	3.20± 0.17	4.21± 0.28	2.51± 0.23	1.93± 0.05
Muscle glycogen	0.22± 0.01	0.34± 0.01	0.38± 0.02	0.54± 0.01	0.61± 0.01	0.20± 0.02	0.17± 0.02	0.26± 0.01	0.23± 0.03
Liver glycogen	1.97± 0.02	2.57± 0.02	4.05± 0.01	5.08± 0.02	6.05± 0.02	1.53± 0.02	1.33± 0.03	2.03± 0.02	2.46± 0.02

All the values are mean ± S.E.

Table 5. Effect of replacement of fish meal by soybean meal on proximate caracass composition of *Cirrhinus mrigala* fry under laboratory conditions.

Parameters	Reference	Diet-1	Diet-2	Diet-3	Diet-4	Diet-5	Diet-6	Diet-7	Diet-8
Dry matter	98.60	98.20	97.00	96.60	96.20	98.00	96.60	95.00	92.80
Crude protein	40.10	40.06	40.05	40.02	40.00	40.15	40.10	40.09	40.00
Crude fat	9.00	8.30	7.83	7.66	7.33	8.66	8.36	8.26	8.03
Crude fibre	5.00	4.50	4.20	4.40	4.00	4.32	4.15	4.10	3.50
Ash	26.20	21.80	17.00	12.60	8.20	20.80	16.80	13.40	8.20

DISCUSSION

There is lot of profit in replacing fish meal by other cheap plant protein sources due to continuously increasing the demand of fish meal and its non availability to fulfill the demand. Based on growth response data FM could be replaced by processed soybean meal without significantly affecting the growth parameters FCR, PER and survival rate of *Cirrhinus mrigala.* Further in our studies fish is able to effectively utilize appropriate levels of soybean meal as main protein ingredient. Comparison of investigative work on different fish species shows that plant protein can replace FM partially in carnivorous fish species like Nile Tilapia, common carp, catla and rohu. As soybean replacement level increased, it declines the growth of fish (Luo *et al.,* 2006). This is may be because the level of amino acids mainly lysine and methionine are changed in experimental diet. This change creates deficiency of lysine which causes loss of appetite and hence directly reduces the growth rate (Luo *et al.,* 2006 and Zhou *et al.,* 2007). Also, it was reported significant decrease in growth performance of gilthead sea bream Sparus aurata at 300 g kg1 replacement of fish meal protein with soybean meal (Nengas *et al.,* 2008) and (Kader *et al.,* 2012) reported reduction in growth that fish meal protein could be replaced up to 360 g kg1 by FSM . Recently (Zhou *et al.,* 2011) reported that up to 200 g kg1 fish meal protein could be replaced by FSM by Candida utilis for black sea bream. A significant reduction in growth was observed in *O. niloticus* (Koumi *et al.,* 2008). Davis *et al*. (2005) reported in juvenile red snapper, *Lutjanus campechanus* when soyabean meal totally replaced for fishmeal. In contrast, (El-Saidy and Gaber, 2002) reported that feeding blue tilapia and Nile tilapia, respectively with 100% SBM, firstly with or without methionine supplementation had no significant effect on growth parameters and feed utilization. In fish, the limited information available on the nutritional value of sesame oil cake showed a significant reduction of growth rate in common carp fry fed diets containing sesame oil cake protein to substitute for fish meal protein from 25% up to 75% of the total protein content (Hasan *et al.,* 1997). The present study indicates that partial replacement of FM with soybean meal and sesame oil cake has no significant difference on growth performance as compared to control diet.

CONCLUSION

In present study, diets include the ingredients to consider their nutritional quality and also their effectiveness. The use of soybean meal after processing can probably be a potential alternative to fish meal. Fish meal could be replaced by soybean meal without significantly affecting the FCR, PER and survival rate of *Cirrhinus mrigala* fish and this fish is able to effectively utilize appropriate level of SBM as main ingredient in the diet. Irrespective of the dietary treatments, mortality during the experimental period remained low in all the treatments.

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