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Article

Growth performance study of Silver barb (*Barbonymus gonionotus*) by replacing fishmeal with soybean meal in the diet

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Abstract: Increasing demand, uncertain availability, and increasing cost for fishmeal (FM), fish nutritionists have been driven to find alternative sources of protein. The aim of this study was to evaluate the effects of substituting FM with soybean meal (SM) on growth performance of silver barb, *Barbonymus gonionotus.* Five diets were prepared 0%SM (100%FM), 25%SM (75%FM), 50%SM (50%FM), 75%SM (25%FM) and 100%SM (0%FM) by replacing FM with SM. *B. gonionotus* having initial length and weight of 8.62±0.9 cm and 8.80±3.11 gm were fed each diet twice a day for 45 days. Fish sampling was done fortnightly. Significantly higher ($P<0.01$ and $P<0.05$) weight and length gain were found up to 75%SM compared to 100%SM. The specific growth rate (6.01±0.34%d^{-1}) was significantly higher ($P<0.05$) in 50%SM compare to 75%SM and 100%SM. Considering the result of present study we recommend to replace 50% SM as a source of protein with 50% FM for better growth of *B. gonionotus*.

Keywords: silver barb; growth; fishmeal; soybean meal

1. Introduction

Aquaculture has a crucial contribution to worldwide human food consumption and nutritional security (Tacon and Metian, 2013). Feed input is the largest operational cost of commercial aquaculture practices. Fishmeal (FM) has been the well-recognized major source of animal protein in commercial fish feeds in the world. Unfortunately, use of FM as the sole source of protein in fish feed is not feasible in Bangladesh because of its high price and unavailability. Therefore, it is necessary to replace FM alternative protein source or sources having cheaper values for boosting up the aquaculture production. To fulfill the feed demand of growing aquaculture, the replacement of FM with plant-based alternatives has become an inevitable choice for the aquafeed industry (Blanchard *et al*., 2017). Consequently, plant feedstuffs with high protein content are preferentially used in formulating diets for most species of fish. Soybean meal (SM) has been identified as one of the most promising substitutes for FM (Booman *et al*., 2018).

SM is widely used as the cost effective alternative for high quality FM in feeds for many aquaculture fish species due to its high protein content, excellent amino acid profile, low cost, availability and steady supply as compared to the other plant protein sources (Kushwaha, 2013). SM has been used as feed attractant, providing vitamins and essential fatty acids that play major role in fish growth (Tocher *et al.*, 2008; Cahu *et al.*, 2009). Considerable success in partial replacement of FM by dietary SM without affecting growth performance (Cabral *et al.*, 2013) has been reported in black sea bream (Ngandzali *et al.*, 2011), Obscure puffer (Ye *et al.*, 2019) and Atlantic Cod (Walker, 2010). Most studies evaluated the impact of such diets on the nutritional value of the fillet, but few focused on gut health and even less on intestinal textural properties (Matos *et al.*, 2012). The amino acid profile of soya protein is generally superior to other plant proteins (O'keefe *et al.*, 2003). Hence the

soybean of present work has been selected as the raw material for formulation of fish feed along with other ingredients of silver barb *Barbynomus gonionotus.*

B. gonionotus, is a fresh water fish of Thailand. It was introduced in Bangladesh in 1977 from Thailand because of its high yielding potential and has become increasingly popular for its bright silvery appearance and good taste. It has been proved to be a good species for culturing in the seasonal ponds and rice fields in Monoculture. Thai silver barb *B. gonionotus*, an exotic fish of Bangladesh belonging to the family Cyprinidae, could be a suitable species for aquaculture due to its good palatability, high yield potential and very large market demand (Wahab *et al.,* 2001). Being an omnivorous species in origin, it prefers a feed of aquatic plants, soft grasses, and planktons. It responds well to a wide range of culture conditions with comparatively low-cost, simple management practices (Rothuis *et al.,* 1998). Silver barb, *B. gonionotus* is the suitable candidate for polyculture with carps for its synergistic effect on the growth and production in Bangladesh (Halim *et al.,* 2018). Therefore, the present study was conducted on replacement of FM with SM as ingredients of fish feed to determine the growth performance of *B. gonionotus*.

2. Materials and Methods

2.1. Research site

The experiments were conducted in the Mini Hatchery and Breeding Complex of the Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

2.2. The experimental design

For conducting experiment, ten cisterns were used in Mini Hatchery Complex of Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh. Eight cisterns corresponded to experimental treatment and two were used for control. Forty fingerlings of *B. gonionotus* having initial weight and length 8.8±3.1 gm and 8.62±0.90 cm respectively were stocked in each cistern and reared for 45 days. For treatment five formulated diets 0%SM (100%FM), 25%SM (75%FM), 50%SM (50%FM), 75%SM (25%FM) and 100%SM (0%FM) were used to observe the growth of the fish.

2.3. Collection of *B. gonionotus*

Required numbers of *B. gonionotus* were collected from Deshbondhu Hatchery, Shomvugonj, Mymensingh, Bangladesh.

2.4. Physico-chemical parameters of water

Temperature, dissolved oxygen (DO) and pH of water in each cistern were recorded daily. Temperature was recorded by using a Celsius thermometer, DO, pH and salinity were measured by a digital DO meter (DO-5509 dissolved oxygen meter, made in Taiwan), a portable digital pH meter (HI 98107, pH ep Tester, Rumania) and Refractometer (ATAGO, S/Mill, salinity. 0-100 ‰, Japan), respectively.

2.5. Feed formulation

Feed containing 0% SM, 25% SM, 50% SM, 75% SM and 100% SM were prepared with rice bran, wheat flour, FM, maize meal, SM, vit-B complex and cod liver oil. Required amount of ingredients were ground finely by a grinding machine and sieved with fine mesh net. The composition of experimental feed is shown in Table 1. The diets were stored in plastic bags in airtight condition and kept in refrigerator.

2.6. Analysis of proximate composition of feeds

The proximate compositions of the dietary ingredients were determined following the standard methods given by Association of Official Analytical Chemists (AOAC, 2019) in the Nutrition Laboratory of Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Percent moisture, ash, protein, lipid, crude fiber, and nitrogen free extract (i.e. carbohydrate) were measured during the chemical analysis.

2.7. Feeding and sampling of the experimental fish

The fishes were fed twice daily in the morning (9:00 AM) and afternoon (5:00 PM). The void food stuff, debris and feces were removed by siphoning on a daily basis. Sampling was done fortnightly for growth assessment. During sampling 6 fishes from each cistern were caught and the weight and length of each fishes were measured by electric balance and measuring scale respectively. Weight of gonad, liver and digestive tract was also measured.

2.8. Estimation growth parameters and somatic indices

The parameters of growth performance were calculated as follows:
Weight gain (WG; g) = $W_f – W_i$
Specific growth rate (SGR; % d^{-1}) = $(\ln W_f - \ln W_i)/\times 100$
Where W_i and W_f are the initial and final fish body weights (g) at the beginning and end of the feeding trial, respectively.

2.9. Statistical analysis

All the data were analyzed by one-way analysis of variance (ANOVA) using SPSS version 22.0 software. When ANOVA detected a difference among groups, Duncan's multiple range tests was used to identify the difference in the means. Data are presented as mean ± standard error (SE).

3. Results

3.1. Physico-chemical parameters of water

The average temperature, dissolved oxygen, pH and salinity of the experimental cisterns were recorded 25.5 ± 1.5°C, 9.5 ± 0.5 ppm, 7.3 ± 0.10 and 0 ppt, respectively. There were no significant differences ($P<0.05$) in all the parameters measured among the experimental cistern.

3.2. Proximate composition analysis of the feed ingredients of diets

Proximate compositions of different feed ingredients were analyzed following the standard methods given by AOAC, 2019. Crude protein contents were higher in fishmeal (60.61%) and soybean meal (41.54%) from other ingredients. Five diets were formulated to contain various percentage of soybean meal as partial replacement for fishmeal. All diets contain similar percentage of protein level. Diets 1, 2, 3, 4 and 5 contained 0%, 25%, 50%, 75% and 100% of SM, respectively. Crude protein and gross energy contents of experimental diets were not significantly different ($P<0.05$). Proximate composition of different feed ingredients and formulated diets is shown in the Table 2. The feeding trial was carried out for 45 days.

3.3. Growth performances

At the start of the growth trial such as weight and length, uniform sized fishes were randomly selected into each cistern, with three replicates per diets. Significantly higher ($P<0.001$) weight gain was found in fishes fed with diets 0%SM, 25%SM, 50%SM, 75%SM and compared to the fishes fed with diet 100%SM after 45days. However, weight gain was not significantly different among fish fed with diets 0%SM, 25%SM and 50%SM after 45days. Significantly higher ($P<0.05$) length gain was found in fishes fed with diets 0%SM, 50%SM, 25%SM, 75%SM and compared to the fishes fed with diet 100%SM after 45 days. However, length gain was not significantly different among fish fed with diets 0%SM, 50%SM, 25%SM and 75%SM after 45days. Average body weight (gm) and length (cm) of *B. gonionotus* fed with different formulated diets for 45 days is shown in the Table 3 and Table 4, respectively.

Table 1. Composition of ingredients used for the formulation of supplemental diet for 200 g.

Ingredients	Diets				
	SM 0	**SM 25**	**SM 50**	**SM 75**	**SM 100**
Wheat flour	20	20	20	20	20
Wheat bran	30	30	30	30	30
Rice bran	40	40	40	40	40
Maize meal	27	27	27	27	27
Fishmeal	80	60	40	20	0
Soybean meal	0	20	40	60	80
Vitamin B	1	1	1	1	1
Cod liver oil	2	2	2	2	2

SM 0, SM 25, SM 50, SM 75, and SM 100 indicates diets containing 0%, 25%, 50%, 75% and 100% of SM, respectively.

Table 2. Proximate composition of feed ingredients and formulated diets.

Feed ingredients	%					
	Moisture	**Crude lipid**	**Crude protein**	**Ash**	**Crude fiber**	**Carbohydrate**
Wheat flour	15.51	2.20	9.22	1.68	0.80	73.59
Rice bran	18.78	10.60	11.98	7.36	7.20	44.08
Wheat bran	14.96	4.80	14.51	2.89	6.90	55.94
Maize meal	14.33	3.20	16.08	7.64	6.70	52.05
Soybean meal	14.80	4.28	41.54	5.54	6.88	26.96
Fishmeal	10.17	8.46	60.61	18.03	1.80	0.93
SM 0	38.36	3.20	25.05	3.77	4.20	25.42
SM 25	42.62	3.36	23.04	5.20	4.48	21.30
SM 50	43.33	3.46	22.02	6.89	4.96	19.64
SM 75	41.83	3.88	22.44	8.11	5.20	18.54
SM 100	45.43	3.96	22.07	10.63	5.86	13.55

Table 3. Average body weight (gm) ± SD of *B. gonionotus* fed the formulated diet for 45 days.

Diets	Intervals			
	Initial	**15 days**	**30 days**	**45 days**
SM 0	8.2±1.51	10.32±1.09	24.43±7.60	44.8±5.76**
SM 25	7.58±0.45	10.674±1.29	26.8±7.76	46.6±2.41**
SM 50	6.5±0.96	10.346±0.87	23.4±6.73	40±5.79**
SM 75	6.6±0.85	9.168±0.47	19.4±3.65	35.8±2.95*
SM 100	6.82±0.67	8.08±0.24	13.6±4.51	18.6±3.65

Values are presented as mean ± SE of triplicate samples. Values with star marks in each row are significantly different (*P<0.05, **P<0.01 and ***P<0.001 vs D_5)

Table 4. Average length (cm) ± SD of *B. gonionotus* fed the formulated diet for 45 days.

Diets	Intervals			
	Initial	**15 days**	**30 days**	**45 days**
SM 0	8.5±1.21	9.86±0.72	10.44±0.84	12.7±0.31
SM 25	7.9±2.34	8.86±0.85	11.44±1.6	12.16±0.57
SM 50	8.2±2.96	8.86±0.75	9.02±0.86	13.98±1.3
SM 75	8.6±3.21	8.14±0.21	9.88±0.65	12.54±0.5
SM 100	8.62±0.91	10.9±0.62	11.6±0.92	12.1±0.76

Values are presented as mean ± SE of triplicate samples.

4. Discussion

Replacement of FM with SM up to 50% shows positive growth performances in the experimental fishes. The growth responses for fish fed diets containing increasing level of soybean meal may be decreased due to the presence of anti-nutritional factors. In this study, growth is lower when there is 100% replacement of FM with SM. According to Cabral *et al.* (2013) plant proteins can be reached up to 75% FM without impairing feed intake, growth performance and protein utilization in Senegalese sole. Wang *et al.* (2015) showed 40% of FM could be replaced by SM for juvenile *Pseudobagrus ussuriensis* without having a significant negative effect on growth. Ward *et al.* (2016) concluded that the group of fish fed with the diet having 60% SM exhibited overall increased length and weight by the lowest amount over the entire 8 week trial in summer flounder (*Paralichthys dentatus*) compared to the fish fed diets with lower SM inclusion levels. Mollah and Hossain (1995) stated the fish growth depends on the presence of optimum protein levels in fish feed. Li *et al.* (2012) evaluated two types of SM including a commercial SM and a high-value SM as alternatives to FM in diets for Japanese seabass (*Lateolabrax japonicas*). Their results showed that FM can be replaced up to 30% with commercial SM while the high-value SM could successfully replace 45% of FM. El-Saidy and Gaber (2003) reported that soybean meal supplemented with 1% methionine only or 1% methionine plus 0.5% lysine can totally replace the FM in Nile tilapia diets. According to Jalili *et al.* (2013) it is possible to replace 40% of FM with plant protein (wheat

gluten, corn gluten and soybean meal) without any noticeable negative effects on growth and humoral immune parameters (lysozyme activity and total antibody) indices. Later, Zhang *et al.* (2014) examined the effects of replacing 25, 50 and 75% of FM with untreated, gamma-irradiated or fermented SM in Japanese seabass (*Lateolabrax japonicas)* feed. Their findings showed that dietary FM can be only replaced up to 25% when untreated SM was used, while the replacement level could be increased up to 50% when the gamma-irradiated SM was used. The results of a recent study by Zhang *et al.* (2018) showed that SM can substitute 60% of FM in Japanese seabass (*Lateolabrax japonicas)* feed; Pervin *et al.* (2020 a, b) reported that 75% replacement of FM with SM in Nile tilapia (*Oreochromis niloticus*) can be possible without affecting the growth of fish. In addition, Jahan *et al.* (2019) suggested that the replacing 50% of FM with SM significantly increased muscle fibre of silver barb, *Barbonymus. gonionotus*.

5. Conclusions

In conclusion, the results of this research shows that increasing amount of soybean meal up to 50% in the diets leads to increase growth performances of *Barbonymus gonionotus* but more than 50% replacement can decrease the growth of the fish.

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Conflict of interest

None to declare.

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