Short Paper

Optimization of protein in supplementary feeds for pond raised cyprinids

Zeb, J.[1*] and Javed, M.[2]

[1]Department of Zoology, Faculty of Sciences, University of Punjab, Lahore-54590, Pakistan; [2]Department of Zoology, Wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faisalabad, Pakistan

[*]***Correspondence:*** *J. Zeb, Department of Zoology, Faculty of Sciences, University of the Punjab, Lahore-54590, Pakistan. E-mail: zebandzoology@gmail.com*

(Received 17 Jun 2017; revised version 28 Oct 2017; accepted 12 Dec 2017)

Summary

Labeo rohita, *Gibelion catla*, *Cirrhinus mrigala*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* were grown together for 365 days in triplicate ponds. Six iso-caloric feeds having varying protein levels i.e. 22, 24, 26, 28, 30 and 32% were prepared and supplemented to fish at 2% fish weight daily. Significantly, higher final average weight (793 ± 197 g) and total length gain (398 ± 40 mm) was recorded for *Ctenopharyndodon idella*. Net fish yield enhanced as the level of digestible protein (DP) in the supplementary diets increased and plateaued at 28% DP level, thereafter significant reduction ($P<0.05$) in fish weight increments was experienced at any surplus protein level. Among the supplementary feeds, 28% DP level resulted in maximum net fish yield (4304 ± 33 kg ha^{-1} $year^{-1}$) and a significantly higher overall nitrogen conversion ratio (NCR) of 1:5.2 ± 0.14. Higher level of DP in supplementary feeds resulted in reduced fish growth.

Key words: Chinese carps, Composite culture, Condition factor, Indian major carps, Supplemental feed

Introduction

Major and Chinese carps are economically important commercially grown fish species in Pakistan. *Labeo rohita* is intensively cultured and consumed in Asian countries (Ahmed *et al*., 2015), *Gibelion catla* have good market potential and taste, *Cirrhinus mrigala* being bottom feeder is grown under composite culture conditions to exploit nutrients that settle down to the bottom. *Ctenopharyngodon idella* has higher growth potential and alone contributes 18% of the total fish production in China (He *et al*., 2015) and *Hypophthalmichthys molitrix* has good aptitude to the acceptability of supplementary diets (Ashraf *et al*., 2011).

Semi-intensive composite culture system results in low cost fish production thus contributing to food security, especially in developing countries (Mataka and Kangombe, 2007). Major and Chinese carps are well suited for pond culture as they occupy different feeding niches and hence utilize all the available food present in pond water (Noman *et al*., 2011). Protein deficiency in fish diet hinders growth as fish will start utilizing its own body proteins to meet its maintenance demands. Regular intake of protein is required by the fish for metabolic processes and tissue repair (Singh *et al*., 2008). Thus optimization of protein in supplementary fish feeds is essential for making the pond fish production a prospective food industry in Pakistan.

Materials and Methods

A 365 day experiment was conducted to optimize protein levels in fish diet. Carps i.e. *Labeo rohita*, *Gibelion catla*, *Cirrhinus mrigala*, *Ctenopharyngodon idella* and *Hypophthalmichthyes molitrix* were taken as experimental animal. All the five fish species were reared together in 18 earthen ponds having equal dimensions of 120 m^2. Fingerlings of five fish species were stocked at a density of 27:10:10:07:13 into six triplicate groups in ponds. Fish from each pond were sampled on a fortnightly basis using drag net to record growth parameters viz. wet weights and total lengths, condition factor and nitrogen conversion ratios (NCR). At the end of the experiment, total harvested fish of all the five fish species were weighed to calculate the net fish yield under different treatments.

Six supplementary iso-caloric feeds (3 mm pellets) having digestible energy of 2500 kcal kg^{-1} at varying protein levels of 22, 24, 26, 28, 30 and 32% were prepared (Table 1) in the laboratory and fed to the fish at 2% of their wet body weight on a daily basis. Proximate composition i.e. moisture, crude protein, total fats, total ash and carbohydrates of supplementary feeds were determined (Association of Official Analytical Chemists, 2006).

Condition factor, NCR and survival rate of all the experimental fish species were calculated following (Carlander, 1970). Live food in ponds was calculated

through evaporation method (Javed, 1988).

Statistical analysis

Obtained data were subjected to statistical analysis through analysis of variance (ANOVA) and the mean values were compared for statistical differences through Tukey's Newman-Keul's test using software *STATISTIX* 8.1 (USA).

Results

Among the five fish species, *C. idella* showed significantly higher final weight and total length gains of 793 ± 197 g and 398 ± 40 mm, respectively. The overall performance of five fish species under different treatments varied significantly and followed the order T3>T4>T2>T5>T1≥T6 (Table 2). The net yield of all five fish species was significantly higher due to 28% DP level. During present study, planktonic biomass was significantly higher (48 ± 20 mg L^{-1}) due to 32% DP (T6). Supplementary feed at 28% DP (T4) level showed significantly higher overall NCR values of 1:5.2 ± 0.14. However, NCR value of 1:4.0 ± 0.07 was significantly lower due to 32% DP (T6). Fish did not suffer any mortality throughout the experimental duration.

Discussion

Growth performance of all the five fish species showed significant variability due to various digestible protein (DP) levels in the supplementary diets. Among the five fish species, *C. idella* showed significantly higher final weight and total length gains of 793 ± 197 g and 398 ± 40 mm, respectively. This variability among different fish species for their responses towards different protein levels was attributed to their diversified feeding habits (Yaqoob *et al*., 2010). When reared in poultry waste recycled ponds, *C. idella* has been reported a major contributor towards total fish production as compared to *H. molitrix* and *C. carpio* (Singh *et al*., 2008). However, there existed some sort of competition for food procurement between *G. catla* and *H. molitrix*, and that is the reason why the growth performance of these two species suffered during present study. Tabinda and Ayub (2010) also reported similar competing trend for food between these two species.

The net fish yield increased significantly and attained a peak at 28% DP. However, further increase in DP i.e. beyond 28% did not improve fish growth, but caused a decline in net yield. Such trend observed showed channelization of more energy towards catabolism of excess proteins (Siddiqui and Khan, 2009). This may also have resulted due to catabolism of excess proteins, beyond optimum, a condition to produce and eliminate a lot of ammonia by the fish (Kim and Lee, 2005).

Supplementary feed at 28% DP (T4) level showed significantly higher overall NCR values of 1:5.2 ± 0.14. However, NCR value of 1:4.0 ± 0.07 was significantly lower due to 32% DP (T6). Significantly lower NCR attained by the fish under T6 might be attributed to the stress imparted on the fish fed higher protein level in supplementary diets. Naz *et al*. (2008) also observed significantly lower NCR for stressed fish as compared to non-stressed fish. Zero mortality across all the treatments

Table 1: Formulation and proximate composition of supplementary feeds at varying digestible protein levels

Ingredients	22% DP	24% DP	26% DP	28% DP	30% DP	32% DP
Wheat flour	13	13	13	13	9	11
Starch	2	2	2	2	2	2
Rice polish	20	18	12.5	5	3	0.5
Wheat bran	15	9.5	5.5	5	2	0.5
Canola meal	1	5	10	12.5	16	25
Rape seed meal	1	1	5	4	9	7
Sunflower meal	0.5	2.5	4	5	7.5	10
Corn gluten 30%	22	22	21	22	18	5
Soybean meal	0.5	2	2	6	7	12
Fish meal	20	20	20	20	20	20
DCP	1.5	1.5	1.5	1	1	1
Soya oil	1	1	1	2	3	3.5
Vitamin and mineral mixture	2.5	2.5	2.5	2.5	2.5	2.5
Proximate composition (%)						
Moisture	7.30	7.04	6.85	6.86	6.90	6.89
Crude protein	22.24	24.00	26.08	28.17	30.00	32.00
Total fats	7.25	7.43	7.48	7.37	7.91	8.33
Total ash	7.13	6.92	6.66	6.19	6.29	5.32
Carbohydrates	56.08	54.61	52.93	51.41	48.90	47.46
Energy (kcal/kg)	2517	2530	2500	2515	2525	2513

Each kg of vitamin-mineral mixture contains: Vitamin A 3,000,000 I.U.; Vitamin E 6000 I.U.; Vitamin B_1 600 mg; Nicotinic acid 12,000 mg; Calcium d. pantothenate 2400 mg; Vitamin B_{12} 8 mg; Biotin 10 mg; Dl-Methionine 30,000 mg; B.H.T. 12,500 mg; Zinc sulphate 48,000 mg; Copper sulphate 6,000 mg; Vitamin D_3 6000000 I.U.; Vitamin K_3 600 mg; Vitamin B_2 1400 mg; Vitamin B_6 800 mg; Folic acid 300 mg; Choline chloride 50% 160000 mg; L-Lysine 15000 mg; Manganese sulphate 51600 mg; Ferrous sulphate 40000 mg; Potassium iodide 400 mg. Carbohydrates were calculated by difference as 100 - (protein + lipid + ash + moisture). Energy was determined by Bomb Calorimeter (Parr Instrument Company Moline, USA)

Table 2: Comparison of growth indices of five fish species under composite semi-intensive pond culture conditions

Fish species	Initial average weight (g)	Final average weight (g)	Initial average total length (mm)	Final average total length (mm)	Condition factor (K)
Labeo rohita	13 ± 2.0^{e}	677 ± 165^{c}	91 ± 5.6^{c}	383 ± 42^{c}	1.2 ± 0.13^{c}
Gibelion catla	07 ± 0.3^{e}	406 ± 105^{e}	64 ± 2.9^{e}	321 ± 23^{d}	1.2 ± 0.15^{c}
Cirrhinus mrigala	21 ± 0.9^{b}	764 ± 150^{b}	116 ± 5.1^{b}	389 ± 39^{b}	1.3 ± 0.16^{b}
Ctenopharyngodon idella	08 ± 0.5^{d}	793 ± 197^{a}	65 ± 3.1^{d}	398 ± 40^{a}	1.2 ± 0.13^{c}
Hypophthalmichthys molitrix	23 ± 1.1^{a}	478 ± 135^{d}	120 ± 4.9^{a}	320 ± 29^{d}	1.4 ± 0.12^{a}

(Means±SD) values with different alphabets in the same column are significantly different ($P<0.05$)

during this study showed conduciveness of aquatic environment for fish growth.

Ctenopharyngodon idella showed highest growth potential and a better inclination towards the acceptability of artificial diets. *Gibelion catla* and *Hypophthalmichthyes molitrix*, were found to be in competition for access to food. Net fish yield increased as the level of DP in supplementary diets increased and attained a plateau at 28% DP level. However, any surplus protein level beyond 28% hindered fish growth. Un-eaten feed recycle in pond ecosystem to contribute towards planktonic productivity. Fish reared under semi-intensive culture conditions had lower protein requirements due to the availability of natural food (plankton) as compared to fish reared under intensive culture conditions. Higher level of DP in supplementary feeds resulted in reduced fish growth.

Conflict of interest

Authors declare no conflict of interest.

References

Ahmed, MK; Shaheen, N; Islam, MS; Habibullah-al-Mamun, M; Islam, S; Mohiduzzaman, M and Bhattacharjee, L (2015). Dietary intake of trace elements from highly consumed cultured fish (*Labeo rohita*, *Pangasius pangasius* and *Oreochromis mossambicus*) and human health risk implications in Bangladesh. Chemosphere. 128: 284-292.

Ashraf, M; Zafar, A; Rauf, A; Mehboob, S and Qureshi, NA (2011). Nutritional values of wild and cultivated silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*). Int. J. Agric. Biol., 13: 210-214.

Association of Official Analytical Chemists (2006). *Official methods of analysis*. 18th Edn., Washington, D. C., Association of Official Analytical Chemists International. P: 1727.

Carlander, D (1970). *Handbook of freshwater fishery biology*. 3rd Edn., Vol. 1, Lowa, USA, The Lowa State University Press. P: 104.

He, L; Pei, Y; Jiang, Y; Li, Y; Liao, L; Zhu, Z and Wang, Y (2015). Global gene expression patterns of grass carp following compensatory growth. BMC Genomics. 16: 184-201.

Javed, M (1988). Growth performance and meat quality of major carps as influenced by pond fertilization and feed supplementation. Ph.D. Thesis, Department of Zoology and Fisheries, University of Agriculture, Faisalabad, Pakistan. P: 67.

Kim, LO and Lee, SM (2005). Effect of the dietary protein and lipid levels on growth and body composition of bagrid catfish, *Pseudobagrus fulvidraco*. Aquaculture. 243: 323-329.

Mataka, L and Kangombe, J (2007). Effect of substitution of maize bran with chicken manure in semi-intensive pond culture of *Tilapia rendalli* (Boulenger). Aquacult. Res., 38: 940-946.

Naz, S; Javed, M; Hayat, S; Abdullah, S; Bilal, M and Shaukat, T (2008). Long term effects of lead (pb) toxicity on the growth performance, nitrogen conversion ratio and yield of major carps. Pak. J. Agric. Sci., 45: 53-58.

Noman, M; Ashraf, M; Abbas, S; Ahmad, I; Naeem, M and Hafeez-ur-rehman, M (2011). Growth performance of common carp (*Cyprinus carpio*) in response to organic fertilizers and supplementary feed. Greener J. Agric. Sci., 1: 32-40.

Siddiqui, TQ and Khan, MA (2009). Effect of dietary protein levels on growth, feed utilization, protein retention efficiency and body composition of young *Heteropneustes fossilis* (Bloch). Fish Physiol. Biochem., 35: 479-488.

Singh, RK; Chavan, SL; Desai, AS and Khandagale, PA (2008). Influence of dietary protein levels and water temperature on growth, body composition and nutrient utilization of *Cirrhinus mrigala* (Hamilton, 1822) fry. J. Therm. Biol., 33: 20-26.

Tabinda, AB and Ayub, M (2010). Effect of high phosphate fertilization rate on pond phosphate concentrations, chlorophyll a, and fish growth in carp polyculture. Aquacult. Int., 18: 285-301.

Yaqoob, M; Ali, MR and Mehmood, S (2010). Comparison of growth performance of major and Chinese carps fed on floating and sinking pelleted supplementary feeds in ponds. Pak. J. Zool., 42: 765-769.