www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 18: 223-227 (2018) DOI: 10.4194/1303-2712-v18_2_01

RESEARCH PAPER

An Evaluation of Optimal Dietary Protein Requirements of All Parts Chicken Meal for Indian Major Carps (*Catla catla*, *Labeo rohita* and *Cirhinus mrigala*)

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Received 28 February 2017
Accepted 31 May 2017

Abstract

A feeding experiment was conducted for one year with six formulated diets containing all parts chicken meal in three different inclusion levels (25%, 35% and 45%) as APCM I, APCM II, APCM III and Fish meal as Control I, Control II and Control III, to examine the potential of all parts chicken meal as a substitute of fish meal in the diet of Indian major carps in intensive polyculture system. Fingerlings of *Catla catla, Labeo rohita* and *Cirhinus mrigala* were fed on experimental diets. It is evident by the results that growth is highly affected by dietary ingredients and its level of inclusion in diet. With increasing level of fishmeal, a noticeable decrease in growth was observed, as Control I, II and III produced 67.3 g, 50.5 g and 39.6 g mean weight gain respectively. While opposite trend of growth was observed with APCM based diet i.e., APCM III (45% inclusion of APCM) produced significantly higher growth with a decreased FCR. The two-way analysis of variance for weight, DFA, SGR and FCR against months showed highly significant relationship in all diets. Except moisture and ash, fish carcass composition was significantly affected by protein source and its inclusion level.

Keywords: Chicken meal, Carps, polyculture.

Introduction

Fish meal is used as a main dietary protein source in aquaculture industry in order to increase the energy content of feed by the expansion of intensive aquaculture (Tacon & Jackson, 1985; Kaushik, Medale, Fauconneau, & Blanc, 1989), However, about 35% of the total global fish catch is being used in the production of fish meal (Tacon & Dominy, 1999), as approximately 1 Kg dry fish meal is obtained from 4 kg of wet fish (Allan *et al*., 2000), but its cost is going to be continuously rising due to its high demand and therefore directly affecting total expenditure of aquaculture industry. The exploration for alternative to replace fish meal is global research precedence nowadays (Manzi, 1989; Hardy & Kissil, 1997). During recent years' substantial research efforts have been made to replace fish meal from aquaculture feed with some other alternative ingredients as potential substitutes of fish meal (Tacon & Jackson, 1985).

Aquaculture of carp`s species has been expanded to a great extent during last ten years in Pakistan. The combination of all parts chicken meal with rice polish and corn gluten meal has been employed for the evaluation of successful carps farming. This research trial has been made to complementing the efficacy of all parts chicken meal diets with fish meal based diets in an intensive polyculture of major carps i.e. *Catla catla*, *Labeo rohita* and *Cirhinus mrigala*.

Materials and Methods

Experimental Design, Diets Formulation and Feeding Regime

Six experimental diets were formulated by using fishmeal and all parts chicken meal in three different inclusions i.e. 25%, 35% and 45%. Fishmeal based diets were named as control I, II, III for 25%, 35% and 45% inclusion level respectively, while diets with all parts chicken meal were labeled as APCM I, II and III for three inclusion levels in that order. All experimental diets were formulated by mixing of fish meal (only in controls) or all parts chicken meal with corn gluten meal, rice polish, starch and canola oil (Table 1). Ingredients were pulverized, mixed and then pelletized with the help of a pellet maker. Pellets were then dehydrated at room temperature for 24 hours and followed by storing in freezer.

Table 1. Percentages of ingredients, proximate values and energy contents per 100 g of experimental diets

	Control I	*APCM I	Control II	APCM II	Control III	APCM III
Ingredients (%)						
Fish meal	25	-	35	-	45	-
All Parts Chicken meal		25	-	35	-	45
Corn gluten meal	1.16	1.74	16.69	16.90	30.98	32.06
Rice polish	63.83	63.24	38.30	38.08	14.00	12.93
Starch	5	5	5	5	5	5
Canola oil	4.5	4.5	4.5	4.5	4.5	4.5
Vitamins and mineral mixture	0.5	0.5	0.5	0.5	0.5	0.5
Proximate composition (%)						
Crude protein	24.99	24.98	35.2	34.98	44.98	44.99
Crude fat	15.19	16.85	12.74	15.12	10.42	13.39
Crude fiber	2.56	2.95	2.48	3.02	2.38	3.07
Ash	13.7	12.02	13.42	11.13	13.25	10.24
Nitrogen –free extract	42.99	42.63	35.6	35.17	28.39	27.74
DE (K cal/Kg)	3109.90	3231.26	3186.43	3356.82	3263.44	3482.67
GE (K cal/Kg)	4520.48	4655.95	4554.32	4824.17	4587.67	4832.79

*APCM = All Parts Chicken meal

Each experiment was performed in triplicates for the accuracy of data and thus eighteen re-circulatory concrete raceways of the dimension 22′×50′ (W×L) were designed. The juveniles of *Catla catla*, *Labeo rohita* and *Cirhinus mrigala* were reared in each raceway at a ratio of 33:33:34 respectively by following Wahab, Rahman and Milstein (2002) for a period of one year.

Water quality variables such as temperature of water, dissolved oxygen, pH and ammonia were recorded weekly. The water temperature ranged 10.1˚C to 30.5˚C, pH ranged 7.8 to 8.4 and dissolved oxygen was within the range of 5.1 to 8.4 mg/l during the whole experimental period.

The Daily feed allowance (DFA) was calculated at 3% body weight and feed was supplied manually twice daily.

Estimation of Feed Response

At the end of each month, a few fishes were randomly opted from each raceway, to measure monthly increase in weight and length and then released back into their respective raceway. The following growth parameters were investigated during whole research trial; Monthly weight gain, survival rate, feed conversion ratio (FCR), specific growth rate (SGR) and Protein efficiency ratio (PER) (Khan, Ahmed & Abidi, 2004).

Proximate Composition of Fish Meat

The proximate composition of under considered carps was evaluated in terms of crude protein, carbohydrate, fat, ash and moisture in accordance with Association of Official Analytical Chemist (A.O.A.C, 2005) to check the effectiveness of formulated diet on nutritional quality of fish after consuming the experimental diets.

Statistical Analysis of Experimental Data

After compilation, data was subjected to statistical analysis from Minitab release 16.1. Fisher's least-significant-difference (LSD) test and Two-way analyses of variance were executed to discover relationships among growth variables.

Results

The response (means of three replicate) of experimental carps against different inclusion levels i.e. 25%, 35% and 45% of fishmeal (Controls) and all parts chicken meal (APCM) is presented in Table 2. It is evident by the results that growth is highly affected by dietary ingredients and its level of inclusion in diet. In the present feeding trial, with increasing level of fishmeal, a noticeable decrease in growth was observed, as Control I, II and III produced 67.3 g, 50.5 g and 39.6 g mean weight gain respectively for all three fish species. While opposite trend of growth was observed with APCM based diet i.e., APCM III (45% inclusion of APCM) produced significantly higher growth with a decreased FCR. However, a considerably higher growth was obtained by APCM II and APCM III in comparison with Control II and Control III, but APCM I couldn't prove itself better than Control I (25% inclusion level of fishmeal) with respect to weight gain although no differences were found in the values of FCR (3.5). 45% fish meal based diet showed minimal weight gain (39.6 g) among all levels of Control and APCM.

However, no significant differences were found in the means of DFA and SGR among all treatments by LSD Test, but the values of FCR were differed significantly in APCM II and APCM III (3.33 and 2.42 respectively). FCR gradually decreased as inclusion of APCM was increased while in case of fish meal (Control) the result was vice versa. Highest

Table 2. Mean values of growth parameters of experimental carps fed with different levels of All Parts Chicken meal based diets

	Weight (g)				ADG (g/day)[2]	DFA (g)[3]	SGR (%/day)[4]	FCR[5]	PER[6]
	Initial	Final	Monthly WG[1]	Mean WG					
					Control I				
C. catla	36.11	823.14	65.6 ±13.3abc		2.18abc		0.37 ±0.09a		8.4±0.20a
L. rohita	18.90	813.85	66.0 ±14.3abc	67.3	2.19abc	679.0± 122a	0.34 ±0.10a	3.53± 0.41a	8.4±0.20a
C.mrigala	44.25	889.14	70.4 ±15.6abc		2.34abc		0.34 ±0.04a		8.4±0.26a
					*APCM I				
C. catla	28.6	615.5	48.90 ±7.66cde		1.63cde		0.37 ±0.04a		6.4±0.20c
L. rohita	37.5	621.2	48.64 ±6.25abcde	51.4	1.62abcde	629.8± 117a	0.33±0.04a	3.51± 0.31a	6.4±0.23c
C.mrigala	64.1	746.3	56.85 ±6.59a		1.89a		0.29±0.03a		7.2±0.25b
					Control II				
C. catla	36.11	623.42	48.94 ±6.4cde		1.63cde		0.45 ±0.10a		4.5±0.20e
L. rohita	18.90	645.14	52.19 ±5.11abcde	50.5	1.73abcde	662.7± 104 a	0.42 ±0.15a	4.05± 0.45a	4.8±0.40e
C.mrigala	44.25	648.71	50.37 ±6.7cde		1.67cde		0.31 ±0.03a		4.5±0.17e
					APCM II				
C. catla	27.9	752.3	60.36 ±9.92cde		2.10cde		0.39 ±0.05a		6.0±0.10c
L. rohita	38.6	801.4	63.56 ±9.36abcd	62.4	2.11abcd	724.2± 146a	0.36±0.04a	3.33± 0.33ab	6.0±0.23c
C.mrigala	61.7	822.0	63.3 ±7.76bcde		2.11cde		0.31±0.04a		6.0±0.00c
					Control III				
C. catla	27.31	466.43	36.59 ±5.5e		1.21e		0.36 ±0.05a		2.6±0.30h
L. rohita	37.52	490.50	37.68 ±3.9de	39.6	1.25de	532.3± 89a	0.32 ±0.07a	3.82± 0.33a	2.6±0.17h
C.mrigala	62.51	599.30	44.73 ±4.1cde		1.49cde		0.27 ±0.03a		3.1±0.40g
					APCM III				
C. catla	28.5	963.5	77.9 ±15.0bcde		2.59bcde		0.42 ±0.05a		5.5±0.10d
L. rohita	37.9	657.1	51.6 ±7.05abcd	68.3	1.72abcd	604.5± 121a	0.34±0.06a	2.42± 0.22b	3.7±0.40f
C.mrigala	64.5	972.0	75.6 ±9.86ab		2.52ab		0.32±0.04a		5.5±0.10d

*APCM = All Parts Chicken meal,

Values are means ± SE of three replicates.

Means in a column followed by different letter were significantly different from each other at P = 0.05 by the Fisher's least-significant-difference (LSD) test.

[1]Monthly weight gain (WG) (g) = Final value of growth variable – Initial value of growth variable

[2] Average daily gain (ADG) (g/day) = weight gain/number of days

[3] Daily Feed Allowance (DFA) (g) = Av body weight X Number of stocks X % Survival X Feeding rate

[4]Specific growth rate (SGR) (%/day) = Log Fish final weight – Log Fish initial weight / Time X 100

[5]Feed conversion ratio (FCR) = Weight of food presented/Weight of animal gained

[6]Protein efficiency ratio (PER) = Weight gain/Crude protein intake

production was obtained by APCM III as 75.08 Kg/treatment followed by Control I which yielded 66.56 Kg/treatment (Table 3). Percent individual contribution indicated a remarkably higher contribution of *Cirhinus mrigala* in all three levels of All parts chicken meal based diets and Controls than other two species i.e. *Labeo rohita* and *Catla catla.* Survival rate was 80% after one-year trial in all treatments. Water quality was not the actual reason of mortalities. Except moisture and ash, fish carcass and fillet nutrient composition was significantly affected by protein source and inclusion level (Table 4).

The two-way analysis of variance for weight, DFA, SGR and FCR against months showed highly significant relationship in all diets (Table 5).

Discussion

A number of studies have been carried out to evaluate the potential of chicken meal as fish meal replacers without any significant reduction in growth of the fish (Fowler, 1991; El Sayed, 1998). In the present feed trial 100% substitution of fishmeal was made by poultry by product meal. It was evident by comparison of FM (Control) with APCM that all parts chicken meal was not so much effective at lower concentrations (25%) as compare to control I, but a noticeable increase in growth was evident in comparison with control II and III. Due to the higher digestibility rate (Sugiura, Dong, Rathbone & Hardy, 1998) APCM produced higher final body weight in APCM II and APCM III than that of the Controls, thereby boosting growth. The acceptance could be basically attributed to improved manufacturing practices, enhancing the quality of the feed (Bureau, Harris & Cho, 1999 & Bureau *et al*., 2000). In addition, chicken meals are locally available and economically more viable than fish meal even at total replacement levels (Rodriguez-Serna, Olvera-Novoa & Carmona- Osalde, 1996).

In most of the treatments *C. mrigala* showed an exceptional growth among all three species, as it attained maximum feed being a bottom feeder. Apparently, replacement of fish meal with APCM did not influence growth, SGR, or FCR of major carps (*Catla catla, Labeo rohita* and *Cirhinus mrigala*) and thus confirmed the capability of major carps to utilize poultry by-product meal as a better protein than fish meal.

Except moisture and ash, all body compositions

Table 3. Observed and computed fish biomass harvested against different inclusions

	Control I	*APCM I	Control II	APCM II	Control III	APCM III
Total harvested weight (Kg per treatment)	66.56	52.30	50.49	62.58	41.06	75.08
Total fish production (Kg/hectare/year)	665.68	523.04	504.97	625.82	410.60	750.87
Percent individual contribution at harvest (%)						
C. catla	32.14	30.59	32.09	31.24	29.53	33.36
L. rohita	31.75	30.87	33.21	33.29	31.05	31.68
C.mrigala	36.06	38.52	34.68	35.46	39.40	34.95

*APCM = All Parts Chicken meal

Table 4. Comparison of means of the proximate values under different treatments

Diet		Moisture %	Crude Protein %	Crude Fat %	Carbohydrate %	Total Ash %
	Catla catla	78.23	16.50	1.94	1.52	1.81
Control I	*Labeo rohita*	76.76	17.54	2.25	1.60	1.57
	Cirhinus mrigala	78.44	17.33	1.89	0.19	2.14
	Mean	77.81b	17.12ab	2.02a	1.10b	1.84ab
	Catla catla	79.01	16.61	2.02	0.42	1.93
APCM I	*Labeo rohita*	75.84	17.89	2.10	2.82	1.35
	Cirhinus mrigala	77.19	17.42	2.15	1.23	1.88
	Mean	77.34b	17.30a	2.09a	1.49b	1.72b
	Catla catla	78.60	16.88	2.05	1.33	1.14
Control II	*Labeo rohita*	76.18	17.82	1.95	2.56	1.42
	Cirhinus mrigala	77.20	17.54	2.01	1.42	1.70
	Mean	77.32b	17.41a	2.00a	1.77b	1.42b
	Catla catla	80.95	12.24	1.07	4.11	2.05
APCM II	*Labeo rohita*	80.15	13.25	1.25	3.62	1.94
	Cirhinus mrigala	80.04	11.83	1.50	4.59	2.58
	Mean	80.38a	12.44c	1.27b	4.10a	2.19a
	Catla catla	76.52	17.23	2.65	1.84	1.71
Control III	*Labeo rohita*	79.48	16.31	1.90	0.65	1.65
	Cirhinus mrigala	77.69	16.91	1.60	1.23	2.34
	Mean	77.89b	16.81ab	2.05a	1.24b	1.9ab
	Catla catla	79.25	15.72	1.70	1.61	1.72
APCM III	*Labeo rohita*	77.09	16.75	1.61	2.49	1.60
	Cirhinus mrigala	78.11	16.20	1.85	1.68	2.13
	Mean	78.15b	16.22b	1.72ab	1.92b	1.81ab
	P Value	0.070	0.000*	0.015*	0.004*	0.174

* Significant.
Means in a column followed by different letter were significantly different from each other at P = 0.05 by the Fisher's least-significant-difference (LSD) test

Table 5. Two-way analysis of variance of different variables against treatments and months

Variables	Weight (g)			DFA (g)	SGR (%/day)			FCR
	C. catla	*L. rohita*	*C. mrigala*		*C. catla*	*L. rohita*	*C. mrigala*	
				Control				
Diet	0.000**	0.002**	0.189*	0.000**	0.782*	0.251*	0.054*	0.348*
Months	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
				*APCM				
Diet	0.001**	0.002**	0.000**	0.000**	0.005**	0.458*	0.054*	0.000**
Months	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**

*APCM = All Parts Chicken meal, **=Significant; * = Non significant

were significantly affected (P ≤ 0.05) by protein source and its inclusion level. Maximum carcass protein was observed by APCM I and control II (FM 35%). In the present feed trial, fish growth was not adversely affected by increased fat content of APCM. This result is similar to the findings of El-Sayed (1998).

APCM showed its potential and could proficiently surrogate up to 100% fish meal protein in diet of major carps. Many researchers have been applied this for many species (Fowler, 1991; Sugiura *et al*., 1998; Steffens, 1994; Alexis, 1997). Several studies have been signified chicken meal for its potential to replace 1000 g per Kg of fish meal for many species (Steffens, 1994; Alexis, 1997; Nengas, Alexis & Davies, 1999; Kureshy, Davis & Arnold, 2000; Takagi, Hosokawa, Shimeno & Ukawa, 2000). A little attention has been paid for the evaluation of APCM on cyprinidae by researchers (Welcomme, 1988).

The results of this finding coincide with those of Alexis (1997), who substituted 100% fish meal by poultry by-product meal in practical diets for sea bass and sea bream devoid of any adverse effect on growth performance. Similar results were also observed in chinook salmon *Oncorhynchus tschawytscha* W. (Fowler, 1991) and gilthead sea bream (Nengas *et al*., 1999). Based on our results, major carps are capable to accept 100% replacement of fish meal with APCM in a higher proportion as compare to fish meal without decrease in growth performance.

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