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Biochemical Alteration and Growth Response of *Catla* Catla Fed with Plant Mixture Fish Meal

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Abstract: ***This study was designed to determine the maximum replacing levels of Fish Meal (FM) by a Plant Protein Mixture (PPM) in six diets for Catla catla. The PPM consisted of plant powders of Asparagus, Gliricidia and Eichhornia, Guar gum Binder, Mineral – Vitamin mixture, Groundnut oil cake, Rice Bran and fishmeal. FM in the basal diet was replaced by PPM in the diets at replacing levels of 20, 30, 40, 50, 60 and 70%. After 120 days of feeding, the highest growth performance was recorded in the 50% diet group as compared to all other diet groups. The protein content was also high in 50% diet group. The finding of present study showed the effective utilization of PPM in fish diets. The inclusion of PPM in fish diet increases feed acceptance by fish which directly promotes fish growth and carcass protein content.***

Keywords: Plant Protein Mixture; *Catla catla*; Growth Performance; Biochemical Alteration

1. Introduction

Diet formulation represents translation of nutrient and energy requirement of a given species for a given response into an acceptable diet using a balanced mixture of ingredients which is economically sustainable. Nutritional composition, biological availability, energy content and digestibility of feedstuff ingredients are important criteria for inclusion of any plant or animal protein ingredient to formulate practical diets for fish. The literature pertaining digestible energy and protein in the feedstuffs, helps to formulate proper and growth effective fish diet (Maina et al., 2002). Much research has been done to evaluate non-traditional protein sources partially or wholly to replace fishmeal in diets of various freshwater as well as marine fish, shrimp and prawn species.

The identification and utilization of non-conventional and lesser utilized plant protein sources to replace fishmeal either partially or totally in practical diets of fish has been an area of research in aquaculture nutrition (Siddhuraju & Becker, 2003). Fish nutritionists have evaluated alternative sources of plant origin protein in fish diets as partial or total fishmeal replacement (Goda et al., 2007).

Mixed feeding in which high protein diet was alternated by a low protein diet could result in improved nutrient utilization. The application of mixed feeding to reduce feed cost and improved nutrient utilization has been reported in Indian carps (Nandeesha et al., 1993), Patel & Yaku pitiyage, 2003) and rainbow trout (Sevgili et al., 2006).

The present study was undertaken to assess the replacement of fish meal protein with PPM, for selected fish species, *Catla catla*.

2. Materials and Methods

The fingerlings of *Catla catla* were used for the feeding experiment. The feeding experiment was conducted for 120 days in triplicates. Each aquarium was stocked with 10 fingerlings of almost of uniform size and weight. Seven pelleted fish diets were prepared using various proportions of *Asparagus racemosus, Gliricidia maculata and Eichhornia crassipes* (control, 20, 30, 40, 50, 60 and 70%) as shown in Table 1. Fishes were fed formulated diet at the rate of 5% to body weight daily. At fortnightly intervals a minimum of 50% of fishes were sampled to record the growth. The chemical analyses of formulated diets were carried out according to the procedures of the AOAC (1990) (Table 1).

Growth performance of experimental fish were determined in terms of final individual fish weight (g), Protein Efficiency Ratio (PER) and Net Protein Retention (NPR). For biochemical study, fishes were sacrificed; liver and muscle tissues were dissected out as quickly as possible and stored to analyze total glycogen, total protein and total lipid contents of liver and muscle tissues. These tissues were weighed and used for the estimation of biochemical components like protein, Glycogen and lipids.

Table 1: Formulation and proximate composition of fish diets containing increasing levels of mixed plant meal (*A. racemosus, G. maculata and E. crassipes*)

Diet							
	Control	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**
Ingredients (%)							
Groundnut oilcake	43	35	29	24	19	13	8
Rice bran	36	27	23	18	13	9	4
Fishmeal	10	09	09	09	09	09	09
Guar gum Binder	10	08	08	08	08	08	08
Mineral – Vitamin mixture	01	01	01	01	01	01	01
A. racemosus root powder	00	6.66	10	13.33	16.66	20	23.33
G. maculata leaf powder	00	6.66	10	13.33	16.66	20	23.33
E. crassipes leaf powder	00	6.66	10	13.33	16.66	20	23.33
Nutrient content (%)							
Moisture	7.05	9.27	8.86	8.30	7.83	7.72	7.32
Total Ash	12.13	10.42	9.51	9.47	9.87	8.25	8.13
Protein	26.24	29.37	32.09	34.95	33.12	33.25	32.74
Fat	3.81	4.22	4.70	5.38	6.86	6.78	8.14
Fibre	10.54	5.08	7.22	7.87	9.80	10.82	12.39

3. Results

Growth Performance

The growth, gain in weights, feed conversion efficiency, specific growth rate, protein efficiency ratio, net protein retention data of fish fed with various test diets containing different levels of PPM are summarized in table 2.

The mixed diet showed marked growth in 50% diet fed fish group. In all the growth parameters and feed utilization indices, the 50% diet group was superior to other diet groups. The 50% diet fed group has highest final body weight (22.87 ± 0.91), weight gain (20.83 ± 0.85). The control diet group showed lowest final body weight (13.23 ± 0.42), weight gain (23.57 ± 0.36).

Table 2: Growth performance and feed utilization in *Catla catla* fed diets containing mixed plant meal:

	Control	20%	30%	40%	50%	60%	70%
Initial body weight (gm)	2.36 ± 0.05	3.50 ± 0.02	1,33 ± 0.06	1.44 ± 0.05	1.65 ± 0.04	2.10 ± 0.05	2.82 ± 0.05
Final body weight (gm)	15.56 ± 0.42	18.73 ± 0.55 **	17.63 ± 0.65 ***	21.32 ± 0.75 ***	24.60 ± 0.91 ***	16.10 ± 0.77 ***	13.40 ± 0.54 **
Weight gain	13.26 ± 0.36	15.23 ± 0.48 **	15.65 ± 0.58 ***	19.88 ± 0.69 ***	23.27 ± 0.85 ***	14.00 ± 0.70 ***	10.55 ± 0.45 **

(Value expressed is mean of n (n=3); ±: SE) *P<0.05, **P< 0.01, ***P< 0.001, NS – Non Significant

Biochemical Alterations

The proximate composition of liver and muscle tissues of fish fed with different plant protein incorporated diet was shown in table 3 and 4.

Among all the mixed diets 50% diet showed better biochemical results in the terms of protein, lipid and glycogen. The liver protein is highest in 50% diet (13.35 ± 0.64) whereas lipid and glycogen content is highest in 40% diet. The same trends of results were found in muscle tissues.

Table 3: Biochemical alterations in liver tissues from the fish *Catla catla* fed with mixed plant diet (mg/100mg wet tissue)

	Control	*20%*	*30%*	*40%*	*50%*	*60%*	*70%*
Protein	6.13 ± 0.39	10.49 ± 0.50*	11.47 ± 0.11***	13.35 ± 0.44***	13.05 ± 0.64***	9.88 ± 0.22 ^{NS}	6.93 ± 0.28*
Lipid	8.40± 0.40	9.90 ± 0.10***	10.67 ± 0.36***	12.37 ± 0.06***	11.72 ± 0.41***	9.54 ± 0.21*	8.32 ± 0.24 ^{NS}
Glycogen	1.67 ± 0.23	3.37 ± 0.10**	5.45 ± 0.29***	5.94 ± 0.07***	3.45 ± 0.17 ***	3.26 ± 0.04 ^{NS}	1.92 ± 0.20 ^{NS}

(Value expressed in mg/100mg wet tissue; ±: SE) *P<0.05, **P< 0.01, ***P< 0.001, NS – Non Significant

Table 4: Biochemical alterations in muscle tissues from the fish *Catla catla* fed with mixed plant diet (mg/100mg wet tissue)

	Control	*20%*	*30%*	*40%*	*50%*	*60%*	*70%*
Protein	13.98 ± 0.53	17.41 ± 0.01**	20.56 ± 0.09***	24.12 ± 0.22***	21.09 ± 0.25***	17.54 ± 0.30***	14.16 ± 0.33**
Lipid	6.08± 0.45	9.24 ± 0.11**	9.86 ± 0.06***	10.75 ± 0.01***	8.57 ± 0.22***	7.25 ± 0.25***	5.54 ± 0.04*
Glycogen	0.88 ± 0.08	2.27 ± 0.01**	2.96 ± 0.06***	3.46 ± 0.13***	2.21 ± 0.09***	1.64 ± 0.01 ^{NS}	1.45 ± 0.10 ^{NS}

(Value expressed in mg/100mg wet tissue; ±: SE) *P<0.05, **P< 0.01, ***P< 0.001, NS – Non Significant

4. Discussion

A major problem in the use of plant meals is its relatively low protein content. The protein content of plant feed may be increased with the combination of two or more plant ingredients. The low protein content of plant meals always results into poor growth of fish. The protein utilization becomes limiting at the lower protein contents in feed. The protein requirement of fish may not be getting fulfilled with such a feed and it results into lower growth. Concerning

proximate body tissue composition of selected fish it was seen that the increasing level of plant proteins in diet increased the protein content in liver and muscle of both the fish species. The increase in such a liver and muscle protein get supported up to a remarkable level. The increase in body protein was not consistent in all diets. There was reduction in body protein as the acceptable feed inclusion level gets crossed. The higher inclusion of plant meals in fish diet reduces the feed acceptance which directly affects the fish body protein. A reduction in the carcass crude protein content in tilapia, with respect to higher inclusion of plant meals in the diets was reported by Olvera et al. (1988). The result of present study indicates increase in dietary plant level reduces the fish muscle and liver protein was supported by Viola & Zohar (1984).

Higher inclusion of plant protein in formulated fish diet causes the retarded growth of fish. In the present study, it was observed that mixed diet also fails to achieve better growth above 50% inclusion level. The data of the present study agree with the finding of Pereira & Oliva - Teles (2003), who reported that significant decreases were found for both, growth and feed utilization with the highest replacement levels of dietary fish meal with plant proteins for gilthead sea bream. There are many evidences, which support the results of present study. Ramchandran & Ray (2004) successfully incorporated grass pea as a fish feed ingredient up to 40% inclusion level. The increased incorporation of grass pea above 40% resulted in reduced growth of *Labeo rohita*.

Mixed diet showed decreased protein efficiency ratio trend above 50% incorporation of plant proteins. Higher inclusion of plant proteins in fish diets usually resulted in a reduced growth and protein efficiency ratio. Several studies have reported reduced growth and PER at higher levels of plant protein inclusion in fish diets (Olli et al., 1995; Fagbenro & Davies, 2001).
The inclusion of plant by-products in fish feed showed impact on liver lipid content. In the present work, it was observed that lipid content of *Catla catla* liver increased in low plant protein inclusion levels and then decreased as per the higher inclusion levels. The inclusion of by-products of plant origin was the most effective in lowering lipid content of whole body and liver in the fish (Kim et al., 2002; Cho et al., 2007).

In the present study, it was reported that the glycogen content was in correlation with plant protein. The increased incorporation of plant protein up to an optimum level increased glycogen from liver and muscle. The feed intake and plant protein inclusion determines the glycogen content in body of fish. The pattern wherein the liver glycogen concentration increased with increasing dietary plant protein inclusion level indicated that, observed carbohydrate that is not used for energy may accumulate in liver as glycogen after being converted, which is in agreement with other reports (Hatlen et al., 2005).

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