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RESEARCH PAPER

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Influence of Corn Gluten Meal on Growth Parameters and Carcass Composition of Indian Major Carps (*Catla catla*, *Labeo rohita* and *Cirhinus mrigala*)

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Abstract

Corn gluten meal is a highly demandable vegetable protein with no anti nutritional factor. It has high potential for utilization in fish diets due to its high digestibility value. Based on these, a research was conducted using corn gluten meal in three different inclusion levels i.e. 25%, 35% and 45% as CGM I, CGM II and CGM III respectively to replace 80%, 50% and 20% of fish meal in the control diet containing 45% protein. This will proffer appropriate inclusion level of corn gluten meal for carps (*Catla catla, Labeo rohita* and *Cirhinus mrigala*) in intensive polyculture. It was resulted that all tested levels of corn gluten meal respond enormously to give significant yield (88.14 Kg, 83.86 Kg and 98.03 Kg respectively) as compare to control diet, however, CGM III with 20% replacement of fish meal produced maximum yield as compare to CGM I and II. In terms of nutrient profile, values of moisture, crude protein, fat, carbohydrate and ash communicated non-significantly among treatments, but incorporation of corn gluten meal enhanced protein and lipid by reducing moisture and ash in body tissues of carps. The results attributed the significance and acceptability of plant based diets by Indian major carps.

Introduction

Accessibility and cost of feed are the major constrains for boost aquaculture production (FAO 1983; James 1992). To avoid fluctuation in availability, quality and costs of feed, researchers are doing work with partial substitution of fish meal with a variety of substitute vegetable and animal protein resources, in order to decrease its percentage in commercial feeds for fish farmers (Tacon & Jackson 1985).

Most of the grain legumes limit their amalgamation level up to 20 to 30% of the dietary protein as a substitute of protein in the diet of the fish, due to their comparatively small amount of protein (Robaina *et al*. 1995; Carter & Hauler 2000; Gouveia & Davies 1998, 2000). Ingredients with high-protein content can increase their incorporation levels. Among high protein plant based cheep commercially available products, corn gluten meal is one of these, which leftovers after the removal of starch from corn. Corn gluten meal has a satisfactory essential amino acid profile with no anti nutritional factor, except arginine, lysine and methionine to a lesser extent (Pereira & Oliva-Teles 2003).

Corn gluten meal has high potential for utilization in fish diets due to its high digestibility values (Gomes, Rema & Kaushik 1995; Regost, Arzel & Kaushik 1999). Therefore, many researchers used corn gluten meal as a feed ingredient either with other sources of protein or as a single source of protein to eliminate quantity of fish meal in the diet of European sea bass (Ballestrazzi, Lanari, Dagaro & Mion 1994), Rainbow trout (Watanabe & Pongmaneerat 1993; Gomes *et al*. 1995), Tilapia (Wu, Rosati, Sessa & Brown 1995), and Carp (Pongmaneerat, Watanabe, Takeuchi & Satoh 1993).

Based on these, the study substituted corn gluten meal at various levels of inclusion in the diet of Indian major carps *Catla catla, Labeo rohita* and *Cirhinus mrigala* to replace maximum level of fish meal and to set up optimum inclusion level of corn gluten meal for these species in an intensive polyculture.

Materials and Methods

Diets Formulation and Feeding Regime

Fish meal in control diet was replaced by a gradient of corn gluten meal to formulate three different diets

i.e. CGM I, CGM II and CGM III. In CGM I, 80% fish meal was replaced by corn gluten meal, to formulate a 25% CP diet, while in CGM II and CGM III, replacement of 50% and 20% fish meal was made to prepare diets of 35% and 45% CP respectively. In control 63% of total CP was provided with fish meal. All ingredients were emulsified with starch and canola oil to form dough. The dough was then passed through a dry pelleting machine. Percentages of ingredients, proximate values and energy contents per 100 g of experimental diets are presented in Table. 1.

For the accuracy of data, all experiments were executed in triplicates. Twelve raceways with the dimension of 22′×50′ (W×L) were used to rear *Catla catla, Labeo rohita* and *Cirhinus mrigala* with the ratio of 33:33:34 fish/ raceway respectively (Wahab, Rahman & Milstein 2002). Feed was given manually twice daily to the carps at 3% body weight (Dada, Fagbenro & Fasakin 2002).

Temperature, dissolved oxygen, pH and ammonia were optimum for the growth of the carps throughout the whole duration of the study. The temperature and dissolved oxygen were evaluated by Dissolved oxygen meter (HI-9146) by fixing the temperature factor at 0˚C unit. The pH was measured by the microprocessor pH meter (HANNA-HI-8520) after setting its range at pH point. Total dissolved solids were determined by TDS meter (HANNA-HI-98302). Total alkalinity and total hardness were determined by MERCK chemical test kits for testing water and waste waters. In present research work concentrations of ammonia in raceways were determined by following the method of John &Hargreaves (2004).

Estimation of Feed Response

All growth parameters were measured by following Khan, Jafri and Chadha (2004). Monthly weight gain, daily feed allowance (DFA), feed conversion ratio (FCR) and specific growth rate (SGR) were monitored to ensure the significance and acceptability of plant based protein diets by Indian major carps. For the confirmation of nutritional quality, chemical composition of fillets was determined by following Association of Official Analytical Chemist (A.O.A.C 2005).

Statistical Analysis

Data was subjected statistically by one-way and two-way analyses of variance find out relationships among growth variables. The comparison of means for various factors was carried out by Fisher's least-significant-difference (LSD) test.

Results

Mean values of growth parameters of experimental carps fed with different levels of corn gluten meal based diets have been summarized in Table. 2. Mean monthly weight gain was found to be highest by CGM III (with 45% CP and 20% replacement of fishmeal) as 101.36 g for all three carps i.e. *Cattla cattla, Labeo rohita, Cirhinus mrigala* with a higher value of DFA (1056.72 g) and FCR (3.01), however a higher value of monthly weight gain was also obvious by 80% replacement of fish meal (CGM I). With respect to monthly weight gain, CGM II showed minimum increase in growth among all treatments (86.55 g) with lowest values of DFA (916.06 g) and FCR (2.97). All obtained values of weight gain were much higher than the control. It was evident by the result that maximum average daily growth (ADG) was noted in *Cattla cattla* in all treatments (3.33 g, 2.94 g and 3.54 g by CGM I, II and III respectively). The comparison of means for monthly weight gain by

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

	Control	*CGM I	CGM II	CGM III
Ingredients (%)				
Fish meal	45	9.13	22.40	35.67
Corn gluten meal	30.98	25	35	45
Rice polish	14.00	55.85	32.59	9.31
Starch	5	5	5	5
Canola oil	4.5	4.5	4.5	4.5
Vitamins and mineral mixture	0.5	0.5	0.5	0.5
Proximate composition (%)				
Crude protein	44.98	24.98	34.98	44.98
Crude fat	10.42	13.51	11.48	9.43
Crude fiber	2.38	3.29	3.05	2.81
Ash	13.25	9.83	10.4	10.98
Nitrogen –free extract	28.39	47.82	39.54	31.23
DE (K cal/Kg)	3263.44	3018.5	3114.5	3209.9
GE (K cal/Kg)	4587.67	4565.3	4590.2	4614.3

*CGM = Corn gluten meal,

Fisher's least-significant-difference (LSD) test showed significant differences among treatments.

The observed and computed fish biomass harvested against different inclusions of corn gluten meal is illustrated in Table. 3. *C. catla* contributed quite well in all treatments. *C. mrigala* ranked second in terms of individual percent contribution in final harvested fish biomass.

Significant differences were observed by two-way analysis of variance with weight and DFA against months and diets in all carps (Table. 4), whereas highly significant relationship was evident between feed conversion ratio and months but not with the levels of CGM. The specific growth rate (SGR) was not considerably differing among all diets for all carps.

A significant relationship was found between increased fish yield (IFY) and daily feed allowance (DFA) in all diets by regression analysis (Table. 5). In terms of nutrient profile, an inverse relationship was observed for protein and fat contents with moisture but values of moisture, crude protein, fat, carbohydrate and ash communicated non-significantly among treatments (Table. 6).

Discussion

Inclusion level of corn gluten meal is the central aspect of the present research trial to discuss as its

Table. 2. Mean values of growth parameters of experimental carps fed with different levels of corn gluten meal based diets

	Weight (g)							
	Initial	Final	Monthly WG[1]	Mean WG	ADG (g/day)[2]	DFA (g)[3]	SGR (%/day)[4]	FCR[5]
					Control			
C. catla	27.3	466.4	36.59 ±5.5b		1.21		0.36 ±0.05a	
L. rohita	37.5	490.5	37.68 ±3.9b	39.67c	1.25	532.3± 89b	0.32 ±0.07a	3.82±0.33a
C.mrigala	62.5	599.3	44.73 ±4.1b		1.49		0.27 ±0.03a	
	*CGM I							
C. catla	20.9	1222.5	100.1 ±15.3a		3.33		0.49±0.11a	
L. rohita	22.3	975.9	79.6 ±13.9a	91.03a	2.65	942.04±203a	0.46±0.09a	2.94±0.39a
C.mrigala	24.1	1147.8	93.4 ±12.1a		3.11		0.45±0.09a	
	CGM II							
C. catla	20.5	1082.7	88.36 ±11.7a		2.94		0.46±0.10a	
L. rohita	18.3	1066.6	87.3 ±14.6a	86.55ab	2.91	916.06±195a	0.49±0.10a	2.97±0.40a
C.mrigala	21.4	1036.4	84.0 ±10.6a		2.81		0.43±0.08a	
	CGM III							
C. catla	26.7	1301.7	106.4 ±16.5a		3.54		0.48±0.10a	
L. rohita	28.3	1260.0	103.2 ±17.5a	101.36b	3.44	1056.72±224a	0.49±0.11a	3.01±0.43a
C.mrigala	29.3	1164.0	94.5 ±12.8a		3.15		0.44±0.09a	

* CGM = Corn gluten meal,

Values are means ± SE of three replicates.

Means in a column followed by same letter are not 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

Table. 3. Observed and computed fish biomass harvested by different inclusions of corn gluten meal

	Control	*CGM I	CGM II	CGM III
Total harvested weight (Kg per treatment)	41.06	88.14	83.86	98.03
Total fish production (Kg/hectare/year)	410.60	881.49	838.64	980.32
Individual contribution at harvest (%)				
C. catla	29.53	36.05	33.56	34.52
L. rohita	31.05	28.78	33.06	33.41
C.mrigala	39.40	35.15	33.36	32.05

* CGM = Corn gluten meal,

Table. 4. Two-way analysis of variance of different variables against treatments (levels of corn gluten meal) and months

Variables	Weight (g)			DFA (g)	SGR (%/day)			FCR
	C. catla	*L. rohita*	*C. mrigala*		*C. catla*	*L. rohita*	*C. mrigala*	
Levels of CGM	0.000**	0.000**	0.000*	0.000**	0.646*	0.471*	0.377*	0.765*
Months	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**

* CGM = Corn gluten meal, **=Significant; * = Non significant

Table. 5. Regression effects of Daily feed allowance (DFA) on increase fish yield (IFY)

	Regression equations	R-Sq	R-sq (adj)	Prob
CGM I	IFY = 101.9 + 0.181 DFA	80.5%	78.5%	0.000**
CGM II	IFY = 103.8 + 0.170 DFA	82.8%	81.1%	0.000**
CGM III	IFY = 112.9 + 0.181 DFA	80.5%	78.6%	0.000**

* CGM = Corn gluten meal, **=Significant

Table. 6. Comparison of means of the proximate values under different treatments

		Moisture %	Crude Protein %	Crude Fat %	Carbohydrate %	Total Ash %
Control	*Catla catla*	76.52	17.23	2.65	1.84	1.71
	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	77.89	16.81	2.05	1.24	1.9
*CGM I	*Catla catla*	75.41	15.35	3.01	3.39	2.78
	Labeo rohita	77.55	15.14	3.63	0.45	3.13
	Cirhinus mrigala	76.15	16.60	3.13	1.25	2.86
	Mean	76.37	15.69	3.25	1.69	2.92
CGM II	*Catla catla*	75.82	15.77	2.84	3.18	2.37
	Labeo rohita	76.75	15.23	3.90	1.27	2.81
	Cirhinus mrigala	75.38	17.11	3.11	2.02	2.27
	Mean	75.98	16.03	3.28	2.15	2.48
CGM III	*Catla catla*	77.80	15.13	2.53	1.44	2.89
	Labeo rohita	76.24	15.01	3.57	1.96	3.22
	Cirhinus mrigala	77.17	16.47	3.08	0.68	2.60
	Mean	77.07	15.53	3.06	1.36	2.90

* CGM = Corn gluten meal,

globally increasing demand due to low price (as compare to fishmeal) draw attention to the need to maximize its inclusion level and minimize animal protein ingredients in feeds. Level of crude protein in animal nutrition triggers pattern of growth. A combination of agricultural and animal by products is quite beneficial to provide essential dietary nutrients of both exotic and indigenous carps given at 5% of body weight (Alam, Maughan & Matter 1996; and Abbas, Ahmed, Rehman & Mateen 2008). Nandeesha, De Silva and Murthy (1995) also claimed that a diet with combination of both exhibit better weight gain, SGR and FCR.

Inclusion of high levels of corn gluten meal significantly decrease growth rate and feed utilization (Pereira & Oliva 2003; Regost *et al*. 1999). Kamur and Saxena (2005) suggested that high level of corn gluten causes retarded growth due to deficiency in amino acids specially methionine, lysine and threonine. They reported that 5% level of corn gluten optimize growth rate and may be a substitute of fish meal. Corn gluten meal replaced 12% to 26% (Gropp, Koops, Tiews & Beck 1976; Alexis, Papaparaskeva & Theochari 1985 and Moyano, Cardenete & Higuera 1992) and 40% (Morales *et al*. 1994) of dietary fishmeal protein in rainbow trout, while up to 20% for sea bass *(Dicentrurchus labrux)* juveniles (Alliot, Pastoreaud, Pelaez & Metailler 1979) and 35% in adults (Ballestrazzi *et al*. 1994) with no negative effects on fish performance. Robaina *et al*. (1997) found no differences in the growth rate, feed utilization or liver histology of gilthead sea bream when fishmeal protein was replaced using corn gluten meal up to 40%.

The finding of Kalla, Bhatnagar & Garg (2004) is somehow contradicted. They suggested that higher than 40% level of crude protein of plant origin could be more effective to obtain better weight gain. Studies showed that, the digestibility values of CGM are

normally very high for carps, with stated value of 95% (Pongmaneerat & Watanabe, 1991; Morales, Cardenete, Higuera & Sanz 1994). In the present research trial 20% replacement of fish meal produced maximum yield, however 50% and 80% replacement of fish meal also produced significant yield in terms of growth as compare to control which confirm the high digestibility of CGM for carps.

It is resulted that all tested levels of corn gluten respond enormously to produce maximum harvest (25%; 88.14 Kg, 35%; 83.86 Kg and 45%; 98.03 Kg) as compare to control. However, at 50% replacement of fish meal, growth response was lower than 80% replacement, but it could be the result of higher inclusion of rice polish in CGM I, which might improve amino acid profile, leading to improve feed consumption. This requires to be further analyzed. These results may attribute the significance and acceptability of plant based diets by major carps.

However, stocked carps showed consistency in all these levels of corn gluten meal and from the fact, corn gluten based diets were proved to be best feed at all three tested levels of inclusion but in addition to these outcomes, fish production rate may also be elaborated by considerable individual performance regarding percent contribution. *C. catla* contributed quite well in all treatments for being a surface feeder. The quantity of feed which sink down after a less floating duration at bottom region likely to utilize by bottom feeder, as a result C. *mrigala* received feed pellets more or less equally to *C. catla* and contributed almost equally in final harvested fish biomass.

These mentioned results regarding the suitability of tested diets in terms of fish production and individual performance of major carps are confirmed by Periera and Olive-Tales (2003), who tried by products of maize, corn gluten meal in test diets to obtain a diet from soy bean, moong, cow pea and guar and fed to *C. mrigala* and *L. rohita* and obtained heavy increments in fish yield.

In terms of nutrient profile, similar to EL-Saidy and Gaber (2005) and Singh *et al*. (2005) an inverse relationship was observed for protein and fat contents with moisture. Although values of moisture, crude protein, fat, carbohydrate and ash communicated non-significantly among treatments, but incorporation of corn gluten meal enhanced protein and lipid by reducing moisture and ash in body tissues of carps, as observed by Pereira and Olive-Tales (2003). These findings are also confirmed by Ramachandran, Bairagi and Ray (2005), who noted high carcass protein and lipid levels in carps fed with 40% composition of grass pea seed meal.

Keeping all above facts and figures in mind, this work has been quite handy to bring as much information as possible to provide comprehensive details for the advancement of polyculture of highly demanded carps. Fishmeal no longer will be the basic protein source of carp`s feed in future. Possible consequences require further attention.

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