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Effects of Dietary Corn Gluten Supplementation on Body Composition and Growth Performance in Common Carp (*Cyprinus carpio*) Juvenile

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Abstract: The effect of dietary corn gluten on growth performance and body composition of common carp (cyprinus carpio) juvenile were studied. Fish were randomly allocated in 12 aquaria (10 fish per aquarium). Experimental feeds with 31% of crude protein, GE: 3.1 Kal g^{-1} in three replacement levels 150, 270 and 490 g kg^{-1} respectively accompanied with a control diet (0 g kg^{-1}) were prepared and fish were feeding in 60 days. At the end of trial, significant differences were found in growth performance ($p<0.05$). Biomass gain, specific growth rate, feed conversion rate and protein efficiency ratio in fish feed with diet 1 was higher ($p<0.05$). However growth performance in diet 2 and 3 have not significantly different ($p>0.05$). Moisture carcass of common carp feed with diet 4 was higher significantly ($p<0.05$). Fat carcass in common carp feed with diet 1 was higher significantly ($p<0.05$). while protein and ash have not significantly different in the 1- 4 experimental groups ($p>0.05$).

Key words: Common Carp · Dietary · Corn Gluten

INTRODUCTION

Feed is the single largest cost in the aquaculture industry. This is because of extensive reliance on marine animal protein sources such as fish meal to meet the high dietary protein requirements of fish. As the demand for fish meal is increasing with the development of the aquaculture industry, worldwide the yield of fish meal cannot meet the production demand of the feeding industry. Thus, to develop economical aquaculture systems, alternative sources of high quality proteins are required to replace high-cost fish meal. In recent years, several sources of plant proteins have been experimented on various fish to either partially or completely replace the more expensive fish meal [1-3].

Various research have been published on digestibility of corn gluten meal (CGM), indicating in general excellent results for inclusion levels below 40% of the dietary protein for distinctive fish species [4]. Digestibility of corn gluten meal is usually high, with reported values of 95 and 96% for *cyprinus carpio* and rainbow trout, respectively [5].

Reconsider on option protein sources have been publicized by Tacon and Jackson [6] and Kaushik *et al.* [7] between plant protein sources. Some studies have reported that partial substitution of dietary fish meal with corn gluten meal (12 to 26% of the diet) has lead to sufficient results of growth rates and feed employment in diets for the *Oncorhynchus mykiss* [8-10]. Alliot *et al*. [11] in with sea bass *(Dicentrarchus labrax)* juveniles, found that replacement of fish meal by corn gluten meal at levels up to 20% did not affect growth or feed efficiency ratios.

The present study was designed to evaluate the application of graded levels of CGM on growth, body composition and also to provide a theoretical basis for developing non-fish meal feed for common carp, which is one of the most valuable freshwater fish species cultured in Iran.

MATERIALS AND METHODS

A total of 120 healthy common carps (mean initial weight of 11.5±0.5 g) (mean±SD) were purchased from the Institute of Pond Fish Culture in Gorgan (Agh Ghala), Iran. A growth trial was designed using four different

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Table 1: Formulation and chemical composition of the studied diets

	Experimental diets			
Nutrient material	Treatment 1 (%)	Treatment 2 (%)	Treatment 3 (%)	Treatment 4 (%)
Fish meal	44.31	31	20	0
Corn gluten	0	15	27.79	49
Cellulose	27.71	29.30	30	28.05
Wheat flour	18.36	14.35	11.12	10
Fish oil	2	2	2	2
Soybean oil	2.35	3.15	3.83	5.01
Lysine	1.5	1.5	1.5	1.5
Methionin	1.5	1.5	1.5	1.5
antioxidant	0.25	0.25	0.25	0.25
Vitamins and minerals*	2	2	2	1.75
Chemical composition (% or cal g^{-1})				
Crude protein	31	31	31	31
Lipid	8	8	8	8
Energy crude	3.2	3.2	3.2	3. 3

*Vitamins and minerals were supplied according to NRC [12]

diets, which contained different levels of CGM (CGM 0, 150, 270 and 490, respectively). Each group had three replicates, each containing 10 fish. Aquaria (70 L) equipped with freshwater from an urban system. 120 fish were separately measured for weight and length. The average values for aerated and dechlorinated tap water used in the both acclimation and experiments was pH 7.21±0.5, dissolved oxygen 7.80±0.06 mg/l, temperature at 25±1°C and total hardness 290±2.35mg/l as $CaCO_3$. The water quality parameters mentioned above were assessed during the experimental period. Throughout the acclimation period and experiment periods, fish were held under a photoperiod of 12 h of light and 12 h of darkness. Four groups (T1 control group and T2, T3, T4 experimental group) were fed by hand twice daily to 2% whole body weight. Each group was weighed every 2 weeks to follow growth and feed utilization. Four trial diets were formulated to contain 31% crude protein (Table 1).

At the end of the feeding period (9 weeks), tissue samples were taken from randomly selected fish. Following overnight fasting, the fish were anaesthetized with 2-phenoxyethanol (0.09 ml L^{-1}). After the fish were killed by blunt trauma to the head, samples of muscle were rapidly excised, frozen and stored at -20°C until body composition analysis.

The whole fish and diet samples were ground and then analyzed for dry matter after desiccation in an oven (105°C for 24 h), ash (550°C, overnight), crude protein (6.25× nitrogen (N); Kjeltec Auto System), lipid (Soxtec HT6 after hydrolysis with HCl) and energy (adiabatic bomb calorimeter).

Whole-body specific growth rate (SGR), expressed as a percentage of the body weight was calculated using the growth rate equation of [13]:

$$SGR\ (\%/day) = \{[\ln(Wf)-\ln(Wi)].100\}/t$$

Where *Wi* and *Wf* are the initial and final wet weights (g) of the experimental beluga, respectively and *t* is the length of the experimental period (in days).

The feed conversion ratio (FCR) was calculated in terms of wet weight as: FCR= wet weight of feed consumed/change in wet weight

Total feed consumption was appraised from the quantity of feed that was not eaten and was collected from the strainer at the bottom of the tank every hour. The pellets remained intact prior to collection and uneaten feed was estimated from the number of pellets using the average weight of a pellet for each feed [14].

The protein efficiency ratio (PER) and percent survival rate was calculated in terms of wet weight as:

PER = Live wt. gain (g)/ Protein intake (g)

Survival (%) = Total live fish (No.) after t/ Total fish at 0 day (No.).100

All data were analyzed with one-way analysis of variance (ANOVA) by using SPSS16.0 for windows. Differences between means were determined using Duncan's multiple test (significance $P<0.05$).

RESULTS

At the end of the trial (9 weeks), there were no dead fish in all groups throughout all feeding periods. Initial and final body weight of common carp fed the four diets is shown in Table 2. Biomass gain, specific growth rate, feed conversion rate and protein efficiency ratio in fish

Table 2: Growth performance in fish fed the experimental diets

	Experimental diets			
	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Mean initial body weight (g)	11.66±0.37	11.77±0.10	11.71±0.15	11.76±0.05
Mean final body weight (g)	19.53±0.20	18.97±0.91	19.02±0.49	17.89± 0.47
Weight gain(g)	7.89±0.52[a]	7.19±0.89[b]	7.30±0.57[b]	6.64±0.85[c]
SGR (%)	0.86±0.06[a]	0.79±0.07[ab]	0.80±0.05[ab]	0.70±0.04[b]
PER	1.37±0.09[a]	1.28±0.12[ab]	1.30±0.09[ab]	1.13±0.07[b]
FCR	2.83±0.11[a]	2.53±0.23[ab]	2.45±0.17[ab]	2.34±0.16[b]
Survival (%)	100	100	100	100

Tank average values of fish weight (Mean±SE) were used as experimental units for the statistical analysis of growth performance

Table 3: Fish composition of whole fish fed the experimental diets

	Experimental diets			
Proximate composition (%)	Treatment 1 (control)	Treatment 2	Treatment 3	Treatment 4
Protein	14.44±0.15[a]	14.44±0.12[a]	14.55±0.07[a]	14.46±0.15[a]
lipid	4.36±0.15[a]	3.10±0.10[b]	3.11±0.10[b]	2.00±0.10[c]
Ash	1.51±0.03[a]	1.56±0.07[a]	1.53±0.09[a]	1.52±0.03[a]
Moisture	78.45±0.27[a]	74.78±0.48[b]	74.46±0.32[b]	72.82±0.59[c]

Means in the same row with same letter are not significantly different (P > 0.05)

feed with diet 1 was higher ($p<0.05$). However growth performance in diet 2 and 3 have not significantly different ($p>0.05$) Table 2.

At the end of the experiment, the lipid content and moisture were lower in fish fed the diet without fish meal than in fish control group ($P<0.05$). CGM did not affect the protein content and ash in fish among all groups. There were no significant differences in protein content and ash in fish among all groups ($P>0.05$) Table 3.

DISCUSSION

The feasibility of fish meal replacement by plant protein sources is highly variable among fish species. In rainbow trout, a total replacement by means of soy protein concentrates [7] or combinations of different protein sources [15] did not have adverse effects in growth and feed utilization.

In contrast, earlier studies in Mediterranean fish species such as European sea bass [16] and gilthead sea bream [8, 17, 18] showed that only a 20-30% of fish meal replacement was feasible. However, very recently, an almost total replacement of fish meal by plant proteins was demonstrated in European sea bass [7].

In recent researches substitution of fish meal with corn gluten meal caused a significant ($P<0.05$) difference in growth performance including SGR, FCR, PER and body composition including moisture, lipid content while significant differences were not found in ash and protein content ($p>0.05$).

One reason for the poor result with plant protein-based diets is a deficient feeding activity and data of the present study indicate that incorporation of plant proteins led to a progressive reduction in voluntary feed intake of juvenile common carp. Growth retardation in the treatment 4 was much lower than other treatment and final weight gain was decreased in 2, 3 and 4 treatment than 1 treatment.

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