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Changes in Growth and Carcass Composition of Caspian Roach (*Rutilus rutilus caspicus*) Larvae in Response to Dietary Phosphorus Levels

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Abstract: This experiment was conducted to investigate the effects of dietary available phosphorus (P) on the growth performance and carcass composition of Caspian roach (Rutilus rutilus caspicus) larvae to determine the optimum P requirement for growth. Five semi-purified diets were formulated with graded levels of P containing 0.0 (A), 0.4 (B), 0.8 (C), 1.2 (D) and 1.6 (E)% P supplied as a mixture of $NaH2PO4/KH2PO4$ with a ratio 1:1 supplemented with 1% Ca. Each diet was randomly assigned to triplicate groups of fish and each group was stocked with 30 fish larvae and fed 3 times a day for 60 days. No significant difference was found in the growth parameters including weight gain (WG), specific growth rate (SGR) and feed conversion ratio (FCR) between treatments ($P>0.05$). The best FCR, SGR and WG were obtained with diet D containing %1.2 available P. Glucose, cholesterol, total protein, triglyceride of carcass in different treatments of P were determined. Results showed a significant decrease in cholesterol among the studied treatments as result of increasing the dietary P level ($P<0.05$), but not in total protein, triglyceride and glucose ($P>0.05$). The results obtained from this study could be beneficial to formulate artificial food for rearing of Caspian roach larvae.

Key words: Phosphorus · Caspian Roach · Growth · Carcass Composition

INTRODUCTION

Phosphorus (P) as key mineral is directly involved in the development and maintenance of the skeletal system and plays an important role in the metabolism of carbohydrate, lipid and amino acids [1]. The diet is the main source of P in fish; because of its low concentration in natural waters and low absorption rate as well [2, 3]. Therefore, dietary P deficiency can effect various aspects of its intermediary metabolism, growth and feed conversion [4, 5]. Some studies have demonstrated growth reduction as result of a dietary P deficiency (Hardy *et al*. [6], juvenile rainbow trout, *Oncorhynchus mykiss*), (Nwanna *et al*. [7], African giant catfish, *Heterobranchus bidorsalis*), (Chavez-sanchez *et al*. [8], American cichlid, *Cichlasoma urophthalmu*), (Chao-Xia *et al*. [9], juvenile grouper, *Epinephelus coioides*). On the other hand, excess P in fish feeds not only increases cost but also contributes to severe environmental impacts. Because of its critical roles on fish growth and aquatic environment pollution, P researches have become a major concern in aquaculture [9].

Caspian roach (*Rutilus rutilus caspicus*) is commercially important, has experienced a remarkable decline in the fishing yields of the Iranian Caspian Sea due to over-fishing and habitat deterioration. Therefore its artificial propagation in hatcheries to recruit its natural stocks is fulfilled for 10 years [10]. Hence, this study was conducted to observe the effect of dietary P on the growth and carcass chemical change in Caspian roach larvae. In the absence of a complete understanding of the requirement levels of P in this species, the result of this research can help to understanding better of requirement levels to formulate its diets to ensure adequate dietary P levels to support growth.

MATERIALS AND METHODS

Caspian roach larvae (with mean weight: 0.108±0.01 g) were obtained from the fish hatchery of Sijval (Gorgan, Iran). The acclimatization period lasted 10 days in a single 1000-L tank in the laboratory conditions (T=24±2°C, pH=7.8±0.2). Then, the larvae were randomly distributed to fifteen 100L experimental tanks, each of 30 larvae.

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Table 1: Formulation and composition of experimental diets (g/100 g dry weight)

Diet	A	B	C	D	E
Casein-dextrin basis[a]	82.5	82.5	82.5	82.5	82.5
Vitamin mixture	5	5	5	5	5
Mineral mixture without P and Ca[b]	2.5	2.5	2.5	2.5	2.5
Monobasic sodium and potassium phosphates (50/50)	0.00	1.68	3.36	5.04	6.72
α-Cellulose	7.50	5.82	4.14	2.46	0.78
Calcium carbonate	2.50	2.50	2.50	2.50	2.50
Available P	0.0	0.4	0.8	1.2	1.6
Available Ca	1.0	1.0	1.0	1.0	1.0

[a]Casein-dextrin basis (% diet): 52% casein); 0.65%, L- methionine; 0.85%, L- arginine; 8% soybean lecithin; 8% fish oil; 12% dextrin; 1% sodium alginate.
[b]Mineral mixture (g/kg mineral mix): KCl, 180; KI, 0.08; NaCl, 80; $CuSO_4$•$5H_2O$, 6; $ZnSO_4$•$7H_2O$, 8; $CoSO_4$, 0.04; $FeSO_4$•$7H_2O$, 40; $MnSO_4$•H_2O, 6; MgOH, 248; Na_2SeO_3, 0.06; NaF, 2. All ingredients were diluted with α-cellulose

They were fed three times per day with experimental diets, 5% of their bw/d during a 60 days growth trial.

Five semi-purified diets were formulated with graded levels of P and Ca (Table 1). The diets A, B, C, D and E were supplemented with 0.0, 0.4, 0.8, 1.2 and 1.6% respectively, available P supplied as a mixture of NaH_2PO_4/KH_2PO_4 with a ratio 1:1. These five diets were supplemented with 1% Ca supplied as $CaCO_3$.

Every two week, sample of fish were withdrawn from each tank to weight fishes and calculate the required food for the following week. Mean fish weight was calculated using the sum of individual fish weight divided by the fish number in each tank. Growth performance was analyzed in terms of specific growth rate (SGR), weight gain (g) (WG) and feed conversion ratio (FCR). The following formulae were used:

% SGR (%) = (lnW_f(Final mean weight) -ln W_i(Initial mean weight))*100/ feeding days.
WG (g) = W_f-W_i
FCR = total feed consumed (g)/ weight gain (g)

After 60 days experimental period, six larvae from each tank were sampled. The sampled larvae were sacrificed by an overdose of MS-222. They were homogenized and centrifuged for 15 minutes at 3000 rpm and stored frozen at -20°C till carcass chemical analysis. The contents of body glucose, total protein, triglyceride and cholesterol were measured by using commercial clinical investigation kits (Pars Azmun).

The results of data were expressed as mean ± SD and were subjected to one-way analysis of variance (ANOVA) (SPSS version 20.0) to determine significant differences among treatments. If a significant difference was identified, differences among means were compared by Duncan's multiple range test (P<0.05) by [11].

RESULTS

At the end of the experiment, no significant differences in growth performance parameters including of weight gain (WG), specific growth rate (SGR) and feed conversion ratio (FCR) were found between dietary treatments (P>0.05). Growth performances of Caspian roach larvae are showed in Table 2. Table 3 displays the carcass composition including glucose, total protein, triglyceride and cholesterol in the Caspian roach larvae fed diets with different levels of P after 60 days experimental period. There were no significant difference in carcass glucose, total protein and triglyceride content between dietary treatments (P>0.05). However, carcass cholesterol was significantly differ between treatments (P<0.05) and fish fed with the diet E had lowest cholesterol.

DISCUSSION

The present experiment showed that increasing P supplements significantly reduce body cholesterol of the Caspian roach larvae. One of the most consistent observations in dietary p deficiency in fish is the accumulation of body fat, resulting from cellular hypoxia and inhibition of oxidative phosphorylation [12]. Hence, significant decrease of the cholesterol content among the treatments might be as a result of dietary p deficiency. However in case of other carcass composition including glucose, triglyceride and total protein no significant change were noticed (Table 3).

No Significant effect of dietary p levels was noticed on growth performance of Caspian roach larvae among groups at the end of experiment. However, the results suggest that the best FCR, SGR and WG were obtained with diet D containing %1.2 available P (Table 2). It is well

Table 2: Growth performance parameters of Caspian roach larvae fed with different levels of P

	A	B	C	D	E
Initial mean weight (g)	0.105±0.02	0.109±0.01	0.096±0.01	0.111±0.01	0.119±0.01
Final mean weight (g)	0.889±0.09[a]	0.916±0.06[a]	0.901±0.17[a]	0.979±0.07[a]	0.925±0.11[a]
Weight gain (g)	0.784±0.07[a]	0.807±0.05[a]	0.805±0.18[a]	0.867±0.05[a]	0.806±0.09[a]
SGR(%)	3.57±0.23[a]	3.54±0.16[a]	3.72±0.49[a]	3.62±0.31[a]	3.40±0.03[a]
FCR	1.92±0.17[a]	1.86±0.12[a]	1.93±0.49[a]	1.74±0.18[a]	1.87±0.22[a]

Means of triplicate values with similar superscript are not significantly different (P>0.05)

Table 3: Composition of the carcass of Caspian roach larvae fed with different levels of P

	A	B	C	D	E
Total protein (g/dl)	31.8±4.4[a]	19.1±0.7[b]	25.5±1.6[ab]	18.8±0.4[b]	19.6±0.5[b]
Cholesterol (mg/dl)	602.2±57[a]	583.4±30[a]	381.7±41[b]	385.0±48[b]	359.6±17[b]
Triglyceride (mg/dl)	850.7±56[a]	631.4±67[a]	605.0±80[a]	828.9±21[a]	629.5±87[a]
Glucose (mg/dl)	505.3±72[a]	442.9±27[ab]	412.5±58[ab]	342.9±52[ab]	229.8±26[b]

Means of triplicate values with similar superscript are not significantly different (P>0.05)

recognized that the requirements of P for maximum bone strength and bone ash content are higher than the requirements for maximum weight gain [13]. Baeverfjord *et al*. [14], reported that juvenile Atlantic salmon (*Salmo salar*) grow properly for 6 weeks on a P-deficient diet (0.35% P), whereas whole-body Ca and P levels declined immediately. Ogino and Takeda [15] pointed out that juvenile carp (*Cyprinus carpio*) for maximum growth need to 0.6-0.7% available p and that for maximum bone mineralization was higher 1.5%. The results of this study indicate the estimated dietary requirement of P for Caspian roach larvae based on growth performance alone may not be accurate and need to determine of bone mineralization too.

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