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Effect of phosphorous supplementation in the formulated fish feed on carcass quality of Nile tilapia *Oreochromis niloticus* L.

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Abstract
A study was conducted to evaluate the effect of phosphorus supplementation in the formulated fish diet on carcass quality of Nile tilapia in net-cages suspended in fertilized earthen ponds. In the experiment 3% di-calcium phosphate (DCP), 3% triple supper phosphate (TSP) and 7% 16:20 inorganic fertilizer were added as phosphorous sources to three diets containing fish meal as main protein ingredient. Feeding tilapia in net-cages with these diets significantly ($p<0.05$) improved the carcass quality and bone phosphorous content of Nile tilapia over fish fed with same diet without phosphorous supplementation and fish given no feed. The final body composition and bone phosphorous content of Nile tilapia fed with DCP, TSP and 16:20 grade fertilizer supplemented diets were comparable.

Key words : Phosphorus, Di-calcium phosphate, Triple super phosphate, Carcass quality, Bone phosphorus

Introduction

Phosphorus is one of the most essential minerals for fish growth and bone mineralization which function primarily as structural component of hard tissues e.g., bone, exoskeleton, scale and teeth. Effects of dietary phosphorous deficiency in fish have been found mainly to be loss of appetite, reduced growth and head and skeletal deformities and under extreme circumstances affect bone formation and lead to death of fish (Lall 1979). In semi-intensive culture system the natural food alone usually may satisfy all phosphorous requirements of fish to support slow growth rate and to avoid gross phosphorous deficiency symptoms. However, in intensive and semi-intensive aquaculture system farmers uses supplementary diets to obtain better fish growth, which may be deficient in phosphorus or contain in an unavailable form to fish. Then addition of phosphorus in supplementary diets may be more appropriate to obtain improve carcass quality and better fish growth.

The aim of the present study was to evaluate the effect of supplementation of di-calcium phosphate (DCP), inorganic fertilizer triple super phosphate (TSP), and inorganic fertilizer 16:20 (16:20 grade fertilizer contains 16 percent N and 20 percent

P_2O_5) as phosphorus sources in the formulated fish feed on carcass quality of Nile tilapia (*Oreochromis niloticus*).

Materials and methods

The study was conducted for a period 60 days in 15 net-cages each measuring 2.0 m x2.0mx1.0m suspended in three fertilized earthen ponds each measuring 200 m^2 at the campus of Asian Institute of Technology, Bangkok, Thailand. Five treatments including one non-feed treatment with three replicates each were tested in a randomized complete block design (RCBD). Four iso-nitrogenous and iso-caloric experimental diets were formulated and prepared. Di-calcium phosphate (DCP), Triple supper phosphate (TSP) and grade 16:20 fertilizer were supplemented at rates 3, 3 and 7% respectively in three diets as phosphorus sources. In treatment 3, 4 and 5 fish were fed with 3% DCP 3% TSP and 7% grade 16:20 fertilizer supplemented diets respectively. In treatment 2 fish were fed with phosphorous non-supplemented diet and in treatment 1 fish were given no feed. All sex reversed male Nile tilapia were used in the experiment and stocked with 25 fish per net-cage. The initial and the final individual length and weight of fishes were measured and recorded. For the analysis of initial carcass proximate composition and bone phosphorus thirty fishes were sacrificed and for the analysis of final carcass proximate composition and bone phosphorus fifteen fishes per replicate were also sacrificed at the end of the experiment. Earthen ponds were fertilized one week before stocking of fish and after that regularly weekly basis with inorganic fertilizer at the rate of 4-kg Urea-N/h/day and 2 kg TSP-P/h/day. Composition, nutrient and energy content of diets used in the experiment are given in Table 1.

Table 1. Composition, nutrient and energy content of experimental diet (g/100g dry weight basis)

Ingredients	DIETS			
	1	2	3	4
Soybean meal	60	60	60	60
Fish meal	5	5	5	5
Cassava starch	29	26	26	22
Corn oil	4	4	4	4
Vitamin premix	2	2	2	2
DCP[1]	0	3	0	0
TSP[2]	0	0	3	0
16:20[3]	0	0	0	7
Total	100	100	100	100
Proximate composition				
% Dry mater	91.01	89.82	90.12	89.63
% Protein	31.52	31.83	32.44	31.66
% Lipid	5.02	4.97	5.11	5.07
% Crude fiber	4.99	7.89	8.53	6.62
% Ash	5.78	8.65	8.03	8.68
% NFE	52.69	46.65	45.89	47.97

% Phosphorus	0.57	1.14	1.18	1.15
Gross energy (kj/g)	18.68	17.65	17.74	17.91
P.E ratio (mg/kj)	16.87	18.01	18.28	17.67

[1] DCP = Di-calcium phosphate [2] TSP = Triple super phosphate [3]16:20= A 16: 20 grade fertilizer contains 16 percent N and 20 percent P_2O_5

In the experiment fish were fed at the rate 3% of body weight (dry feed/wet fish weight) twice in a day (50% in the morning between 9.00 –10.00 a.m. and rest of the 50% in the evening between 5.00- 6.00 p.m.). The feed was given in feeding trays suspended in water column. The ration was adjusted biweekly intervals according to batch weight after every sampling.

Water samples were taken at weekly and biweekly intervals and analyzed for assessing temperature, dissolved oxygen, pH, ammonia, nitrogen, total alkalinity, total phosphate, nitrite, total suspended solid (TSS), chlorophyll-*a*, phaeophytin-*a* and plankton biomes.

Proximate composition of ingredients, diets and fish carcass were analyzed according to the analytical methods of AOAC (1984) and phosphorous were analyzed by molybdate–vandate and spectrophotometric (420nm) method.

To test significance of treatments at 0.05 confidence level ($p<0.05$) on the mean final carcass composition and bone phosphorous, the multi-factor analysis of variance (ANOVA) and paired t-test was used. The Mstatc statistical software package was used for this purpose.

Results

Proximate composition of fish body carcass

The initial and final proximate composition of fish carcass in different treatments reflected the significance alteration in proximate composition. The initial and final mean proximate compositions of fish carcass are given in Table 2.

Table 2. The initial and final mean proximate composition of fish carcass (± S.E n=3)

Composition	Initial	Final composition in treatment				
		1	2	3	4	5
% Moisture	78.67±1.13	79.39±0.28	75.83±0.46	74.77±1.13	75.56±1.81	76.10±0.83
% protein	60.28±0.55	62.61^{d}±0.22	65.23^{c}±0.33	67.12^{a}±0.49	66.18^{b}±0.59	66.50^{b}±0.56
% Lipid	9.56±0.42	9.60^{d}±0.27	16.12^{a}±0.51	15.48^{b}±0.28	15.22^{b}±0.40	15.51^{b}±0.30
% Ash	17.51±0.62	21.55±0.60	15.45±0.37	16.66±0.58	16.81±0.67	19.26±0.36

** Figures in the same row having the same superscript are not significantly different ($p>0.05$)

Final carcass crude protein content of fish in different treatments ranged from 62.61 to 66.50% with means of 62.61%±0.22, 65.23%±0.33, 67.12%±0.49, 66.18%±0.59 and 66.50%±0.56 in T_1, T_2, T_3 T_4 and T_5 respectively. Carcass protein difference among the treatments were significant ($p<0.05$). The highest carcass protein content was in treatment 3 (DCP) and the lowest was in treatment 1(Non-feed). Final carcass protein content of fish fed with DCP, TSP and 16:20 supplemented diets were comparable. Carcass crude lipid content ranged from 9.60 to 16.12% and the lowest crude lipid content was in fish given no feed. Carcass lipid content differed significantly ($p<0.05$) among the treatments. Ash content in fish carcass ranged from 15.45 to 21.55 % in different treatment the highest ash content was in non fed fish. Comparison between initial and final carcass protein and lipid level in different treatment is shown in Fig. 1

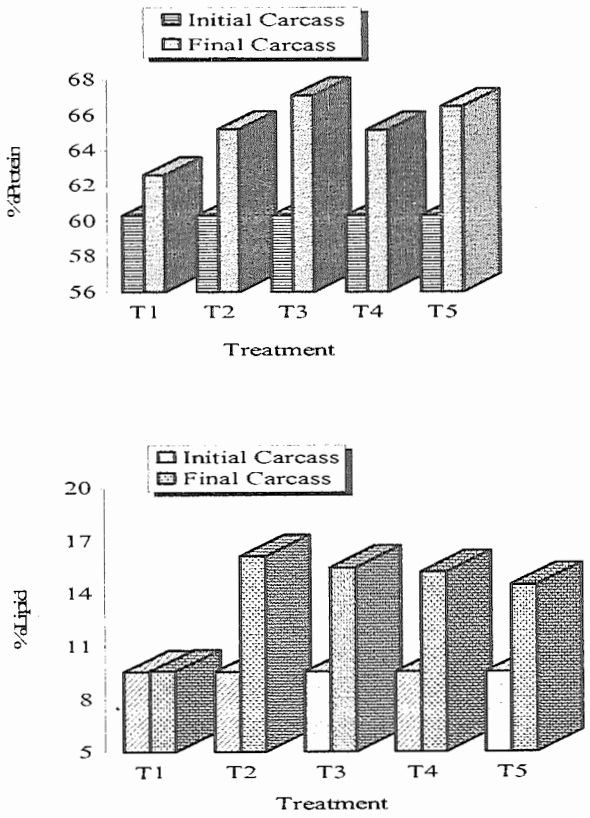

Fig. 1. Comparison between initial and final carcass protein and lipid level in different treatments

Phosphorous level in fish carcass and vertebrae bone

The mean value of phosphorous content in initial and final fish carcass and bone are summarized in Table 3.

Table 3. The initial and final mean phosphorous content of fish carcass and bone (± S.E)

	Initial	Final composition in treatment				
		1	2	3	4	5
Carcass						
% Ash	17.58±0.16	21.55±0.06	15.45±0.37	16.66±0.58	16.81±0.67	19.26±0.36
%Phosphorous	2.34±0.03	2.54^{b} ±0.06	2.69^{ab}±0.06	2.95^{a}±0.06	2.85^{ab}±0.16	2.81^{ab}±0.05
Bone						
% Ash	44.02±0.43	58.77±2.06	46.54±1.19	50.98±0.90	50.71±0.80	50.28±0.51
%Phosphorous	5.78±0.05	6.19^{c}±0.03	7.32^{b}±0.18	7.87^{a}±0.15	7.78^{a}±0.06	7.77^{a}±0.35

** Figures in the same row having the same superscript are not significantly different ($P<0.05$)

Carcass phosphorous content of fishes ranged from 2.54 % to 2.95% in different treatments. The highest phosphorous content was in carcass of fish fed with DCP supplemented diet and the lowest was in fish given no feed. Phosphorous content in vertebra bone of fishes ranged from 6.19% to 7.87 % and meal values of vertebra bone differed significantly ($p<0.05$) among the treatments. The highest phosphorous content was in carcass of fish fed DCP supplemented diet and lowest was in fish given no feed. Carcass phosphorous and vertebrae bone phosphorous content of fishes fed DCP, TSP and 16:20 fertilizer supplemented diet were comparable. Comparison between initial and final carcass and bone phosphorous are shown in Fig.2.

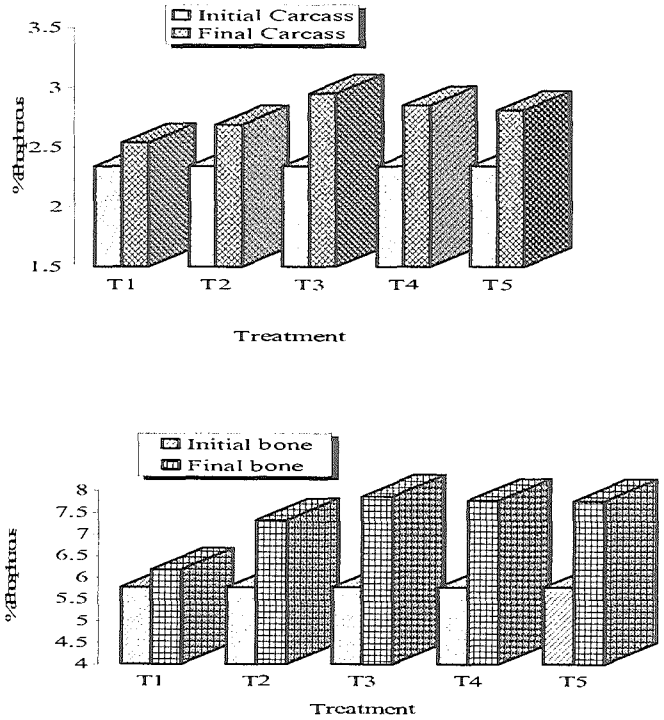

Fig. 2. Comparison between initial and final carcass and bone phosphorous level in different treatments

Water quality parameters

The water quality parameters analyzed at the start of the experiment and during the whole experimental period are summarized in Table 4. Water quality parameters in different ponds was almost uniform and within suitable range for fish culture.

Table 4. Mean value of water quality parameters during whole experimental period

Pond	DO (mg/l)	pH	Temp	NH_4-N (mg/l)	Alkalinity (mg/l)	TSS (mg/l)	Chlo-a (µg/l)
1	2.69 ± 0.3	7.64± 0.3	29.22± 0.45	0.62± 0.02	237± 5.28	43.91± 16.43	64.38± 0.75
2	2.59 ± 0.2	7.31± 0.3	29.16± 0.39	0.60± 0.02	230± 3.12	31.52± 13.23	55.20± 2.67
3	2.79 ± 0.3	7.39± 0.5	29.24± 0.39	0.72± 0.01	239± 13.23	43.46± 16.93	66.30±1.91

Discussion

In the present study Nile tilapia fed diets, supplemented with 3% di-calcium phosphate (DCP), 3% triple super phosphate (TSP), 7% inorganic fertilizer 16:20 as Phosphorus sources. The supplementation of phosphorus in diets reflected the significant alteration in proximate composition of final fish carcass of tilapia. The highest body protein level was in fish fed with DCP supplemented diet and the lowest body protein level was in phosphorus non-supplemented diet. Body protein and lipid content of fish in DCP, TSP and 16:20 supplemented diets were resembling. The highest lipid content was in phosphorus non-supplemented diet. Murakami (1970, cited in Lall 1979), Hung (1989) and Wee and Shu (1989) found that supplementation of phosphorus in the diet causes decrease in the lipid content of the muscle and viscera and increase in muscle protein of fishes. Phosphorus supplementation in diets influenced the carcass and bone ash content and phosphorus level of fishes. The lowest ash content and phosphorus level in body carcass and vertebrae bone was found in fishes fed with phosphorus non-supplemented diet. Higher and coinciding ash content and phosphorus level were found in carcass and bone of fish fed with DCP, TSP and 16:20 supplemented diets respectively. It indicates that there was a positive relationship between dietary phosphorus level and ash content in carcass and bone as well as phosphorus level in carcass and bone. Similar results also found by Robinson et al. (1987) and Haylor *et al.* (1988). Phosphorus supplementation also affected the phosphorus deposition in fish body carcass. The lowest phosphorus deposition was in fish fed with phosphorus non-supplemented diet. Higher and alike body phosphorus deposition observed in fish fed with DCP, TSP and 16:20 supplemented diets. It also indicates that phosphorus availability from DCP, TSP and 16:20 to tilapia were almost same.

Conclusions

In view of the above study it may be concluded that, phosphorus supplementation in the formulated fish feed play significant role on fish carcass quality and bone

phosphorous content. Body composition and bone phosphorous content of Nile tilapia fed with di-calcium phosphate (DCP), triple super phosphate (TSP) and a 16:20 grade fertilizer supplemented diets were comparable.

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