EFFECTS OF SUPPLEMENTAL SELENIUM IN DIETS OF *Heterobranchus longifilis*

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ABSTRACT

The effect of selenium supplementation into diets of *Heterobranchus longifilis* fingerlings was investigated using a completely randomized design with triplicates in a mini-flow through experimental system. 245 fingerlings (mean wt., 1.5±0.23g) were stocked and fed either normal (Basal) diet (Control group) or diets supplemented with 0.16, 0.24, 0.32 or 0.64 mg sodium selenite Kg^{-1} Selenium addition to the diets and fed to the fish caused a significant increase ($P<0.05$) in weight gain and fingerlings growth rate was accelerated by 18-22% compared to 17-18% in the control group. There were significant differences ($P<0.05$) in survival rate between treatments, indicating that diets are likely to be responsible for increased survival rate, observed in fish fed diets supplemented with 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} diet. Results indicated that a diet supplemented with, 0.24 and 0.32 mg of sodium selenite Kg^{-1} diet is important for growth and survival of *H. longifilis* fingerlings.

INTRODUCTION

The intensification of aquaculture development in Nigeria had called for developing highly productive sustainable diets for the common species of catfish cultured in Nigeria. The quantitative dietary requirement for trace elements depends upon the amounts required for growth and reproduction and that which is unavoidably lost by the animal through gut, kidney and by passive diffusion across the gills and generally body surface. Little effort has been made to quantify the relative importance of dietary sources of trace minerals in freshwater (Watanabe *et al.*, 1997). However, freshwater fish depends on an adequate supply of minerals as there is continuous effluent of ions from the body (Cowey and Sargent, 1979).

Selenium is required by the fish for normal growth and physiological function. Inadequacies are associated with low glutathione peroxidase (GSHPx) activity, slow growth and exudative diathesis in rainbow trout (Hilton *et al.*, 1980; Bell *et al.*, 1987). The dietary requirement for selenium (supplied as sodium selenite) for normal growth has been calculated to be 0.38 mg / kg for rainbow trout while levels of 13 mg/kg have been found to be toxic (Gatlin and Wilson, 1984; Lovell and Wang, 1997). Selenium supplementation is a necessity for fish species such as catfish and tilapia, fed grain, oilseed products and fish meal based diets which do not contain adequate amounts of selenium. Sodium selenite is the most common form of selenium used for supplementation to date. Selenium from these supplements is usually passively absorbed from the gut and then reduced in the liver where it is incorporated into cysteine to form selenocysteine. The biological availability of minerals from the diet is marked by the efficiency with which the body utilizes the dietary minerals. It varies depending on the feedstuffs and the form of the nutrient, nutrient interaction which may be synergistic or antigenic, physiological and pathological condition of the fish, waterborne mineral concentration and the species under consideration (Watanabe *et al.* 1997, Hilton 1989 and Steffens 1989). There is a dearth of information of trace mineral requirements of *H. longifilis*.This study was designed to evaluate the growth and feed utilization of *H. longifilis* fed diets supplemented with selenium.

MATERIALS AND METHODS

A Completely Randomized Design with three replicates of 15 *H. longifilis* fingerlings each was used in different levels of dietary $Na_2SeO_3.5H_2O$ (0.0, 0.16, 0.24, 0.32, and 0.64mgkg^{-1}) supplemented into a 42.5% crude protein basal diet. The basal diet comprised Clupeid fish meal 25%, Soybean meal 35%, Groundnut cake 14.40%, Maize bran 16.35%, oil 4%, starch 2%, Bone meal 1%, Premix 1%, methionine 0.5%, salt 0.25% and silica 0.5%. Proximate composition of the diet include crude protein 41.62%, Crude fat 12.7%, crude fibre 2.1%, ash 7.8%, NFE 27.91%. Five dry pelleted diets were formulated from a basal diet. The sodium selenite was first dissolved in water and mixed with the basal diets. 225 fingerlings (mean wt., 1.06±0.24g after acclimationwere fed 5% of body weight. Water temperature, pH, conductivity and dissolved oxygen were monitored during the experiment. 30 fingerlings were taken to determine the initial mineral composition at commencement of the study. Forth-night sampling was carried out for monitoring growth, health status and used for feed adjustments. At the end of the experiment, five fish were randomly taken from each replicate tank for

analyses. Growth performance parameters were determined according to Cho and Kaushik (1985). Blood samples were collected from the caudal vein using heparinized 27- gauge needles and tuberculin syringes (20 units/ml) for determination of hemoglobin (Hb) and total serum protein. Hemoglobin was determined using cyanomethemoglobin method by the total hemoglobin kit (Sigma Diagnostics, Sigma, St. Louis, MO). Data obtained were subjected to one way ANOVA and where significant difference were observed, the treatments were separated with Duncan's multiple range tests at 5% level of significance (Statistica for Windows, 1998).

RESULT AND DISCUSSIONS

During the experimental period, water temperature ranged from 26.7 to 30.3°C, DO from 4.7 to 6.2mgL^{-1}, pH from 6.1 to 8.2 and total ammonia from 0.02 to 0.04 mg L^{-1}. The water quality parameters were found to be within the acceptable range for fish growth (Stickney, 1979). The results of the experiment (Table 1), indicated that fish fed on diets supplemented with 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} diet, gained more weight than those fed control diet and diet 0.64 mg level ($P<0.05$). Numerically higher growth rate was obtained when fish fed on diet supplemented with 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} diet, although it was not significantly different ($P>0.05$) from that achieved by the fish fed on diet with 0.16 mg sodium selenite kg^{-1} (Table 1). Poorest growth was recorded for fish fed on diet supplemented with 0.64 mg sodium selenite kg^{-1} diet which was not significantly different ($P>0.05$) from the control. Differences in specific growth rate (SGR) were found to be significant ($P\leq0.05$) between control diets and those fed on 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} diet (Table 2). These results agree with the observations of Poston and Combs, (1979) and Hilton and Hodson (1983). There were significant ($P<0.05$) variation in feed intake in all treatments. The fish fed the control diet and diet with 0.64 showed lower feed intake than those recorded in fish fed on diet with 0.24 and 0.32 mg. It appeared that fish intake was affected by the addition of Sodium selenite to the diets and 0.24-0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} seemed to stimulate fish intake and growth. Optimum performance seems to be attained with 0.24 and 0.32 supplementation level beyond which a decline in general performance sets in. Similar observation was reported by Gatlin *et al.*, 1986. In the study of Gatlin *et al.*, (1986) levels above 0.13-0.15 mg kg^{-1} in the diet channel catfish had toxic effect, resulting to increased mortality.

Supplemental $Na_2SeO_3.5H_2O$ in the diets increased feed efficiency ratio (FER) so that weight gain produced per unit weight of feed consumed was higher for diets supplemented with $Na_2SeO_3.5H_2O$ than control diet. Significantly ($P\leq0.05$) higher value of 38.5% and 39.6% were recorded for fish fed on diets with 0.24 and 0.32 mg respectively compared with average value of 32.7% recorded for control diets. Feed conversion ratio (FCR) decreased progressively ($P<0.05$) with increasing dietary sodium selenite levels and reach minimum at diet with 0.32 then increased at diet with 0.64mg. Kayano et al. (1993) reported that, the production in fish culture is generally dependent on feed consumption.

Table 1 Mineral content in the basal diet for *H. longifilis*

	Dietary Levels Selenite (mg kg-^{1})				
Mineral	0.0	0.16	0.24	0.32	0.64
Ca	0.92	1.14	1.16	1.19	1.23
P	1.38	1.39	1.4	1.43	1.48
K	1.41	1.43	1.45	1.47	1.51
Mg	0.55	0.56	0.57	0.59	0.61
Na	0.40	0.41	0,43	0.46	0.49
Cu	4.62	4.65	4.71	4.76	4.83
Fe	160.	161.5	163.	167.	174.1
Se	47	3	8	5	2
Zn	0.04	0.08	0.12	0.20	0.36
Mn	19.5	19.6	19.8	20.2	20.5
	14.2	14.31	14.3	14.5	14.68
	7		7	1	

Ca, P, K, Mg and Na expressed as (%) and Cu, Fe, Se, Zn, and Mn as mgkg^{-1} dry matter.

Table 2: Effect of dietary selenium on *H. longifilis* after 8 weeks .

Parameters	Dietary Levels Selenite (mg kg^{-1}) 0.0	0.16	0.24	0.32	0.64
IBW (g)	7.5±0.3	7.5±0.25	7.5±0.31	7.4±0.12	7.6±0.2
FBW (g)	11.8±0.25^{c}	12.4±0.25^{b}	13.4±0.3^{a}	13.6±0.25^{a}	10.0±0.25^{d}
FI (gfish^{-1})	13.1±0.2^{b}	13.5±0.2^{b}	15.1±0.1^{a}	15.3±0.1^{a}	12.4±0.4^{c}
SGR (%day)	1.6±0.1^{b}	1.77±0.06^{b}	2.06±0.08^{a}	2.11±0.04^{a}	1.31±0.18^{c}
FCR (F/WG)	3.06±0.5^{b}	2.8±0.46^{a}	2.59±0.31^{a}	2.52±0.21^{a}	3.31±0.42^{b}
FER	32.7±0.6^{c}	35.7±0.6^{b}	38.7±0.5^{a}	39.6±0.2^{a}	27.1±2.9^{d}
PER	0.99±0.02^{b}	1.08±0.02^{b}	1.16±0.01^{a}	1.18±0.04^{a}	0.81±0.1^{c}
Hemoglobin (g %)	8.87±0.2^{ab}	8.97±0.2^{a}	9.2±0.1^{a}	9.3±0.1^{a}	8.5±0.4^{b}
TSP (%)	2.9±0.1^{bc}	3.0±0.1^{b}	3.3±0.2^{a}	2.7±0.1^{c}	2.7±0.1^{c}
Survival %	55.20±0.2^{d}	75.0±1.0^{c}	78.3±1.0^{b}	86.±0.5^{a}	57.8±0.6^{d}

a-e Means with different superscripts within row are significantly different (P≤0.05).
IBW: initial body weight; FBW: final body weight; SGR: specific growth rate; FCR: feed conversion ratio; PER: protein efficiency ratio. TPS=total serum protein

Similar to FER values, differences in PER values between dietary treatments were significant (P≤0.05) (Table 2), indicating that weight gain per unit of protein intake is different in all treatments. The differences in levels of $Na_2SeO_3.5H_2O$ supplement to diets are likely to be responsible for the increased feed efficiency ratio observed in fish fed diets supplemented with 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1}.

Hemoglobin content increased significantly (P≤0.05) with increasing dietary sodium selenite levels. Total serum protein increased with increasing sodium selenite levels and reach maximum at diet with 0.24 mg sodium selenite kg^{-1} with that significantly different from diet with 0.32 mg. The increasing effects on total serum protein might have been due to selenium availability and its interaction with cystein in protein synthesis and increased gluthathion peroxidase activity (Hilton *et al.*, 1980; Bell *et al.*, 1987). There were significant (P≤0.05) differences in survival among treatments (Table 2), indicating that diets are likely to be responsible for increased % survival observed in fish fed diets supplemented with 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1}. The experiment showed that supplementation of 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} had determinable effects on fish growth indicating that culture fish in intensified culture require more trace minerals.

From this study, supplementary selenium (0.64 mg kg^{-1} $Na_2SeO_3.5H_2O$ or 0.30 mgkg^{-1} selenium) incorporated into *H. longifilis* diets could be compensated by decreasing the feeding level and the growth rate. There was similar observation by Gatlin, *et al.*, (1986) for channel catfish; they reported that high levels of selenium (levels above 0.13-0.15 mg kg^{-1}) in the diet had toxic effect, resulting to increased mortality. There was a significant differences (P<0.05) on the whole body mineral composition after the feeding trial indicating that there is possibility of one mineral influencing the absorption and utilization of the others as selenium supplementation influenced the other minerals in the body of the fish (Table 3).

Table 3: Effect of dietary selenium on mineral composition of *H. longifilis*.

Minerals	Diets 0.0	0.16	0.24	0.32	0.64
Ca	4.54±0.04^{e}	5.04±0.03^{d}	5.37±0.04^{c}	5.64±0.04^{b}	6.03±0.02^{a}
P	2.19±0.07^{d}	2.29±0.06^{c}	2.41±0.05^{b}	2.57±0.04^{a}	2.57±0.05^{a}
K	1.12±0.02^{b}	1.13±0.04^{b}	1.14±0.06^{ab}	1.1±0.02^{a}	1.06±0.02^{c}
Mg	0.11±0.02^{d}	0.14±0.01^{b}	0.17±0.01^{a}	0.17±0.01^{a}	0.14±0.02^{c}
Na	0.63±0.02^{c}	0.67±0.01^{b}	0.7±0.02^{ab}	0.71±0.02^{a}	0.62±0.02^{c}
Cu	4.3±0.1^{d}	4.7±0.1^{c}	5.1±0.1^{b}	5.4±0.1^{a}	4.3±0.1^{d}
Fe	112.7±4.1^{c}	119.4±4.7^{bc}	123.3±5.3^{b}	128.4±4.8^{ab}	134.23±8.3^{a}
Se	1.04±0.03^{e}	1.13±0.02^{d}	1.23±0.02^{c}	1.29±0.02^{b}	1.43±0.02^{a}
Zn	104.4±1.01^{e}	114.3±1.1^{d}	128.6±1.76^{b}	138.7±2.2^{a}	124.3±0.75^{c}

a-e Means with different superscripts within same row are significantly different (P≤0.05). IBW: P, K, Ca, Na, and Mg expressed as % and Fe, Ma, Cu, Se and Zn as mg kg^{-1} of dry matter,

It might be concluded that the reduced growth performance of *H. longifilis* fed diets supplemented with 0.64 mg kg^{-1} $Na_2SeO_3.5H_2O$ or 0.30 mg kg^{-1} selenium might be due to the fact that it is compensated by decreasing the feed consumption and growth rate. The significantly better growth of fish fed diets supplemented with 0.24 and 0.32 mg $Na_2SeO_3.5H_2O$ kg^{-1} or 0.12 and 0.15 mg kg^{-1} selenium would be responsible for increase growth rate more than 18- 22% and feed intake by 12-18% leading to increased feed utilization.

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