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EFFECT OF HEAVY METAL POLLUTION ON GROWTH HORMONE (GH) LEVELS AND GROWTH RATE OF OREOCHROMIS NILOTICUS

BY

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ABSTRACT

The effect of different concentrations of heavy metals (Pb and Cd) on growth hormone (GH) levels and growth rate of Oreochromis Niloticus raised in glass aquaria are examined.

The GH levels and growth parameters (final gain in weight, daily gain in weight, % gain in weight and condition factor) showed decreased values with increasing heavy metal concentrations in comparison with the control (without heavy metal treatment). It was found that the concentrations of heavy metals in muscles of Oreochromis Niloticus varied directly with its concentrations in water.

INTRODUCTION

Pollution and its effects constitute one of man's greatest crimes against himself Pollution in the world has received considerable attention. In the recent years, it became a great problem with increasing the human activities. Heavy metals are among the pollutants which receive attention in various countries.

The concentrations and effects of heavy metals on fish biology and physiology in Egypt and in different parts of the world were previously mentioned by large number of investigators, among which are Djanmah and Grove (1970), Martin (1975), Ogu and Yang (1978), Hein et al. (1980), Dowidar et al. (1981), Eisler (1981), Bert (1982,1985), Talbot and Chegwidden (1982), Ajmal et al. (1985), Ghazaly et al. 1988), Saleh et al. (1985), El-Sharnouby et al. (1986), Ajmal and Khan (1988) Dowidar and El-Nady, (1987), Fouda (1987), Rifaat (1989), Abdel- Monem et al (1994), El-Deek et al. (1994), El-Shebly (1994, 1998), Abdel-Bakey et al. (1998) and Khallaf et al. (1998). Many physiological functions in fish, including GH, growth rate and osmoregulation are affected by environmental, and chemical stress such as temperature, salinity, pollution etc. (Piekering, 1981, 1990, 1993; Leloup-Hatey, 1988 and Auperin et al., 1997). The present study focuses on the effect of Pb and Cd on GH and growth rate of *Oreochromis Niloticus* and their accumulation in muscles. The aim of the present work is to establish a natural background about the effect of heavy metals

on GH levels, growth rate and accordingly on the total production of the national fish, O. niloticus.

MATERIALS AND METHODS

The present work was carried out at four glass aquaria (100L/ each) where O. niloticus fingerlings with an initial weight of 21.8 gm/fish and an initial length of 10.34 cm/fish were stocked at a rate of 10 fish/ aquarium.

Three concentrations of heavy metals (Pb and Cd) were used as follow: (0.1 mg Pb/l and 0.1 mg Cd/l for aquarium number 2, 0.5 mg Pb/l and 0.2 mg Cd/l for aquarium No 3 and 1.0 mg Pb/l and 0.4 mg Cd/l for aquarium No 4. The first aquarium (No. 1) was remained without treatment (control). Experiment was conducted for 80 days under controlled laboratory conditions. Water quality (temperature, pH, Oxygen and Alkalinity) were readjusted within the optimal values (22 – 25 °C for temp, 7.8 for pH, 8.5 mg/l for oxygen and 140 mg/l for alkalinity). Fish were fed an artificial diet of 25 % protein twice daily at a rate of 5 % of body weight.

The water was aerated continuously and filtered daily for removal of accumulating waste materials. Biweekly individual measurements for length and weight were carried for all fish stocked. All cultured fish were survived. At the end of experiment, blood was collected directly from the caudal artery of fish in glass tubes, centrifuged and serum is collected in Eppendorf tubes and frozen at –20 °C until GH analysis.

Heavy metals concentrations (Pb and Cd) were estimated in the muscles by using atomic absorption spectrophotometry (Perkin Elmer, M 2380) according to Allen et al. (1979). Heavy metal concentrations were expressed as mg/kg dry weight.

RESULTS

The results of the present study are summarized in Tables from 1 to 6 and figure 1. The average final weight (gm/fish), gain in weight (gm/fish), the daily gain in weight (gm/fish) and percentage gain in weight/fish decreased gradually with increasing heavy metal concentrations. Where the maximum growth levels was recorded in control (table 1). On the opposite side, the lowest growth rate levels were recorded in aquarium No 4 which received high concentrations of heavy metals (Table 4).

The condition factor (K) of the cultured fish also decreased with increasing heavy metal concentrations.

The concentrations of heavy metals (Pb and Cd) in O. niloticus muscles are given in table (5). The average concentrations of Pb in muscles ranged from a minimum of 0.073 mg/l in the control to a maximum of 0.195 mg/l in fish cultured in aquarium 4.

Table (1) : Growth in weight and length of *O. niloticus* cultured in glass aquaria without heavy metal treatment (control)

Items	Rate
Average initial weight (gm/fish)	*21.80*
Average final weight (gm/fish)	*79.00*
Average initial length (cm/fish)	*10.34*
Average final length (cm/fish)	*16.00*
Gain in weight (gm/fish)	*57.20*
Rearing period /day	*80.00*
Daily gain in weight (gm/fish)	*0.720*
% increment in weight /fish	*262.39*
Condition factor (k)	*1.930*

Table (2) : Growth in weight and length of *O. niloticus* treated with 0.1 mg Pb/l + 0.1 mg Cd/l in glass aquaria

Items	Rate
Average initial weight (gm/fish)	*21.80*
Average final weight (gm/fish)	*54.00*
Average initial length (cm/fish)	*10.34*
Average final length (cm/fish)	*15.00*
Gain in weight (gm/fish)	*32.20*
Rearing period /day	*80.00*
Daily gain in weight (gm/fish)	*0.400*
% increment in weight /fish	*147.71*
Condition factor (k)	*1.600*

Table (3) : Growth in weight and length of *O. niloticus* treated with 0.5 mg Pb/l + 0.2 mg Cd/l in glass aquarium

Items	Rate
Average initial weight (gm/fish)	*21.80*
Average final weight (gm/fish)	*49.00*
Average initial length (cm/fish)	*10.34*
Average final length (cm/fish)	*15.00*
Gain in weight (gm/fish)	*27.20*
Rearing period /day	*80.00*
Daily gain in weight (gm/fish)	*0.340*
% increment in weight /fish	*124.77*
Condition factor (k)	*1.450*

Table (4) : Growth in weight and length of *O. niloticus* treated with 1 mg Pb/l and 0.4 mg Cd/l in glass aquarium

Items	Rate
Average initial weight (gm/fish)	*21.80*
Average final weight (gm/fish)	*38.00*
Average initial length (cm/fish)	*10.34*
Average final length (cm/fish)	*14.00*
Gain in weight (gm/fish)	*16.20*
Rearing period /day	*80.00*
Daily gain in weight (gm/fish)	*0.200*
% increment in weight /fish	*74.31*
Condition factor (k)	*1.380*

Table (5) : Pb and Cd concentrations in *O. niloticus* muscles treated with different concentrations of Pb and Cd

Aquarium No.	*Pb dose mg/l*	*Pb conc. mg/kg*	*Cd dose mg/l*	*Cd conc. mg/kg*
1 (control)	--	*0.073*	--	*0.032*
2	*0.1*	*0.134*	*0.1*	*0.058*
3	*0.5*	*0.178*	*0.2*	*0.064*
4	*1*	*0.195*	*0.4*	*0.072*

Table (6) : Changes in serum concentrations of growth hormone (GH) in *O. niloticus* treated with different concentrations of lead (Pb) and cadmium (Cd) under laboratory conditions

Aquarium No.	*Lead and cadmium concentrations in water, mg/l*	*GH ng/ml*
1	*Control (without heavy metal treatment)*	*< 0.8*
2	*0.1 Pb + 0.1 Cd*	*< 0.5*
3	*0.5 Pb + 0.2 Cd*	*< 0.3*
4	*1 Pb + 0.4 Cd*	*< 0.1*

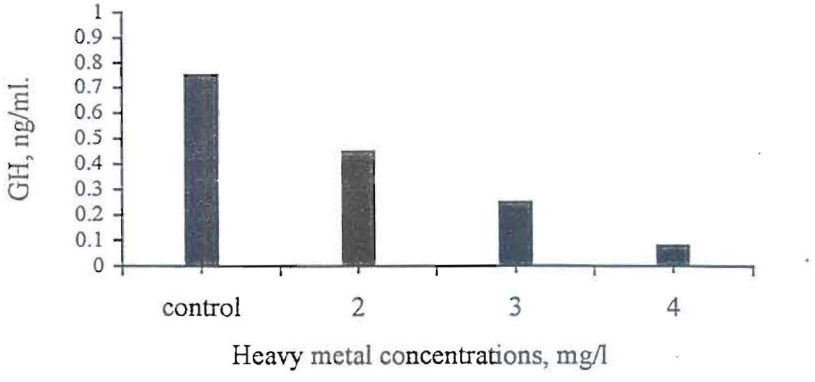

Fig. (1) Changes in serum concentrations of growth hormone (GH) in O. niloticus treated with different concentrations of lead (Pb) and cadmium (Cd) under laboratory conditions

Cadmium concentrations ranged from a minimum of 0.032 mg/l in the control fish to a maximum of 0.072 mg/l in muscles of fish reared in high concentrations of heavy metals (table 5).

Growth hormone (GH) levels in serum decreased with increasing heavy metal concentrations (table 6 and Fig. 1). The maximum levels of GH (< 0.8 ng/ml) was recorded in the control fish while the minimum levels (< 0.1 ng/ml) was recorded in fish treated with high concentrations of heavy metals (aquarium 4).

DISCUSSION

In the present study, the effect of heavy metal pollution on serum GH and growth rate of O. niloticus were reported. The growth was better in control aquarium (without heavy metal treatment) where total gain in weight, daily gain in weight and % gain in weight/ fish were higher than that in the aquaria treated with heavy metals.

The lowest condition factor (K) was recorded in aquarium (4) which receives high concentrations of heavy metals in comparison with control, which indicate he negative effect of heavy metal pollution on the degree of well-being of fish.

Heavy metals analysis were carried on O. niloticus muscles because muscles are of more concern to man than other tissues. The present results showed increasing concentration of heavy metals in muscles with its increasing in water. The present results agree with Portmann (1972), A jmal and Khan (1987), Cossa et al. (1992) and El-Shebly (1994 and 1998). They recorded a direct proportionality between the concentrations of heavy metals in water and their concentrations in aqua. : organisms.
Serum GH concentrations were studied as an indicator of the effect of heavy metal stress on growth.

The present study demonstrated decreased serum GH values with increasing heavy metal concentrations which indicate a high sensitivity of the somatotrop cell activity to stress. A similar observations recorded by Pickering et al. (1991) and Auperin et al. (1997) where they recorded a significant decrease in GH levels in rainbow trout and O. niloticus serum after stress.

Also, Wedemeyer (1970) reported that physical and chemical parameters might influence hormonal plasma concentrations.
Finally it is concluded that an increase of heavy metal can cause a stress and decrease in growth of O. niloticus.

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