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EFFECT OF EGYPTIAN COPPER WORKS EFFLUENT ON TILAPIA ZILLII GERV.

BY

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ABSTRACT

*The effects of Egyptian Copper Works Effluent on **Tilapia zillii** Gerv. have been investigated. This waste water was characterized by high concentrations of heavy metals and solids besides low pH and dissolved oxygen. The results of acute toxicity tests showed that the 96-hr TL_m was 0.58% (%vol/vol), which means that the effluent of this company is highly toxic. On the other hand, fish exposed to sublethal concentration of Copper Works Effluent (0.25%) for 14 days exhibited a depression in feeding rate and the condition of fish flesh while blood glucose levels and hemoglobin content are increased. It is concluded that, the waste water of Egyptian Copper Works does not comply with the standard emission of the Egyptian law for the discharge of industrial wastes into drainage canal.*

INTRODUCTION

During the last decade, concentration of industrial activity in Alexandria has led to disequilibrium in the ecological balance and significant deterioration in the quality of the environment. The impact of industrial pollution in Alexandria is evident in the decrease of fish catch from water resources, deterioration of valuable recreational areas and development of offensive odours and floating layers of scum which create unfavorable effects on the beauty of the city.

Although some of industrial waste problems are readily corrected, yet the majority are irreversible and consequences may be so great as to detect the purpose of industrial developments (Hamza *et al.*, 1985).

Egyptian Copper Works are located in Haggar El-Newatya. This company comprises two basic production lines, one for variety of steel product and the other for copper and aluminum production (non-ferrous metals). At present, the waste waters of this company are collected in public sewers and discharged to Lake Mariut without treatment. Feddii (1967); Mourad (1984) demonstrated that the waste water of Copper Works have high concentrations of trace metals which can cause adverse effects on the aquatic life.

The aim of this study is to assess the following:

1- The physio-chemical characteristics of Egyptian Copper Works effluent (non-ferrous metals).
2- The effect of raw effluent on fish toxicity.
3- The influence of sublethal concentration of raw effluent on some physiological parameters of ***Tilapia zillii*** Gerv.

MATERIALS AND METHODS

Representative large samples from Egyptian Copper Works Effluent (non-ferrous metals) were brought to the laboratory in plastic containers. Determination of the physico-chemical characteristics of the waste water were carried out according to the Standard Methods for the Examination of Water and Waste water (1975).

Specimens of ***Tilapia zillii*** Gerv. obtained from El-Mex Fish-farm, weighing 27.9 ±11.7 g and measuring 12.0 ±1.6 cm, were brought to the laboratory and acclimated under appropriate experimental conditions for two weeks. The fish were fed by commercial fish food. Acute toxicity tests were carried out according to the Standard Methods for the Examination of Water and Waste water (1975).

Growth rate as expressed by the condition factor of fish flesh (K_f) was calculated according to this formula:

$$K_f = \frac{\text{Gutted weight of the fish in gram}}{(\text{Total length in centimeter})^3} \times 100$$

Blood was obtained directly from the caudal artery into heparinized capillary tubes for hematological studies. Blood glucose levels was measured using Diascan-s blood glucose monitoring meter (HDI) and Diascan blood glucose monitoring test strips. Hemoglobin content was measured using Sahli haemometer.

Statistical test "t-test" was made to evaluate the significant changes caused by the effluent of Egyptian Copper Works.

RESULTS AND DISCUSSION

The physico-chemical characteristics of Egyptian Copper Works Effluent (non-ferrous metals) are shown in Table (1). This waste water was characterized by relatively high acidity (5.2), variable colour density (1600 PCS), turbidity (300 NTU) as well as high concentrations of heavy metals especially copper and magnesium (6675; 2115 ug/l, respectively). Moreover, dissolved oxygen was very low (3.6 mg/l). It is evident that, the waste waters generated at this company when analyzed was not acceptable by all measures to specifications given to the law governing the discharge of industrial wastes to drainage canal.

The results of acute toxicity tests showed that the median tolerance limit (96-hr TL_m) value for ***Tilapia zillii*** Gerv. exposed to serial dilutions of Copper Works Effluent was 0.58% (%vol/vol) which means that this waste water is highly toxic. The toxicity of this waste water is attributed mainly to combination of several synergistic factors e.g. high concentration of heavy metals and solids besides low pH and dissolved oxygen. It is well known that high accumulation of heavy metals on the fish causes its asphyxiation and death (Keckes and Miettiment, 1972). Moreover, the toxicity of heavy metals increase with a corresponding increase in acidity by either affecting metals speciation or

the biological sensitivity at the cell surface (Campbell and Stokes, 1985). Also, high concentrations of solids found in this waste water may cause gills fouling (Saleh, 1982) which contributed to asphyxia and death (Lloyd, 1960). The obtained results are in disagreement with Mourad (1984) who found that the 96-hr TL_m for ***Tilapia zillii*** Gerv. exposed to Copper Works Effluent was 100%. This may be attributed to the distinct differences in the physico-chemical characteristics of waste water.

On the other hand, the initial response of fish exposed to sublethal concentration (0.25%) of Copper Works Effluent was the cessation of feeding. Appetite suppression have been observed after exposure of fishes to different types of pollutants. Drummong ***et al.***, (1973) observed that brook trout, *Salvelinus fontinalis* initially ceased feeding when exposed to copper. Similarly, the appetite of ***Tilapia zillii*** Gerv. was depressed after exposure to domestic waste water (Mourad, 1994). However, within about 5-7 days, fish had resumed feeding but at a longer rate in comparison with the control. The gradual return of appetite suggests that fish are capable of adapting to this waste water.

As shown in Table (2), fish exposed to sublethal concentration of Copper Works Effluent for 14 days exhibited a significant ($P<0.01$) depression in the growth rate as expressed by the condition of fish flesh from 1.527 to 1.384. These results are in accordance with Mount and Stephen (1969); McKim and Benoit (1971) who showed growth retardation of fish exposed to copper. The reduction of growth was possibly the result of elevated metabolic rate and hence energy expenditure by the fish which was not completely satisfied by the subexcess rations being fed (Lett ***et al.***, 1976).

In this study a significant ($P<0.01$) hyperglycemia was developed after exposure of fish to Copper Works Effluent (Table 2). For example, fish control had mean blood glucose levels of 70.7 mg/100ml while fish-treated exhibited an increase in the levels of blood glucose to 154.9 mg/100ml. This means that fish had subjected to some sort of hyper toxic stress. It is well known that stressful stimuli elicit rapid secretion of both glucocorticoids (Wedemeyer, 1969) and catacholamines (Nakano and Tomlinson, 1967) from the adrenal tissues of fish and both of these hormones produced a rapid hyperglycemia (Oguri and Nace, 1966). The obtained results are in agreement with Dange

Table (1): The physico-chemical characteristics of Egyptian Copper Works Effluent (non-ferrous metals).

Parameter	*Unit*	*Mean*
Temperature	°C	22
pH		5.2
Turbidity	NTU	300
Colour	PCS	1600
Total solids	mg/l	1620
Dissolved oxygen	mg/l	3.6
Oil and grease	mg/l	130
Copper	µg/l	6675
Magnesium	µg/l	2115
Zinc	µg/l	495
Lead	µg/l	445
Iron	µg/l	338
Nickel	µg/l	225
Manganese	µg/l	158
Cadmium	µg/l	29

Table (2): Changes in blood glucose levels, hemoglobin content and fish condition of ***Tilapia zillii*** Gerv. exposed to sublethal concentration of Copper Works Effluent.

Parameter	*Control*	*Treated*	*% changes*
Glucose (mg/100ml)	70.7 ±32.0	154.9 ±103.6 *	119.1
Hemoglobin (%)	46.1 ±8.7	57.0 ±12.0 *	23.6
Fish condition (K_f)	1.527 ±0.1	1.384 ±0.1 *	-9.4

* Significant differences ($P<0.01$).

(1986); Benson ***et al.***, (1987) who recorded an increase in blood glucose levels after exposure to heavy metals.

A significant ($P<0.01$) increase in the level of hemoglobin content from 46.1% to 57.0% was also observed after exposure of fish to Copper Works Effluent which may be attributed to gill damage or increased demand for oxygen by certain tissues (Andersson ***et al.***, 1988). These results are in agreement with McKim ***et al.***, (1970) whofound a significant increases in the level of hemoglobin content after exposure of fish to different concentrations of copper.

From the above results, it has become clear that the effluent of Egyptian Copper Works is highly toxic and unacceptable for discharge to drainage water canals.

The following points are recommended as adequate means to reduce the existing pollution problem from Egyptian Copper Works Effluent :

1- The final effluent should be subjected to pH adjustment.
2- Treatment of waste water by activated carbon or activated clay to reduce the high concentrations of heavy metals.
3- Reduce the wastage of water and materials through recirculation and recovery systems.

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