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TOXICITY OF MERCURY TO MUGIL CAPITO FRYS IN PRESENCE OF EDTA AND COPPER SULPHATE

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ABSTRACT

Some experiments were undertaken to study the effect of EDTA and $CuSO_4$ on the toxicity of mercury to **Mugil capito** fries of a length ranging between 3-5 cm. The lethal doses of $HgCl_2$, $CuSO_2$ + $HgCl_2$ + $CUSO_4$, $HgCl_2$ + EDTA and $HGCl_2$ + $CuSO_4$ + EDTA for the **Mugil capito** fries are as follows :

24 hr LC_{50} is 0.64 ppm $HgCl_2$
96 hr LC_{50} is 2.00 ppm $CuSO_4$
120hr LC_{50} is 0.64 ppm $HgCl_2$ + 2.0 ppm $CuSO_2$
72 hr LC_{50} is 0.64 ppm $HgCl_2$ + 2.0 ppm EDTA and
96 hr LC_{50} is 0.64 ppm $HgCl_2$ + 2.0 ppm EDTA + 2.0 ppm $CuSO_4$.

The effect of $CuSO_4$ and EDTA on the acute lethal toxicity of the fries is clearly obvious. The presence of $CuSO_4$ was found to render the toxicity of mercury (LC_{50}) from 24 hr to 120 hr, while EDTA rendered it from 24 hr to 72 hr.

INTRODUCTION

The deleterious effect of mercury compounds on the environment was first noted in Sweden, where the effluent from paper mills contained mercury. The mercury released to the environment as metal (e.g. by loss from electrolytic cells used for NaOH and Cl_2) production which was recorded in Alexandria waters by El-Sayed and Halim (1978) or in compounds (such as mercury seed dressings or fungicides) is converted to CH_3Hg^3 by biological methylation. It is also known as a catalytic poison and substance having a detrimental effect and influence on almost other elements. As almost heavy metals, particularly the toxic ones have a more or less inhibitory effect on the growth, metabolism and the rate of survival of the aquatic organisms, it is of importance to study such effect of one of these toxic metals, especially that of unknown biological function.

Most studies of heavy metals effect on the aquatic organisms relate to experiments where single element was applied. However in natural environments several metals of different compounds are present together in different concentrations. So to obtain an approximate picture of the potential impact of the elements from the surrounding habitats, it is preferable to use a group of elements or compounds.

On this basis mercury was selected as it is the most toxic metal to all living organisms, even at lower concentrations, and probably has no chemical or biological benefit to living things.

on the other hand fish are frequently used as monitoring, since the are the most quit control for the state of pollution in the aquatic environment, and from the point of view of protecting man's health or his food resources rather than degradation on the environment. Also, many fish species are eminently suitable as test organisms because of their size availability and t generation time.

EXPFRIMENTS

All experiments were done using bioassay methods. Static bioassay was adopted due to its convenience (Chapman and Stevens, 1978 and Holcombe and Andrew, 1978). Short term test was carried out with **Mugil capito** frys of about 3-5 cm lengths. Fish used for these tests were brought alive from some professional fishermen in Alexandria. The water used for tests was taken from the natural environment, in nearly clean water 6 km away from the coast.

Aeration was done using small air pumps, polyethylene tubing was used for aeration. No pumice stones were used to overcome adsorption of mercury on them. Aquaria used were all glass made. Fish used were all starved.

The containers were washed in diluted HNO_3, rinsed several times with water and soaked for one week in water which is frequently renewed so that they may release the soluble substances which could be toxic.

Temerature recorded daily, light was 12 hours day/night cycle. Pollutant solutions were prepared in advance, so that the required quantities were added to the aquaria to obtain the desired concentrations. Duration of tests was 120 hours without renewal of test medium. Observations after 24, 48, 72, 96 and 120 hourse were recorded. Duplicate tankes were used for each concentration. Fish fries were kept in a controlled tank for about one week to acclimatize with the experimental conditions. The test solutions were added to the aquaria 48 hours before adding the fries, and the concentrations were checked up daily by atomic absorption spectrophotometer until a constant concentration. A cold vapour system was used for mercury measurements. The solutions were prepared according to that in Table 1.

Table 1
Preparations of the different solutions used.

Aquarium No	No. of fish	Solutions
1	10	2.0 ppm $HgCl_2$
2	10	2.0 ppm $CuSO_4$
3	10	2.0 ppm $HgCl_2$ + 2.0 ppm $CuSO_4$
4	10	2.0 ppm $HgCl_2$ + 2.0 ppm EDTA
5	10	$HgCl_2$ + $CuSO_4$ + EDTA

RESULTS AND DISCUSSION

The physical properties of water (aquarium water) are shown below:

PH	7 ± 0.5
Temp.	$18.0 \pm 0.6^{o}C$
S ‰.	30.0 ± 1.0

The present results show that there was certain accumulation of mercury in the fish body. This is confirmed more from the corresponding decrease in mercury concentration with time in the aquarium water from 2 ppm to about 0.[illegible]4 [illegible] (Table 2 and Fig. 1).

Table 2
Observed variations in concentration of Hg and Cu.

Time (hr)	Hg (ppm)	Cu (ppm)
0	2.00	2.00
24	1.20	1.90
40	0.80	1.90
57	0.64	1.95
72	0.66	1.80
96	0.64	1.90

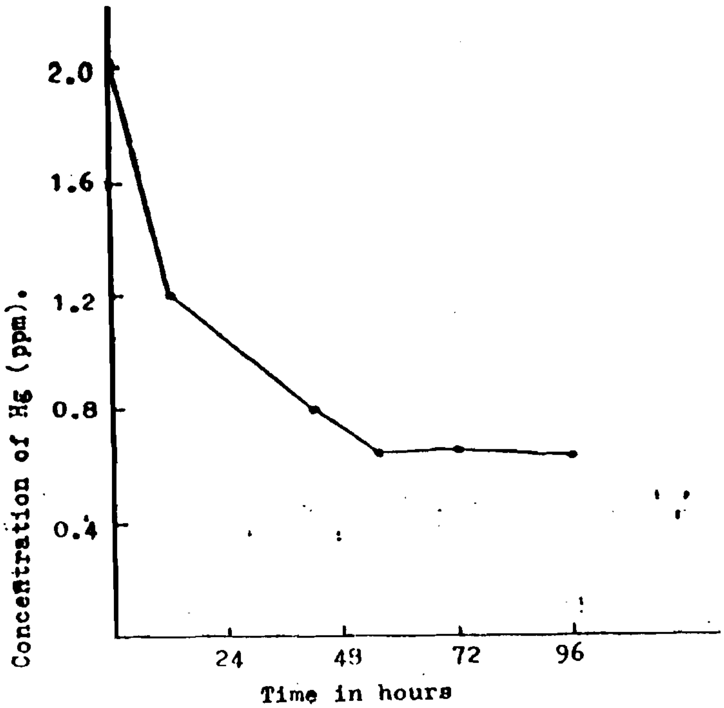

FIG. 1
Variations in mercury concentrations with time

After the addition of fish, mercury concentration in the aquarium decreases again. This decrease is mainly accumulated or fixed by fish.

Rhodes (1972) recorded that 90% of mercury is fixed by organisms. The effect of $CuSO_4$ and EDTA on the LC_{50} of mercury on Mugil capito fries is clearly obvious as shown in Table 3.

This experiment illustrates how the addition or presence of chelating agents such as EDTA and $CuSO_4$ suspend the inhibiting effect of mercury, which increases in the presence of $CuSO_4$.

The results obtained proved that EDTA acts as a strong synthetic chelator (Table 3). $CuSO_4$ also proved to be of great influence on the toxicity of mercury. Copper is essential to all living organisms; constituent of redox enzymes and O_2 transport pigments. At the same time, it is very toxic to most plants; highly toxic to invertbrates. On

Table 3
Effect of the addition of $CuSO_4$ and EDTA on the LC_{50} of mercury on *Mugil capito* fries.

Solution	LC_{50}
0.64 ppm $HgCl_2$	24
2.0 ppm $CuSO_4$	96
$HgCl_2$ + $CuSO_4$	120
$HgCl_2$ + EDTA	72
$HgCl_2$ + $CuSO_4$ + EDTA	96

incorporation or reaction with other metals it forms a complex or ligand (as it is a transition element) as with the other metal (Hg) which decreases its concentration as a free metal and so decreases its toxicity. Sunda and Guillard (1976) have believed that the free cupric ion is the most toxic of the different copper species which exist in the aquatic environment.

The toxicity of Hg in relation to copper sulphate or copper ion and EDTA has been investigated by using the LC_{50} as a biotest. It is of interest to note that, during the experiment the activity of fish decreases gradually and it became pall, dark in colour and defattened. So, we may conclude that, toxic elements altered swimming behaviour and cause death of the fish, as also found by Toledo and Delavechia (1983).

The addition of $CuSO_4$ to $HgCl_2$ renders the LC_{50} from 24 hr to 120 hr while EDTA renders it from 24 hr to 72 hr (Table 4). One of the reasons is the formation of the complex of copper-mercury compounds which reduce the toxicity of mercury. Also the high values of the formation constant of EDTA with both Hg and Cu which are 6.3×10^{21} and 603×10^{18} respectively. This shows an increase in the metal as EDTA complex concentration due to the high increase in EDTA concentration, and this may reduce their toxicity function. So the 96 hr LC_{50} for $CuSO_4$ which was 2.0 ppm is the same as that found with addition of $HgCl_2$ and EDTA to $CuSO_4$ solution. This may indicate that Hg compounds are more toxic than copper compounds. Toledo and Delavechia (1983) recorded 900 hr LC_{50} of 0.626 ppm Cu^{++} for *G. brasiliensis*. Sastry and Agrawal (1979) have found that LC_{50} for the teleost fish, *Channa punctatus* after 96 hr exposure is 1.8 ppm $HgCl_2$. They also found that treatment for 96 hr resulted in more marked inhibition than treatment for 30 hr. Finally, all evidences obtained in these experiments have lead to the conclusion that differential uptake of Hg is conditional on many factors, such as Hg concentration in the ecosystem and the presence of chelating

Table 4
Lethal doses of different solutions to Mugil capito fries.

Aquarium 1 (0.64 ppm mercury				Aquarium 2 (2.0 ppm $CuSO_4$			
Time in hours	Conc. in water ppm	No. of dead fish	% of mortality	Time in hours	Conc. in water ppm	No. of dead fish	% of mortality
0	0.66	0	0	0	2.00	0	0
24	0.64	5	50	24	1.80	2	20
48	0.60	6	60	8	1.62	3	30
96	0.62	8	80	96	1.44	5	50
120	0.59	10	100	120	1.20	7	70

Aquarium 3 ($HgCl_2$ + $CuSO_4$)			Aquarium 4 ($HgCl_2$ + EDTA)		
Time in hours	No. of dead fish	% of mortality	Time in hours	No. of dead fish	% of mo ality
0	0	0	0	0	0
24	3	30	24	2	20
48	4	40	48	3	30
96	4	40	72	5	50
120	5	50	96	7	70
-	-	-	120	7	70

Aquarium 5 ($HgCl_2$ + $CuSO_4$ + EDTA)

Time in hours	No. of dead fish	% of mortality
0	0	0
24	2	20
48	4	40
96	5	50
120	7	70

agents or other compounds. Naturally, sea water contains a great deal of chemical compounds and natural substances which may act as inhibitory agents againt toxicity. The presence of mercury resistant bacteria has been shown to convert Hg^{++} and other Hg compounds into the less toxic forms. The use of bacterial bioassay methods can provide semiquantitative data on metal complexing capacity that are probably the most relevant, in terms of metal toxicity. Davey et al. (1973) measured the effect of copper additions on the growth of Thalassionsira pseudonona to determine the complexing capacity of artificial sea water to which synthetic chelators such as EDTA were added.

CONCLUSION

All these data combined allow us to conclude that natural chelating agents present in the aquatic environment may reduce greatly the toxic effect of many metals to living organisms.

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