BIO-ACCUMULATION OF COPPER AND LEAD IN DIFFERENT ORGANS OF GOLD FISH *CARASSIUS AURATUS* AND THEIR EFFECT AMMONIAON BLOOD

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**SUMMARY**

The study was conducted on gold fish *carassius auratus* to show:
1. effect of different concentration of copper (2 and 3 mg/L) and lead (25 and 35 mg/L) on accumulation of these metals in different organs (liver, gut, kidney and muscles) exposed for 96 hours. Lead has a great ability to accumulate in tissue more than copper. The highest

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concentration of both metals was noted in liver and it was followed by gut, kidney and muscles.

2. Effect of the above metals concentration on the levels of blood ammonia, for two time intervals (48 and 96 hours) were studies also. There were proportional relationship between metals concentration the levels of ammonia in the blood. Ammonia concentration were affected by the presence of copper more than lead.

**Introduction**

Heavy metals were naturally found, in minute concentration, in most aquatic ecosystems, unless the human activities had a negative role in raising their concentrations (McDonald et al., 1989).

Fishes and other aquatic organisms may absorb these metals, or their soluble form, either directly through gills and intestine or indirectly via food chain, ultimately affecting individual survival and reproduction (Helfman et al., 1997).

Copper is one transitional metals, which are required in low concentrations in building many biological and contribute molecules (Clark, 1997). However, high concentration of cooper in the environment may cause several problem to the aquatic life (Helfman et al., 1997). On the other hand, lead is among the metalloids, which are not generally required for metabolic activities and are toxic to the cell at quite low concentrations (Clark, 1997).

Several studies dealing with the effect of copper and lead on accumulation, and other physiological aspects were locally performed on some cyprinids, such as (Barbus belayew) (Khalaf et al., 1986), Cyprinom marcrostomus (Khaleel, 1988), Garra rufa (Dawood, 1988) and Cyprinus carpio (Abdullah & Ahmed, 1998 and Al-Ali, 1999).

The study of metals accumulation in fishes is of great importance as it provides an indication to detect the level of pollution in a given environment and also to assign harmful effects on public health. Therefore, the present study was designed to shed some light on
copper and lead accumulation in different organs of *Carassius auratus* and their effects on ammonia concentration in the blood.

**MATERIALS AND METHODS**

Gold fish *Carassius auratus* (13+2cm) were collected from local waters, Garmat Ali canal, during January and February, 1999 by using cast net. Fish were acclimated to laboratory condition for one week in well aerated water. The physical and chemical characteristics of water were recorded (Temperature=17.9+0.8 °C, pH=7.8+0.3, Salinity=1.1+0.1%, Dissolved Oxygen=8.8+0.2 mg/L and Hardness=780+8.5 mg CaCO3/L). Fish administered commercial diet containing 23% protein.

Stock solution (1g/L) of copper and lead were prepared by dissolve 3.9294 gm of CuSO4.5H2O and 1.8308 gm of CH3COO in one liter of D.W. respectively. Stock were used to prepare two concentration of copper (2&3 mg/L) and lead (25&35 mg/L) with 2 replicates (Total No.=12 fish) for each concentration in addition to control group. Experimental fish were exposed to above concentration for 96 hours. Kidney, liver, gut and a piece of muscle were removed and dried in oven at 105°C for 24 hours. The dried tissues were ground by using pottery mortar. A mixture of perchloric acid (HClO4) and nitric acid (HNO3) was used to extract the metals. Metals concentration were measured, on dry weight basis, by flame absorption spectrophotometer along with standard solutions (ROPME, 1983).

Blood samples which were represented in two time interval (48&96h.) and two different treatments for Cu & Pb beside control treatment were collected from caudal vein or artery-after cutting the caudal peduncal –by using heprinized capillary tubes. Blood ammonia was measured according to Ravindranaths (1981).

Data were analysed statistically according to analysis of variance by using Minitab program. The significance of differences means was tested by using revised least significant differences (R.L.S.D.) (Al-Rawi & Khalafallah, 1980).

**RESULTS & DISCUSSION**

**Bio-accumulation of Cu and Pb in Different Organs**

The study revealed that both metals (Cu & Pb) and their bio-accumulation in different organs were directly correlated. In general, lead has a great chance to accumulate in tissues (Mean=33.075 mg/g) as compared to copper (Mean=19.517 mg/g) (Table 1&2). Clark (1997) found that flounder *Platichthys flesus* feeding largely on polychaete in polluted area was able
to limit the assimilation of copper in gut and do not acquire an increased body burden of the metal, although there is some evidence of liver damage in flounders exposed to high levels of metals.

Table (1) reveals that the highest value of copper bio-accumulation (54.6 mg/g) was recorded in liver during the second treatment with significant differences (P < 0.01), followed by gut (33.75 mg/g), kidney (32.4 mg/g) and muscles (9.3 mg/g). Whereas, copper accumulation in muscles and kidney was not detected in control treatment. However, it was (2.5 mg/g) in liver and (1.8 mg/g) in gut.

Table (2) shows a significant difference (P < 0.01) in lead accumulation; it was (78.5 mg/g) in gut and (75.9 mg/g) in liver for the second treatment, followed by kidney (95.9 mg/g) and muscles (23.2 mg/g), while the differences were insignificant in control treatment.

Liver’s ability to accumulate metals is attributable to its role in detoxifying and metabolizing these poisonous substances, through production of metallothioneins (Chaffai et al., 1995 & 1997). Metallothioneins are low molecular weight proteins that form a complex with metals, so they cannot be involved in chemical processes which are the source of their toxicity (Clark, 1997). Therefore, information about the levels and activities of these types of enzymes can provide information about the environment in which fishes live (Helfman et al., 1997). However, fishes in areas with contaminated sediments may show a high incidence of liver tumors, irregular nuclei and necrotic cells, and these abnormalities may subsequently affect other physiological function due to the importance of liver in energy storage and metabolism, contaminant detoxification and egg yolk production in females (Helfman et al., 1997).

The increment of metals accumulation in gut can be interpreted either by their ability to pass through gut membrane by diffusion, or through competing on sites of active transport for calcium and sodium (Handy, 1996).

The efficiency of freshwater teleosts kidney in producing a fairly large volume of diluted urine as a result of constant influx of water and also its ability in reabsorbing sodium and chloride during blood filtration can lead to an increase of metals accumulation in its tissues due to the binding of these metals with metallothioneins (Fargg et al., 1995 & Helfman et al., 1997).

On the other hand, the low concentration of accumulated metals in muscle for all treatments may be attributed to their inactive metabolized ability in respect with detoxification as compared to liver and kidney. This result agrees with (Clark, 1997) who pointed out that the predator marlin (Makaira indica), which is at top of a food chain and caught from contaminated area, was containing low concentrations of copper in
muscles (0.4 ppm, wet weight) as compared to liver (4.6 ppm, wet weight).

In general, our results agree with several studies which deal with different fish species that were exposed to different concentration of copper and lead (Khaleel, 1988; Dawood, 1988; Villegas-Navaro & Villerreal-Trevino, 1989; Abdullah & Ahmed, 1998; and Al-Ali, 1999).

Effect of Cu & Pb on Blood Ammonia Concentration

In general, blood ammonia levels increased in blood of fish exposed to different concentrations of copper and lead in comparison with control group (Table, 3). This increment had a proportionally correlated with prolonged time of exposure. However, the highest concentration of blood ammonia were measured in fish exposed for both copper concentrations in the second exposure time (96 h.), while those exposed to lead have the highest concentrations at second treatment after 96 hours with significant differences (P<0.05).

The prime source of ammonia is the deamination of amino acid and breakdown of the nucleotides; and some of ammonia is converted to urea, these reactions have taken place in liver (Love, 1980). Ammonia is a highly toxic compound for animals, and fish is able to get rid of it by removing the main quantity of ammonia rapidly and continuously through the gills, while minor quantity is excreted by kidney (Schmidt-Nielsen, 1997). There are two ways for ammonia elimination, either by diffuse out passively or through exchange system, sodium molecule enters the gills in exchange with ammonia molecule (Love, 1980). Finally, the sensitivity of gills to various environmental stressors, such as metals, may related to excess mucus production and thickening at the gills epithelium. This may interfere and affect their function through inhibiting the mechanism of ammonia removal and this may lead to increase its concentration and toxicity in the blood (Hinton & Lauren, 1990).

Table (3) shows that the concentration of blood ammonia was affected by the presence of copper more than that of lead, and this was noted clearly through variation in general mean (0.41 and 0.38 mg% for copper and lead respectively) during second time of exposure, after excluding the effect of treatment. Clark (1997) indicated that despite the existence of anumber of detoxifying and storage systems for copper, it is the most toxic metal after mercury and silver, to a wide spectrum of aquatic life. It seems that lethal concentration of lead on C. aurtus were strongly connected with water quality which were varied from 6.6 mg/L in acidic soft water to 110 mg/L in alkaline hard water (Katz, 1975).
REFERENCES


الخلاصة:

أظهرت الدراسة المنجزة على الأسماك الذهبية *Carassius auratus*:

1- تأثير التركيز المختلفة من النحاس (0.1 ملغم/لتر) والرصاص (0.25 و 0.3 ملغم/لتر) على تركيم هذه العناصر في الأعضاء المختلفة (الكبد، القناة الهضمية والكلية والعضلات) المعرضة لمدة 96 ساعة. إن الرصاص قدرة كبيرة على التركيم في الأنسجة أكثر من النحاس. وقد أظهر الكبد أعلى تركيز حيوي لكلا العناصرين تلي القناة الهضمية والكلية والعضلات.

2- تأثير تركيز العناصر علاج على مستوى الأمونيا الدم ولفترتين زمنيتين (48 و 96 ساعة). وتبين أن هناك علاقة طردية بين تركيز تلك العناصر ومستويات الأمونيا في الدم. إن تركيز الأمونيا تتأثر بوجود النحاس أكثر من الرصاص.

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