Histological changes induced by Heavy Metals in fishes at Red Sea- Jazan –KSA

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Abstract: Fish living in polluted waters tend to accumulate heavy metals in their tissues. Generally, the distribution of heavy metals (Pb, Cu, Zn, Fe, Se and Cd) in the surface and bottom water layers, as well as their accumulation in some commercial fish species (*Scomberomorus commerson*) was determined in the red sea of Jazan. Samples of liver and muscle were used for histopathological studies. Histopathological examination of the liver revealed hepatocytes vacuolation, cellular swelling, nuclear degeneration and congestion of blood vessels. While changes of muscles on the form of degeneration of muscle fibers and hemorrhage. Therefore, the problem of metal pollution is considered among the most serious once that faces mankind in the twenty-one century. It is supposed to be one of the greatest national health problems with referring to peoples eating sea foods in KSA, it require special and intense effort at all level individual, groups, national, and international.

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1.Introduction:

In the last years, world consumption of fish and its products has increased mainly due to their health benefits such as preventing cardiovascular and other diseases (Cahu *et al.,* 2004). Fish and seafood are considered important sources of high quality protein, minerals and essential polyunsaturated fatty acids (Guérin *et al.,* 2011) and (Kris-Etherton *et al.,*2003). Despite their recognized benefits, fish and seafood may represent a risk for human health since they can accumulate contaminants from aquatic environment and magnify them up the food chain ([Türkmen *et al.,* 2009], [Tuzen, 2003] and [Matta *et al.,* 1999). Moreover, fish metabolism may be harmed by some toxic trace elements that suppress essential trace elements such as copper, zinc, and selenium (Morgano *et al.,* 2011). Selenium is a trace element that is essential for animal and human nutrition. It has been recognized as cellular antioxidant, and a protective agent against toxic trace elements, cancer and cardiovascular diseases. Selenium deficiency can cause several pathological conditions. However, this element can also be toxic to human, certain plants and animals (Al-Saleh, 2000). Iron deficiency is frequently associated with anemia and, thus, with reduced working capacity and impaired intellectual development. The RDA for children (0.5–1 year old) and adults (male and female) is 11 and 18 mg/day, respectively (Schümann *et al.,*2007). Zinc is an important trace element in human nutrition and fulfills many biochemical functions in human metabolism. Zn deficiency in human organism leads to several disorders, but an excessive Zn intake can cause acute adverse effects (Scherz & Kirchhoff, 2006). The RDA for Zn is 11 mg/day and 8 mg/day for man and woman up to 19 years old, respectively. Copper is important in the process of biological transfer of electrons, and is vital for the synthesis of red blood cells and the maintenance of nervous system structure and function. Copper deficiency in adults can result in blood and nervous system disorders (Dabbaghmanesh *et al.,* 2011). Cadmium is a toxic element that could be present in fish organism at high concentrations (Türkmen *et al.,*2009). The maximum Cd level for fish established by the Brazilian legislation is 1.0 mg kg^{-1} (ANVISA, 1998)

It has been well documented that cadmium at excessive amount in aquatic environments may affect the functions in digestive, immune, and reproductive organs of fishes (Hallare *et al.,* 2005). Moreover, cadmium is commonly considered as a fish neurotoxic substance and a blood circulating system disruptor due to its competition with intracellular calcium (Fraysse *et al.,* 2006). Lead is one of environmental contaminants which can promote serious damage to human health. The main exposure route of non-occupationally exposed individuals is by food consumption (Liu *et al.,*2010). In the Brazilian legislation, maximum Pb level established for fish is 2.0 mg kg^{-1} (Saei-Dehkordi *et al.,* 2010).

The purpose of this study was to analyze and evaluate the levels of essential and toxic inorganic trace elements in edible fish species of coast and bottom of the red sea at Jazan and ordinarily consumed by the population of Jazan and studying the effect of these elements on the histological structure of liver and muscle of *Scomberomorus commerson* fish.

2.Material and Methods:

Sampling and analytical methods:

Water and fish samples were collected from the red sea coastal and bottom water using Nansen bottles at 2 m depth, and then, stored in acid-washed polyethylene bottles until analysis. All the precautions recommended by Kremling (1983) to minimize risks of sample contamination were followed during collection and treatment of sample.

The apparatus used in the study :

The concentration of trace elements were measured by Polargraph instrumental 746 VA trace analyzer with 747 VA stand or from Metrohm company.

WE Multi Mode Electrode (MME)
Mercury drop capillary for MME
AE Pt rod electrode
RE Ag/AgCl reference system
c(KCl) = 3 mol/L
Electrolyte vessel filled with c(KCl) = 3 mol/L

The information storage is done by a computer, from Toshiba company 757 VA computracy joined with the device.

Histological preparation:

Liver and muscle were extirpated from the body cavity. The organs were fixed immediately in Bouin's solution, dehydrated through ascending series of ethyl alcohol and cleared in xylene and embedded in paraplast. Sections of liver and muscle were stained with hematoxylin and eosin and tested under microscope.

3. Results:

Essential elements**:**

There are no differences between the concentrations of elements compared between the surface and bottom of the sea, except for zinc where the concentration (0.036 mg/l) on the bottom while concentration at the beach (0.004 mg/l).

Toxic elements: There are no differences between the concentration of cadmium compared between the surface and bottom of the sea. While others have found wide variations between the concentration of lead is high (0.005 mg/l) on the bottom while at the beach is (0.001 mg/l).

Histological Results

The muscle of Scomberomorus *commerson* fish is formed of multinucleate fibers contain myofibrils. The myofibrils are composed of hundreds of myofilaments divided into thin (actin) and thick (myosin) elements. Skeletal muscles are composed of segmental myomers, inserted into broad sheets of collagenous connective tissue termed myosepta (Fig.1).

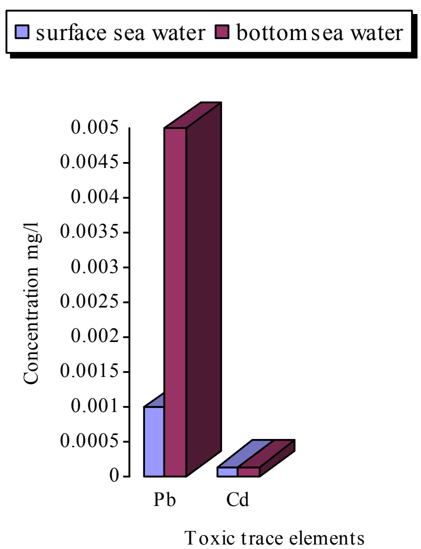

Figure 1: Concentration of toxic trace elements (mg/l).

Table 1. Concentrations of Essential trace elements in mg/l (mean ± S.D.) in the surface and bottom of the sea waters.

Essential trace elements	Concentrations of trace elements (mean ±S.D.)	
	Bottom sea waters	beach sea waters
Selenium (Se mg/ml)	0.000332	0.0002
Iron (Fe mg/l)	0.002	0.003
Zinc (Zn mg/l)	0.036	0.004
Copper (Cu mg/l)	0.002	0.001

Muscles of fishes taken from the coastal area showed that the muscle fibers were degeneratn ed and collagen bundles were loose and dissociated (Fig.2). While in figure (3) muscles become atrophy with necrotic nucleus and an intra fibrillar edema also illustrated. The muscle of Scomberomorus *commerson* fish taken from the bottom showed nearly normal histological structure with no pathological changes of the muscle (Fig.4).

Microscopical examination of the liver showed that it is formed of connective tissue stroma and paranchymal cells.The parenchyma cells are branched into hepatic lobules.The hepatocytes are arranged in interconnecting cords. Sinusoids separate the hepatocytes and Kuppfer cells are present in the wells of sinusoids (Fig.5). liver of coastal area showed fatty degeneration of hepatic cells, dilation and construction of the blood sinusoids and accumulation of inflammatory cells. the nuclei of the hepatocytes appear dark due to the pyknosis (Figs. 6&7). While liver section of fish from the bottom did not demonstrate Pathological changes except for some vacuolated cell cytoplasm (Fig.8).

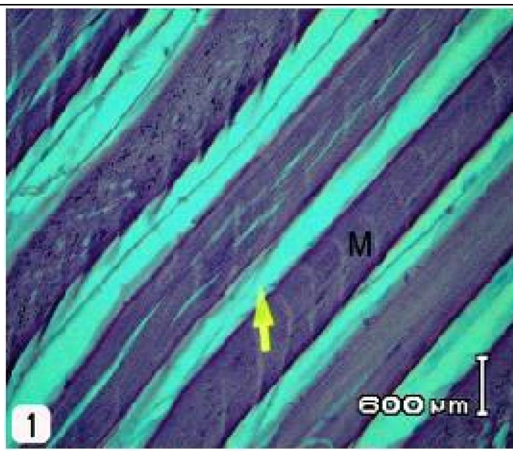

Fig. (1): Sections of muscles of *Scomberomorus commerson* fish showing the muomers (M) and myosepta.

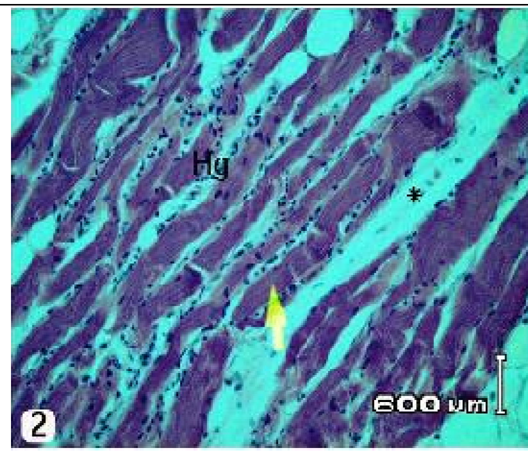

Fig. (2): Section of muscle from coastal area showing degeneration of muscle fibers (arrow)and loose of collagen bundles.

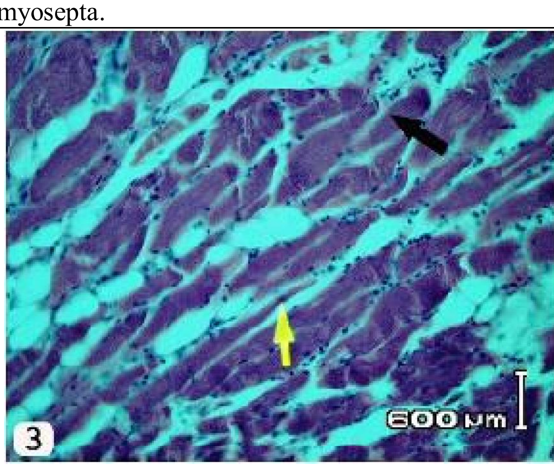

Fig. (3): Section of muscles from coastal area showing atrophy and necrosis of muscle fibers nuclei (MF) and intra fibrillar oedema(*).

Fig. (4): Section of muscle from the bottom area showing nearly normal structure of muscle fibers and sarcolemma.

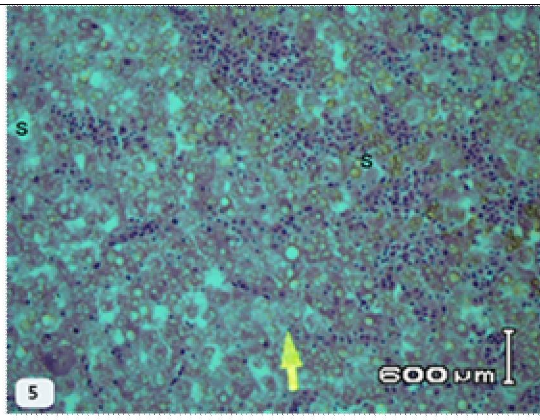

Fig. (5): Section of control liver showing hepatic cells (H), kuppfer cells (K) and blood sinusoids(s).

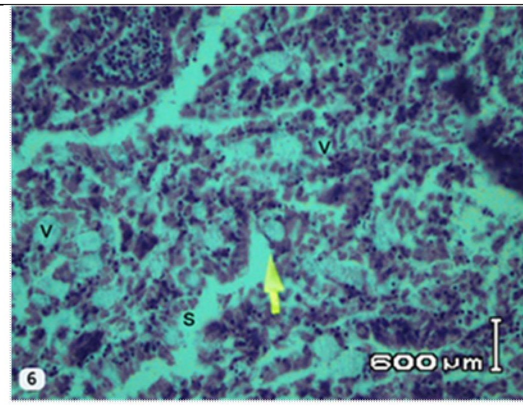

Fig. (6): Section of liver obtained from the coastal area, showing vacuolated hepatocytes(v)with cells accumulation of haemosidrin pigment. Notice the inflammatory pyknotic nuclei (p) and dilated blood sinusoids(s).

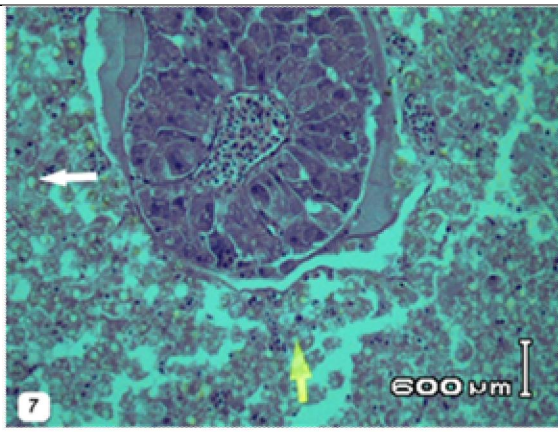

Fig. (7): Section of liver of coastal region showing degeneration of hepatic cells(H) and large necrotic area.

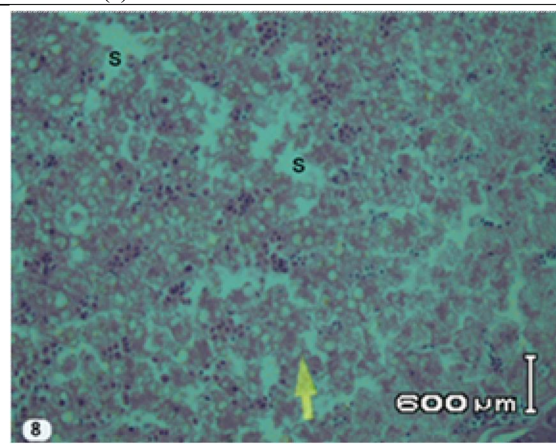

Fig. (8): Section of fish from bottom region showing liver with nearly normal structure of hepatocytes,but some hepatocyte cytoplasm with little vacuoles.

4.Discussion:

Heavy metals are taken into the body via; 1) inhalation, 2) ingestion, and 3) skin absorption. To conclude that the high concentration of Pb and Zn in the studied fishes species from Jazan might be due to the following reasons:

1- The feeding habitats of the fishes.

2- Fish activities.

3- Anthropogenic activity in the study area.

Generally, the higher metal concentration in the environment, the more may be taken up and accumulated by fish. Relationship between metal concentrations in fish and in the water was observed in both, field and laboratory studies (Moiseenko *et al.,* 1995; Linde *et al.,* 1996). Interspecies differences in metal accumulation may be related to living and feeding habits. Kidwell *et al.* (1995) observed that predatory fish species accumulated more mercury but the benthivores contained more cadmium and zinc. Ney and Van Hassel (1983) found that lead and zinc concentrations were higher in benthic fish. The data obtained by many authors indicate that metals show different affinity to various organs. The major part of total body loads accumulated at different concentrations of metals in the water, and at various exposure times are found in liver, (Al- Mohanna, 1994) the muscles, comparing to the other tissues, usually show low concentrations of metals but are often examined for metal content due to their use for human consumption Cadmium is accumulated primarily in the kidney and liver, but it may reach high concentrations also in the gill, digestive tract and spleen. Lead deposits in various organs: liver, kidneys and spleen, Liver accumulates high concentrations of metals, irrespectively of the uptake route. The liver is considered a good monitor of water pollution with metals since their concentrations accumulated in this organ are often proportional to those present in the environment. That is especially true for copper and cadmium. Metal levels in the liver rapidly increase during exposure, and remain high for a long time of depuration, when other organs are already cleared (McGeer *et al.,* 2011).

The concentration of heavy metals in teleost fishes may be affected by many variables most important of which are: species, body size, organ, and feeding habits (Cross *et al.,*1973; Eustace, 1974). The present work reveals significant differences of metal concentration among different region of the sea, particularly the presence of lesser concentrations of metals in the surface than those in the bottom.The effect of the concentration occur in the muscle and liver of the studied fish. Similar conclusions were reported by other workers. Wahbeh and Mahasneh (1987) found lesser concentrations of metals in the muscles than those in the livers, gills, and gonads of six species of fish from the Gulf of Aqaba. Similarly, the muscles of 21 fish species from the Red Sea proper contained lesser metal concentrations than the livers (Hanna, 1989). Comparable lower metal concentrations were also found in the muscles than the livers of Chondrichthys fishes from North Atlantic (Windom *et al.,* 1973). In experimentally contaminated perch, the muscles contained lesser concentration of Cd than other organs (Edgren and Notter, 1980, Ikem and Egiebor,2005).

Conclusion

The rapid development of industry and agriculture has resulted in increasing pollution by heavy metals, which are a significant environmental hazard for invertebrates, fish, and humans (Uluturhan and Kucuksezgin, 2007 E. Uluturhan and F. Kucuksezg).

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