Estimation of Heavy Metal Accumulation in Cardiac Tissue of Gallus gallus Within Polluted Areas

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Abstract : Objective: this research investigates the concentration of heavy metal (Pb, Fe, Cu, Cd and Zn) bio accumulation in cardiac tissue in samples taken from areas near oil fields and brick factories. Method: Atomic absorption spectrometry analysis of powdered, air-dried, acid-digested materials to determine lead, cadmium, zinc, iron, and copper concentrations. Results: The result showed that Zn and Cd were within normal range for samples from both studied areas. Whereas, Cu and Fe with high concentration, Pb in the other hand result showed the concentration of the mineral in samples form brick factories where within normal limits while in samples from oil fields were above the normal limits. Furthermore, the concentration was higher in samples taken from oil fields than those of the brick factories.
Conclusion: It has been shown that some of these metals were estimated within normal concentration a further investigation on another animals and human are recommended to consider these metals are safe and are not considered as hazard to human health. In contrast other metals were estimated with high concentration that reported by other studies to be hazard on human health.

Key words: Bioaccumulation, Cardiovascular diseases, Heavy metals, Bio hazard.

1. Introduction

Environmental degradation is one of the most pressing concerns confronting modern society[1]. Heavy metal pollution and poisoning of the environment pose a major hazard to the environment[2]. Heavy metal contamination is a product of increasing industrialization and urbanisation, and the rates at which these metals are mobilised and transported through the environment have increased dramatically since the 1940s[3]. Weathering of volcanic eruptions and metal-containing rocks are natural sources, whereas industrial emissions, smelting, mining, and agricultural operations such as phosphate fertilizer application and pesticide are major human sources. Heavy metals like cadmium (Cd) are released into the environment as a byproduct of burning fossil fuels[4]. Heavy metals persist in the environment, damage food systems, and cause a wide range of health problems because of their toxicity. Chronic environmental exposure to heavy metals poses a serious hazard to living beings[5]. When toxic

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heavy metals accumulate in ecosystem biota, it has unfavourable effects on wildlife and people[6]. Essential heavy metals perform important roles in biological systems, but excessive or prolonged exposure to most heavy metals is toxic to living creatures[7]. The maxim "too much of anything is dangerous" rings true in toxicology. Heavy metals that aren't essential to life, including (Cd, Pb, and Hg), and their metalloid cousins may be harmful even in trace amounts[8]. Tiny quantities of heavy metals are essential for proper bodily function, but once their levels rise over a certain threshold, they can cause harm[5]. The essentiality and toxicity window for some elements is rather limited. Heavy metals have been linked to cancer, mutagenicity, and teratogenicity[9].

Lead, the most dangerous of the heavy metals, may be ingested or inhaled in its inorganic forms by drinking water, eating contaminated food, or just breathing it in[10]. The teratogenic impact of lead intoxication is a particularly significant side effect[11]. Studies have shown that lead poisoning can decrease haemoglobin production, produce problems with joints, kidneys, and the cardiovascular system, have negative effects on fertility, and cause acute and chronic damage to the central nervous system and the peripheral nervous system[12]. Cadmium, on the other hand, is poisonous at very low concentrations. However, continues long-term exposure causes renal impairment in humans[13]. The symptoms of zinc poisoning are similar to those of lead poisoning, therefore the two are often misinterpreted as the same thing. When used orally, zinc is widely believed to be safe from harmful effects[10].Excess amounts might create system malfunctions, impairing development and reproduction[14]. However, iron is the second most prevalent metal in Earth's surface, the 26th the more abundant element in the periodic table, and essential to the development and survival of nearly every known species[15]. The clogging action of iron precipitation will cause severe harm, and it will also obstruct fish respiration, which will have a direct impact on the fishing sector[16]. Finally, copper poisoning can cause serious and perhaps fatal multi-organ dysfunction[17].

2. Methodology

2.1. Obtaining Samples

Iraq's Wasit province served as the study's primary location. Wild birds (Gallus gallus) were captured from two heavily contaminated regions: I areas close to the Al-Ahdeb oil fields, and ii) rural areas close to the Al-Hay brick factory. The samples (Hearts) were acquired after slaughtering 20 birds (10 from each location).

2.2. Analyzing Method

After 17 days of drying at room temperature (about 28.4-33.6 ^{o}C), the samples were analysed. After that, we took one gramme of each sample and mixed it with ten millilitres of nitric acid to make a powder. Using a SHIMADZU AA-7000 atomic absorption spectrophotometer to determine the lead, cadmium, zinc, iron, and copper concentrations in samples.

3. Results and Discussion

The Pb, Fe, Cu, Cd, and Zn concentrations mean, chi square, confidence and P value in the study of heart tissue of chicken (*Gallus gallus)* has been summarized in (table 1). The highest concentration recorded for Al-Ahdeb oil field samples for Pb, Fe, Cd and Zn minerals, in contrast the Cu samples recorded higher in Al-Hay brick factory (figure 1,2). Overall, the result of Pb, Cu and Fe detected to be above the permeable limits except for Pb in samples of brick factories detected under the permeable limits, while, Zn and Cd detected to be within the permeable thresholds.

Table 1: Chickens from the Al-Ahdeb oil field and the Al-Hay brick industries had higher levels of heavy metals in their hearts compared to chickens from other sources. Concentrations (µg/g)

Mineral Parameters	Heart Samples (µg\g)		95% confidence	X^2	P value
	Al-hay brick factories	Al-Ahdeb oil Fields			
	Mean ±SD	Mean ±SD			
Lead (Pb)	0.0087± 0.0006	2.532± 0.678	0.00833 to 3.0091	69.44	<0.0001*
Iron (Fe)	306.29± 33.67	357.62± 114.43	285 to 327	8.635	0.0192*
Zink (Zn)	36.417± 1.284	41.073± 2.115	35.6 to 37.2	0.2111	0.1460
Copper (Cu)	18.389± 3.696	16.43± 6.945	16.1 to 20.7	0.0651	0.4628
Cadmium (Cd)	0.001± 0.0009	0.090± 0.006	0.0004 to 0.0015	32.067	0.0082*

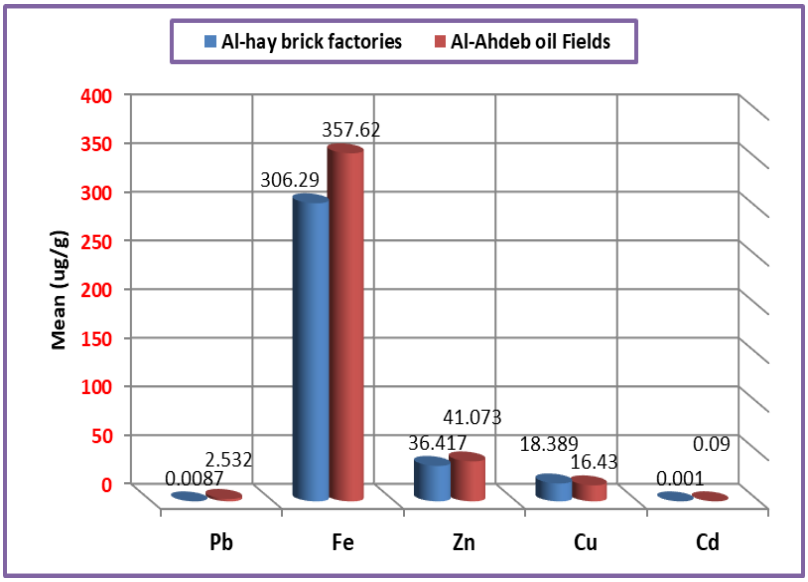
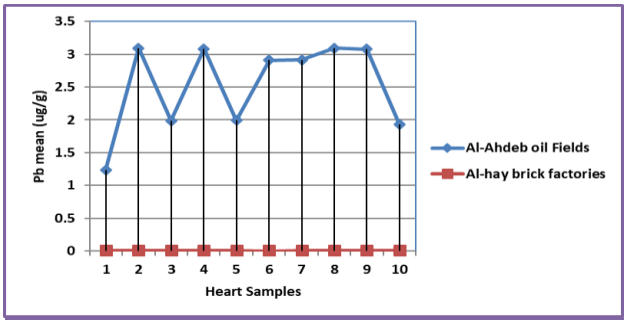
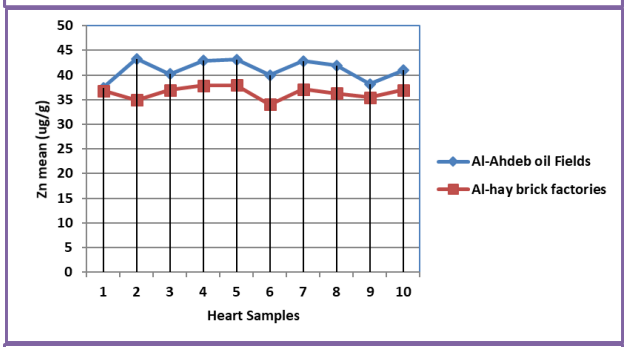
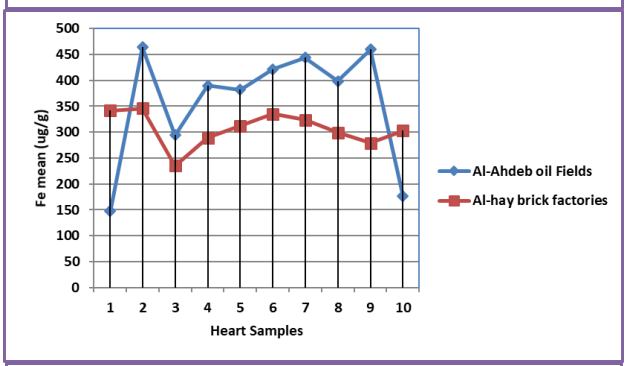
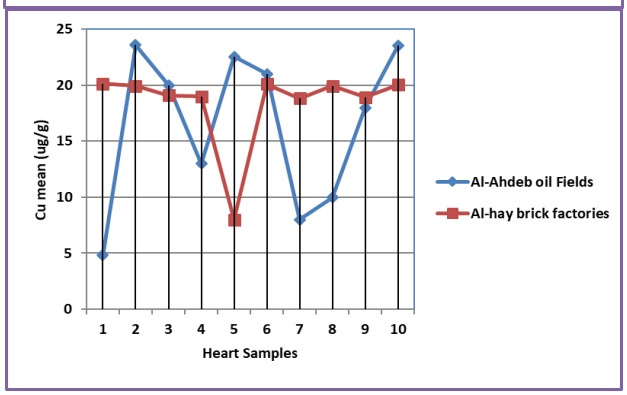


Figure 1: Showing average levels of lead, iron, zinc, copper, and cadmium in the Al-Ahdeb oil field and the Al-Hay brick factory.


Pb mean (ug/g)
3.5
3
2.5
2
1.5
1
0.5
0
1 2 3 4 5 6 7 8 9 10
Heart Samples
Al-Ahdeb oil Fields
Al-hay brick factories


Zn mean (ug/g)
50
45
40
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10
Heart Samples
Al-Ahdeb oil Fields
Al-hay brick factories


Fe mean (ug/g)
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10
Heart Samples
Al-Ahdeb oil Fields
Al-hay brick factories


Cu mean (ug/g)
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10
Heart Samples
Al-Ahdeb oil Fields
Al-hay brick factories

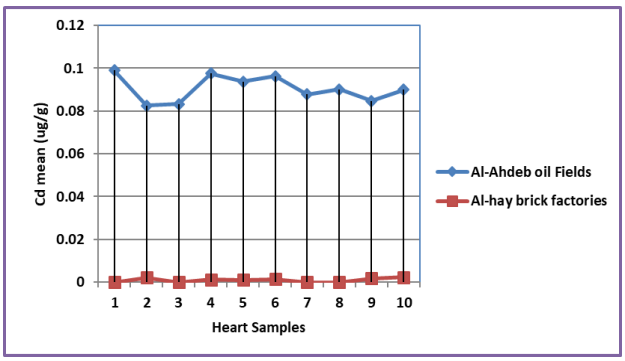


Figure 2: This graph compares the concentrations of lead, iron, copper, and zinc in the Al-Ahdeb oil field to those in the Al-Hay brick kilns.

All of the heavy metals found in the research have been identified as severe environmental bio toxicants linked to the development of heart disease[18]. This study was first to be conducted in cardiac tissue in chicken in Wasit province within polluted areas. The result showed that Zn and Cd were within normal range for samples from both studied areas (figure 2). Whereas, Cu and Fe with high concentration, Pb in the other hand result showed the concentration of the mineral in samples form brick factories where within normal limits while in samples from oil fields were above the normal limits (figure 2), furthermore, the concentration were higher in samples taken from oil fields than those of the brick factories, this is due to the fact that three out of five factories were shut down since the 2003 which lowered the amount of emissions of heavy metals to the environment. Oil field in the other hand showed a higher concentration since Iraq considered an oily country and the extraction of oil has increased for the last decade. As the heavy metal concentrations increases, there are increased risks of cardiovascular diseases. Previous research suggests that Pb exposure is associated with a higher risk of clinical cardiovascular abnormalities such as peripheral arterial disease, stroke, as well as coronary heart disease, as well as disorders of cardiovascular function such as left ventricular hypertrophy as well as changes in cardiac rhythm[19,20]. Also, Cu is a potent pro-oxidant that may contribute to atherogenesis[19]. Since oxidation is involved in the production of both LDL cholesterol and free radicals, it is presumed to have a crucial role in the pathogenesis of coronary heart disease[21]. Finally, iron is one among the heavy metals that produces the hydroxyl radical (OH), which is the most prevalent free radical produced by iron oxidation[22]. OH• has the ability to damage biological molecules such as proteins, lipids, and DNA[23].

4. Conclusion

To conclude, 20 samples were tested to detect five biohazard heavy metals, and it has been shown that some of these metals were estimated within normal concentration a further investigation on another animals and human are recommended to consider these metals are safe and are not considered as hazard to human health. In contrast other metals were estimated with high concentration that reported by other studies to be hazard on human health and had a negative effect on cardiac tissue and has a role in the occurrence of cardiovascular diseases.

5. Highlights

Study analyzed heavy metal accumulation in cardiac tissue near oil fields and brick factories. Results showed high levels of Cu, Fe, and Pb in oil field samples. Zn and Cd concentrations were normal in both areas. Study recommends further investigation into the safety of these metals in animals and humans.

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