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Heavy Metal Estimation in Lungs of *Gallus gallus* Within Polluted Areas

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Abstract | Pollution with heavy metals is thought to be resulted from rapid urbanization and industrialization. However, due to their toxicity, heavy metals remain and accumulate in the environment, thus pollute food systems. Furthermore, it creates a variety of health issues and concerns worldwide. Metals can accumulate in biological tissues and organs as a result of excessive exposure via eating, skin contact, or inhalation. Heavy metals can interfere with physiological systems, such as brain function, heart and circulatory system function, and liver function. This study aims to observe the concentrations of lead (Pb), cadmium (Cd), zinc (Zn), iron (Fe) and cupper (Cu), in lungs of *Gallus gallus* specimens collected from polluted sites. Investigation of samples using atomic absorption indicate high level of metals in lung tissue that makes the sites targeted sites a highly polluted and unsuitable for living due to the hazardous effect resulted from high rate of accumulation of toxic heavy menials. With the continued extraction of oil and the manufacturing of brick from brick factories in Wasit province, the number of heavy metals discharged into the atmosphere is continually increasing. As a result, substantial levels of buildup of these pollutants can occur, as well as poisoning of humans and animals living nearby, posing a risk to ecosystems, animals, and human health.

Keywords | Pollution, Bioaccumulation, Heavy Metal, Toxic, Lead, Zinc, Iron, Copper, Cadmium

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INTRODUCTION

Many factories have been established to meet the needs of humanity since the industrial revolution, of course, some wastes are produced depending on the production of these factories (Ronco *et al.*, 2008). One of the issues that has been related to the growth and spread of industrial civilization, as well as increased population density, during the twentieth century is environmental pollution (Bellomo *et al.*, 2008). The massive manufacturing of anthropogenic compounds with qualities suitable for certain objectives adds to environmental pollution (Meshra *et al.*, 2005). Pollutant emissions are rising over the world, posing serious health and environmental risks (Youn-Joo, 2003). A combination of heavy metals is typically seen in pollution (Harikumar and Nasir, 2010). Any metallic element with a relatively high density that is dangerous or deadly even at low concentrations is referred to as "heavy metals" (Terzano *et al.*, 2010). Heavy metals enter the environment through natural and human-caused processes. Examples of heavy metal sources include soil erosion, natural weathering of the earth's crust, mining, industrial effluents, urban runoff, sewage discharge, pest or disease control chemicals used on crops, and many more (Chen *et al*., 2014). Heavy metals like zinc, copper, and lead can induce a variety of physiological problems in humans, including hypertension, occasional fever, nausea, kidney damage, cramping, and more (Georgieva *et al*., 2014). Bioaccumulation is defined as the net accumulation of a chemical in an organism as a result of simultaneous absorption and disposal of that substance in organs such as the liver, kidney, and muscle. Whole organisms are examined to assess metal concentrations (Förstner and Wittmann, 2012). Excess copper harms cells, resulting in protein degradation and decreased cell growth (Cheng and Gobas, 2007). Its overabundance resulted in the production of extremely reactive oxidative species (such as hydroxyl radicals), which are well recognized for their damaging effects on cells, including DNA damage and lipids (Hordyjewska *et al*., 2014). Excess iron intake, on the other hand, is a severe concern in developed and meat-eating nations, and it raises cancer risk (Al-Najare, 2012). Workers who are exposed to asbestos, which contains over 30% iron, are at a higher risk of developing asbestosis, which is the second leading cause of lung cancer (Al-Samawi, 2017). Asbestos-related cancer is considered to be connected to free radicals (Olgunoglu and Olgunoglu, 2011). Intracellular iron that isn't tightly bound can cause DNA damage (Nicoara *et al*., 2009). Iron can cause cancer mostly by the oxidation of DNA molecules, and lead is a carcinogen (Chertow *et al*., 2005). The effects of lead on several regions of the body are significant (Aregger *et al*., 2009). The distribution of lead in the body is first determined by blood flow into various tissues, and over 95 percent of lead is deposited in skeletal bones as insoluble phosphate (Richetti *et al*., 2011). Zinc is an important trace mineral that is necessary for the metabolic activity of 300 of the body's enzymes, as well as cell division and DNA and protein synthesis (Ul-Haq and Sveriges, 2013). Zinc is reasonably safe when compared to various other metal ions with comparable chemical characteristics. Toxic effects are only seen at large concentrations (Olgunoğlu, 2011). Zinc is involved in the control of life and death choices at the cellular level, in addition to its systemic harmful effects. The influence of zinc on apoptosis is confusing since the specific role of zinc in apoptosis control is unknown (Coca *et al*., 2009). According to several studies, zinc may be pro- or anti-apoptotic depending on its quantity, and both zinc shortage and excess can cause apoptosis in the same cell line (Hobson *et al*., 2009). Apoptosis has been induced by high amounts of intracellular zinc in a variety of organs and cell types (Xu *et al*., 2014).

This study aims to investigate the concentrations of key toxic elements in the lungs of *Gallus gallus* specimens collected from polluted sites. The findings highlight the presence of substantial levels of buildup of these pollutants which could potentially poison humans and animals living nearby these sites, posing a risk to ecosystems, animals, and human health.

MATERIALS AND METHODS

This research was conducted in Wasit province, Kut, Iraq. Fresh samples were taken from the contaminated sites in Wasit, Kut, Iraq. The birds (*Gallus gallus*) investigated were obtained from two contaminated locations: villages near the Al-Ahdeb oil fields and villages near the Al-Hay brick industries. A total of 20 birds, 10 from each site, weighing between 1 and 1.5 kg, were slain, and the necessary sample (lungs) was taken. For 11 days, samples were dried at room temperature (28.4 -33.6 °C). Following that, each sample was ground to powder and wet digested with nitric acid (1gm sample + 10 ml acid) overnight. Then after, 1 ml Hydrogen peroxide (H_2O_2) were added, mixture was evaporated then samples were cooled and diluted to 5 ml with distilled water and filtered using Whatman filter paper. The estimation of (Pb, Cd, Zn, Fe and Cu) concentration in samples by atomic absorption spectrophotometer, model AA-7000, SHIMADZU brand.

Statistical analysis

SPSS Statistics 20 was performed to analyze the data. Normality of data with a 95% confidence level were determined by using Anderson-Darling test. The results of this investigation were given as mean standard deviation (SD). Analysis one-way and two-way of variance (ANOVA) were used to detect whether there were any significant differences in the amounts of heavy metals in the lungs (tissue samples) and the locations. Means were compared using a multifactor analysis of variance comparison. If the *P* value is less than 0.05, the test result is deemed significant.

RESULTS AND DISCUSSION

Lead (pb)

Samples were collected from brick factory demonstrates that the trace of lead (Pb) slightly rose in comparison to control group (0.005 ug/g). However, there was a significant elevation (p valuation <0.0001) in trace of lead (Pb) in extracted samples of areas surrounding to brick factories (0.012 ug/g) compared to oil fields samples (0.009 ug/g) as shown in (Table 1 and Figures 1, 2).

Iron (Fe)

The iron traces in same collected tissue were also evaluated in present study compared to control samples (272.193 ug/g). Iron level followed the same trend of iron (Fe) in liver which was significantly higher (p value=0.0222) in samples from Al-hay brick factories (752.42 ug/g) as compared to Al-Ahdeb oil fields (592.05 ug/g) as shown in (Table 1).

Table 1: Statistical analysis for mineral parameters of samples.

Mineral parameters	Lung samples (ug/g)		95% confidence	X^2	P value
	Al-hay brick factories	Al-Ahdeb oil fields			
	Mean ±SD	Mean ±SD			
Lead (Pb)	0.012± 0.0012	0.009± 0.008	0.0007 to 0.014	31.82	<0.0001*
Iron (Fe)	752.42± 79.029	592.05± 194.35	503.31 to 800.06	8.555	0.0222*
Zink (Zn)	27.937± 1.415	20.778± 7.029	19.546 to 30.840	2.077	0.0522
Copper (Cu)	7.85± 1.089	8.769±1.473	6.944 to 9.111	0.238	0.4117
Cadmium (Cd)	0.0138± 0.005	0.060± 0.032	0.002 to 0.0664	5.370	0.0401*

*significant differences (p<0.005), X^2: chi square, SD: standard deviation.

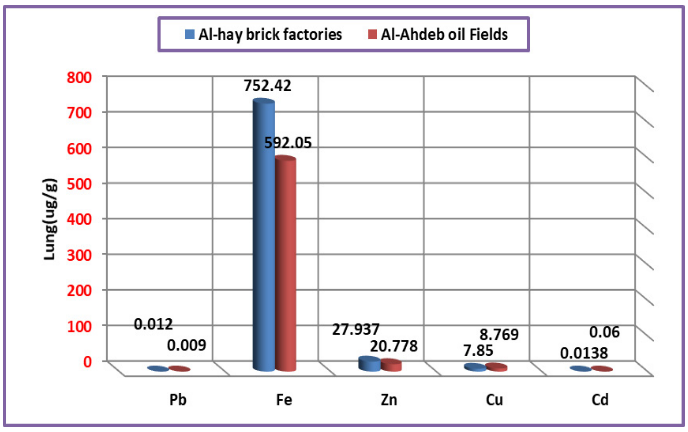

Figure 1: A graph showing the mean value of mineral parameters for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

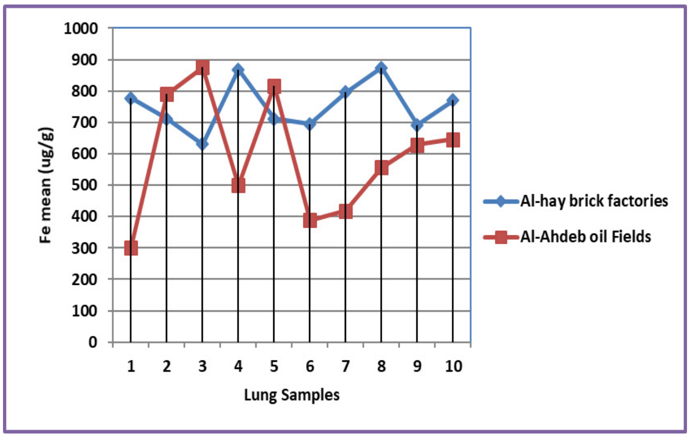

Figure 3: A graph showing the mean value of iron (Fe) for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

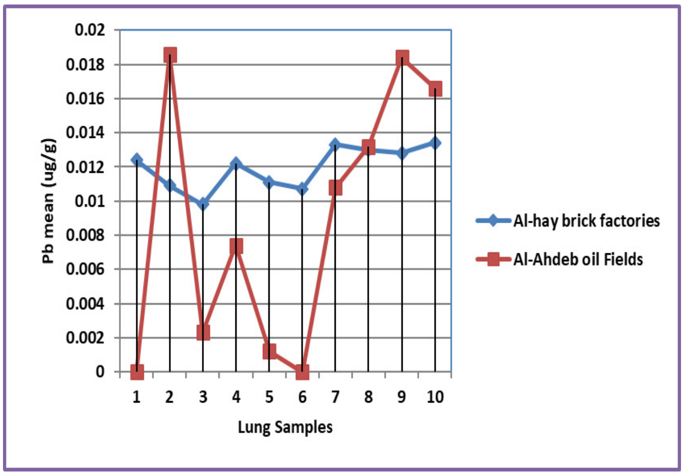

Figure 2: A graph showing the mean value of Lead (Pb) for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

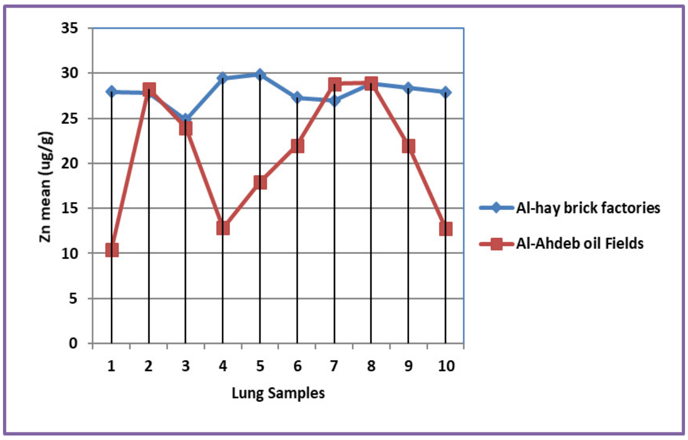

Figure 4: A graph showing the mean value of zinc (Zn) for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

Zinc (Zn)

An elevation also seen in samples collected from two studied areas for zinc compared to control group(10.395ug/g), however no significant difference (p value = 0.0522) was seen between two sites of sample collection. The amount of Zn trace was 27.937 ug/g in Al-hay brick factories and 20.778 ug/g in Al-Ahdeb oil fields as shown in (Table 1 and Figures 1, 4).

Copper (Cu)

Element copper was detected along within lung tissue in present study. Compared to control group (4.665 ug/g) both site show increase in trace of copper in collected lung samples. Similar to zinc level, no significant difference (p value = 0.4117) was seen in amount of copper trace in lung samples from Al-Ahdeb oil fields (8.769ug/g) and Al-hay brick factories (7.85ug/g) as shown in (Table 1 and Figures 1, 5).

Links Researchers

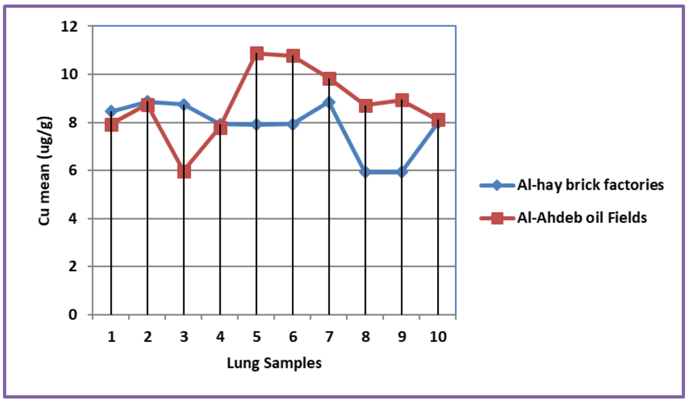

Figure 5: A graph showing the mean value of copper (Cu) for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

Cadmium (Cd)

Significant difference (P =0.0401) was seen in cadmium trace between Al-hay brick factories (0.0138ug/g) compared to Al-Ahdeb oil fields samples (0.06ug/g) as in (Table 1 and Figures 1, 6). Both site show increase in level of cadmium compared to control group (0.0053 ug/g).

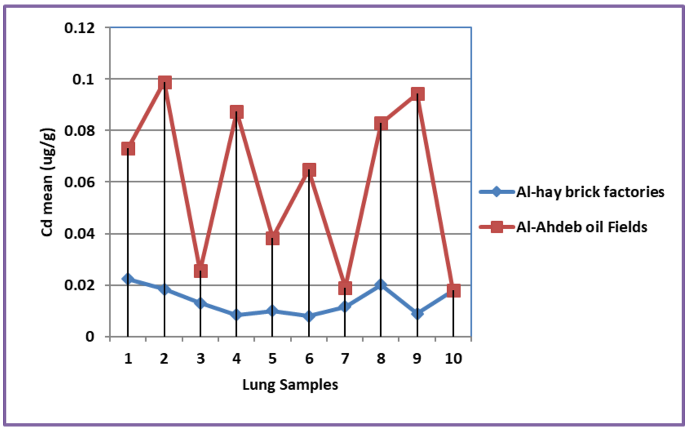

Figure 6: A graph showing the mean value of cadmium (Cd) for lungs taken from Al-Hay brick factories and Al-Ahdeb oil field.

The studied metals showed a high accumulation rate of metals compared to control that is considered poisonous (Aregger *et al.*, 2009; Förstner and Wittmann, 2012; Hordyjewska *et al.*, 2014; Xu *et al.*, 2014; Chen *et al.*, 2014). Furthermore, there was a variation in percentage between samples taken near Al-Hay brick factories, as well as, in samples taken near Al-Ahdeb oil fields. Despite of that, both sites considered to be a heavily contaminated areas and are unsafe for human habitation due to the hazardous effect associated with high rate of concentration of toxic heavy metals. Nevertheless, it should also be remarked that the variable percentage of accumulation between the two aforementioned regions could be due to the fact that those in responsible for managing the oil field equipped filters to decrease the quantity of pollutant emitted from combustion of gases produced from oil extraction operations.

CONCLUSION

With the continued extraction of oil and the manufacturing of brick from brick factories in Wasit province, the number of heavy metals discharged into the atmosphere is continually increasing. As a result, substantial levels of buildup of these pollutants can occur, as well as poisoning of humans and animals living nearby, posing a risk to ecosystems, animals, and human health.

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NOVELTY STATEMENT

This study reveals high levels of heavy metals (Pb, Cd, Zn, Fe, Cu) in the lungs of *Gallus gallus* from polluted sites in Wasit Province, Iraq. The findings highlight severe environmental contamination from industrial activities, posing serious risks to ecosystems, wildlife, and human health due to metal accumulation.

AUTHOR'S CONTRIBUTION

All authors contributed equally to the conception, design, experimentation, and overall execution of the study. However, Dr. Rafal, as the corresponding author, was primarily responsible for manuscript preparation and conducting the statistical analyses.

Ethics approval

The project was approved from environmental office in Wasit province, and was further approved by the local research committee in Wasit university. Birds were collected under the consent of the locals raising it, and was approved to be used for research purposes.

Generative AI and AI-assisted technology statement

Used the Quillbot tool for rephrasing and turnitin tool for plagiarism and AI detector.

Conflict of interest

The authors have declared no conflict of interest.

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