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RESEARCH PAPER

Assessment of Heavy Metals as an emerging environmental pollutant in liver organs of Sheep and Goats from Erbil, Kurdistan Region of Iraq

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A B S T R A C T:
Bioaccumulation of heavy metals occurs in a variety of tissues in food animals as a serious environmental pollutant. The present study was to examine heavy metal levels such as Iron (Fe), Mercury (Hg), Manganese (Mn), Zinc (Zn), Arsenic (As), Cobalt (Co), Chromium (Cr), and Copper (Cu) in sheep and goat liver tissue from a polluted region in northern Iraq called Kurdistan. A comparison was made between all results and World Health Organization (WHO) standard limits. In this study, forty of samples tissue were taken from the livers of Sheep (n=20) and goats (n=20) from a slaughterhouse in Erbil, Kurdistan region north of Iraq. The concentration of eight vital heavy metals has been targeted by performing Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES) and concentrated HNO_3 and H_2O_2 were used to dry and digest the samples. The result obtained from the study of heavy metals for instance (Mn, As, Zn, Co, and Cr) in the liver of sheep and goats is within the admissible limit recommended by World Health Organization (WHO). However, the remaining elements (Cu, Hg, and Fe) were found in danger, as they are higher than the normally accepted standards. Moreover, there is a significant difference for (Fe, Mn, Zn, Co, and Cr) and a non-significant for (Hg, As, and Cu) between the livers of sheep and goats in the study area. Variations in liver element values are likely attributable to feeding, environmental conditions, animal feed constituents, and analytical terms.

KEY WORDS: Heavy metals, Environmental pollutants, Animal liver, Kurdistan Region, ICP-OES.
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1. INTRODUCTION:

In recent years, there has been a rise in the amount of environmental pollution that is a direct consequence of the continuous and rapid growth in population, industrialization, and transportation, as well as the associated indiscriminate exploitation of natural resources (Marfo et al., 2013). It has been shown over and over that indeed pollution has a detrimental effect on the quality and safety of food chains all over the globe and the health of people and animals alike is negatively impacted when there is an increase in contamination (Gall et al., 2015, Ercumen et al., 2017). Heavy metals are one of the most discussed and monitored environmental factors that contribute substantially to environmental contamination and are present in soil, water, air, plant, and animal tissues (Kovacik

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et al., 2017). Monitoring their concentrations is therefore crucial for the health of all forms of life. Some metals have a propensity for bioaccumulation in the environment and biomagnification in food chains; as a result, even when found in low concentrations in environmental samples, their levels may exceed toxic thresholds (Madgett et al., 2021). The most notable of these are mercury (Hg), cadmium (Cd), lead (Pb), copper (Cu), and zinc (Zn). On the other hand, cadmium, lead, and mercury are three non-essential metals that have been the subject of extensive research over the years (Yi and Zhang, 2012).

Metals are responsible for many diseases, especially those affecting the cardiovascular system, the kidneys, the nervous system, and even the bones, and some metals are deemed to be carcinogenic, mutagenic, and teratogenic in animal studies (Swaileh et al., 2009). In addition to their toxic effects on the bodies of living creatures, these heavy metals can cause damage to other organs such as the kidneys and liver, as well as changes in the levels of a variety of hormones and biochemicals (Sharaf et al., 2020). Most of the time, goats and sheep are noticed grazing in contaminated environments, indicating that the soil, vegetation, air, and water may be contaminated with heavy metals, which then penetrate the tissues of the livestock. The liver and kidneys of livestock are responsible for the detoxification of poisonous substances that enter the body; as a result, these organs show greater concentrations of these substances than other organs do (Elshaer et al., 2022). The liver and kidney tissues are essential to the human diet because they provide a significant amount of nutrients, as well as trace elements (Abdel-Salam et al., 2013). In many countries of the Middle East, visceral organs (such as the liver and kidney) are ingested as valuable and appetizing food products, and in the majority of countries, these products are offered in many restaurants. Unfortunately, visceral organs occasionally contain toxic substances, such as heavy metals (Bazargani-Gilani et al., 2016).

The present study was to investigate the distribution of heavy metals such as Iron (Fe), Arsenic (As), Mercury (Hg), manganese (Mn), zinc (Zn), chromium (Cr), copper (Cu), and Cobalt (Co) in the livers tissue of goats and sheep slaughtered in the municipal slaughterhouse of Erbil in the Kurdistan Region of Iraq (KRI) and destined for consumption by the population of this city.

2. MATERIALS AND METHODS

2.1 Selection of Animals

As per the study protocol; the selected animals were adult sheep and goats, aged less than 3 years old with good physical health, and 40-50 kg in weight. Tissue samples of their liver were collected ethically and aseptically from domestic animals; goats and Sheep. The samples were transported to the lab in sterile polyethene containers and kept refrigerated until they could be analyzed and digested. To eliminate contaminant particles, distilled water was utilized to rinse samples. In this investigation, we used the wet method; this technique was using a small piece of sample in a clean scalpel that was dried in OVEN at 100 ℃ degrees for 1 hr. This method is required for water dehydration in samples, and water will evaporate from the samples. The samples were split and digested using a modified technique (Ntakoulas et al., 2022). All plastic and glass items were rinsed in distilled water and allowed to air dry after soaking in diluted HNO_3. Weight 1 gram of the dried sample, using a sensitive balance. Were taken in a conical flask in which 10mL and 1mL were added of HNO_3 and H_2O_2 concentrations, respectively, after 20 min repeats the heating process once more with the same procedure. This mixture was digested in a Microwave digester for 45-50 minutes (Sai Chaithanya et al., 2022). The mixture should cool down and then dissolve in deionized water until it has a clear solution. The cellulose filter paper was utilized to filter the solution of the sample and dilute the filtrate to 25 mL with deionized water. After finishing the preparation of the sample the time duration is around 16 to 24 hours to send the sample for detecting heavy metals by conducting Inductive Coupled Plasma – Optical Emission Spectroscopy(ICP-OES) (Zerizghi et al., 2022).

2.2 Study Area

The sample was collected from Erbil General Slaughterhouse in the KRI; the animals were growing up and living on the grazing land near polluted environment speciation; industrial, urban, and rural areas of Erbil. Figure 1 shows the circle the most of the animal farmlands that have been used in this study. The study area has a Mediterranean climate system, which contains hot and dry summers and cool and damp winters with mild autumn and spring, the average annual rainfall is 456.2 mm (Seeyan et al., 2022). The study area has been a potential of scientific research attraction as the largest industrial and oil field in the area. It is considered polluted based on the already published papers in different aspects including ambient air quality which quite critical for Particular Matters PM2.5, PM10 and ground level O_3 (Hamadamin et al., 2022) and the groundwater quality is out of standards in several aspects including turbidity, color electrical conductivity (Ali et al., 2018). A particular research regarding elevating heavy metals in crude oil workers blood confirms that Pb and Zn is quite high in their blood that possibly resulted in polluted and unprotected environment (Saleh et al., 2021). Another similar study as the current study has revealed that Hg, Al, and Fe are higher WHO standard in sheep and cow meats (Hamadamin et al., 2019).

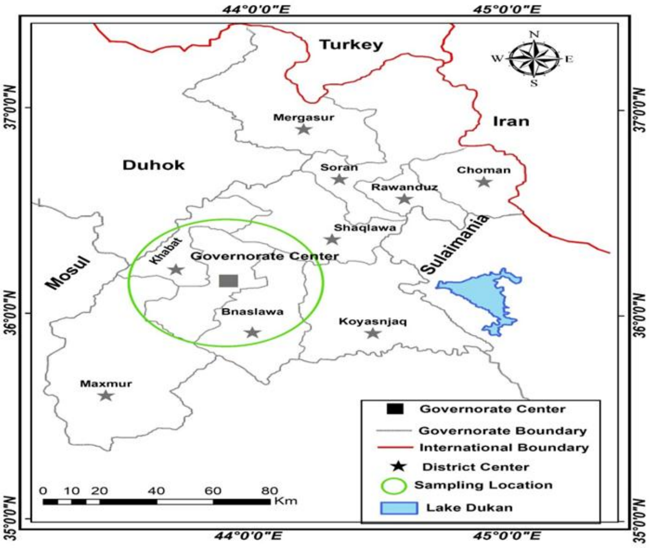

Figure 1. Map of the Study Area which is located at Erbil General Slaughterhouse in the KRI.

2.3 Statistical analysis

The concentrations of statistical data were supplied using (GraphPad Prism 9 statistical package, version 9.3.1 software). The student's t-test was used to assess the number of heavy metals to find mean and standard deviation (SD) values in the liver tissue of sheep and goats at the Erbil General Slaughterhouse. P <0.05 was used to determine significance and mean values are given.

3.RESULTS AND DISCUSSION

In recent years, there has been a great deal of interest in the concentrations of heavy metals in animals and other foods to ascertain whether or not they are detrimental to humans (Velusamy et al., 2022). There are a lot of variables that impact the quantities of trace elements in meat products, including environmental conditions, pasture type, and therapies are significant (Aregheore, 2005)

The liver and the kidneys are the target tissues for monitoring metal contamination in mammals because they are responsible for the elimination of toxic metals from the body (Abdel-Salam et al., 2013). Therefore, this research has collected samples from goat and sheep livers in exposed regions to indicate some heavy metal levels such as (Fe, Hg, Mn, Zn, As, Co, Cr and Cu) by elements Inductive Coupled Plasma – Optical Emission Spectroscopy (ICP-OES). The mean and standard deviation for these metals shown in Table 1. So, the present study revealed the highest level of Zinc with the lowest level of Cobalt in the liver of goats and the highest concentration of Iron and the lowest concentration of Chromium in the liver were noted in sheep. In addition, the above-mentioned heavy metals are compared to World Health Organization (WHO) standards (Organization, 2022).

Table 1. Heavy metal concentrations by part per billion (ppb) in livers of goats and sheep.

Metals	(WHO) standards	Goat Liver (MEAN ± SD)	Sheep Liver (MEAN ± SD)	P-Value
Fe	300	474.1 ± 121.2 N=20	3720 ± 534.3 N=20	< 0.0001
Hg	6	26.91 ± 0.4848 N=20	26.78 ± 0.5847 N=20	0.8619
Mn	400	179.7 ± 28.88 N=20	110.0 ± 12.45 N=20	0.0329
Zn	3000	1081 ± 128.8 N=20	1688 ± 264.4 N=20	0.0458
As	10	7.478 ± 0.9854 N=20	8.015 ± 1.019 N=20	0.7071
Co	3	0.2660 ± 0.07658 N=20	1.242 ± 0.2001 N=20	< 0.0001
Cr	50	6.692 ± 2.468 N=20	0.7524 ± 0.1920 N=20	0.0214
Cu	1000	1038 ± 208.9 N=20	922.2 ± 167.1 N=20	0.6671

Since the liver is responsible for transporting the elements throughout the body, iron (Fe) is one of the elements that commonly accumulate in the liver, kidney, muscle, and other organs in the gut. When their intake is excessively raised the vital metal can yield toxic effects, and Iron (Fe) deficiency causes anemia (Falandysz, 1993, Sandstead et al., 2007). So, Iron has a highly significant difference value in the study area between goat and sheep samples about 474.1 ppb and 3720 ppb, respectively. Also, this study area for the quantity of Fe is greater than the WHO acceptable limit of 300 ppb (Organization, 2022). However, that is dry plants included in the feeding routine may be a very good source of the above elements and industrial emissions can cause contamination of pasture (Badis et al., 2014), or a high level of Fe may be present in the water consumed. Liver and kidney accumulate iron, in the northern part of Poland, Falandysz reported a similar pattern of accumulation (Falandysz, 1993). Erdogan et al. found a high level of Fe in Sheep, goats and cattle livers (Erdogan et al., 2004).

The arsenic value of sheep samples of the study area was 8.015 ppb and 7.487 ppb for Goats that were reported. This study has found that all the samples of both types fall within the 10 ppb limit set by the WHO (Organization, 2022). According to Determination of Heavy Metals in Water, Blood, and Urine Samples Using ICP and AES and ISE by Akan et al., arsenic can be eliminated from the blood within a few hours, which may be because of the body's immune system (Akan et al., 2014).

Chromium was determined in Sheep and goat samples from all locations. Goat livers had a significantly greater concentration of chromium than sheep livers. The distribution of heavy metals in the liver, kidney, heart, pancreas, and meat of cow, buffalo, goat, sheep, and chicken from Kohath market Pakistan found that high chromium levels lower insulin efficacy in blood sugar control and cause flushing and irritation (Abdel-Salam et al., 2013). However, the samples of sheep and goats are lower than the WHO limit of 50 ppb (Organization, 2022).

Cobalt is needed in the form of vitamin B 12 containing cobalt widely distributed in animal organs (Girard et al., 2009). Cobalt concentration was highly significantly lower in the goat's sample (0.266 ppb) compared to the sheep sample (1.242 ppb). However, the cobalt value in the analysed samples was still within the normal range and the WHO-authorized limit of 3 ppb (Organization, 2022).

Mercury (Hg) metal is a volatile liquid found in rocks, soils, and air due to human activities like using Hg chemicals in paints, cosmetics, fungicides, paper pulp, etc. Mercury causes neurological changes or certain diseases, as well as urban soils, had the highest amounts (Kolipinski et al., 2020). In this finding, Mercury was high for both liver samples of sheep and Goats about 26.78 ppb and 26.91 ppb, respectively. These values are above the WHO accepted range (Organization, 2022). High mercury values have been reported in some studies for beef meat from Algeria (Badis et al., 2014, Sathyamoorthy et al., 2016). This may be since oil processing, which results in the flaring of natural gas, is the primary cause of elevated Hg levels at the study site, as determined by an assessment of heavy metal pollution (Malarkodi et al., 2007, ATSDR, 2012).

Zinc is a vital element required for the activity of a variety of enzymes in mammals. In both situations, zinc deficiency and excess are detrimental to human and animal health (Burk and Zarus, 2013). Zinc Provisional tolerable weekly intake (PTWI) for meat is 700mg/week/person (Bettinelli et al., 2000). In this study, there were significant differences in liver zinc levels in goats (1081 ppb) and sheep (1688 ppb). Also, depending on these results Zn in all samples indicate under the WHO which recommended a limit of 3000 ppb (Organization, 2022). The lack of zinc concentration may be due to zinc-deficient farm soils (Farmer and Farmer, 2000). One other reason for the lack content of zinc in tissue is due to precise homeostatic mechanisms that controlled zinc for gastrointestinal absorption and excretion and some Studies of zinc levels in the livers and kidneys of animals according to sex and age are in agreement with these results (Alonso et al., 2004, Amani et al., 2014, Miranda et al., 2006).

Likewise, copper is crucial for plant and animal growth that assists blood haemoglobin production. However, excessive consumption can result in anaemia, liver and kidney damage, as well as stomach and intestinal irritation (Martınez and Motto, 2000). Copper is essential, but high levels in sheep liver samples may harm animals and people. Copper is toxic in high amounts, so avoid eating too much (Borobia et al., 2022). Copper was found in all study area samples with no significant variation. The concentration in Cu liver goats and sheep is slightly close to the WHO reference standard 1000 ppb (WHO as it is marginally higher than the WHO 1000 ppb limit (Organization, 2022). Recent studies have found higher copper levels in sheep and cow meat in Middle East countries (Emami et al., 2023).

The essential organ with an accumulation of manganese was the liver and kidney. All animals tested had liver manganese levels below the permitted toxic level. Manganese is often regarded as one of the least toxic trace elements in mammals, even though it can be toxic in higher amounts. Identify the significant mean concentrations of manganese in the Goats and Sheep of the study are shown as 179.7 ppb and 110 ppb, respectively. Furthermore, both values are within the permitted limit of WHO which is 400 ppb (Organization, 2022). Miranda et al., have identified manganese concentration in cattle liver from Asturias (Miranda et al., 2006).

4.CONCLUSIONS

Goats and sheep livers were assessed for heavy metal concentrations and compared to the recommendations of the World Health Organization. The various heavy metal levels in livers were detected generally lower than the standard safe limits, such as (As, Mn, Zn, Co, and Cr). But the other three elements (Cu, Hg, and Fe) were higher than the permissible standard, especially Hg which is more than four times the standard of 6 ppb and Fe almost three times for sheep and two times for goats higher than the 1000 ppb limit. Moreover, some heavy metals like (Fe, Mn, Zn, Co and Cr) have a significant difference between liver samples of both goat and sheep groups. While, some others like (Hg, As, and Cu) have non-significant differences among both groups. It is recommended to conduct further studies to find out the reason for recording high levels of heavy metals in the sheep and goat liver of the study location.

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Conflict of Interest

The authors declare no conflict of interest.

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