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STUDY THE RELATIONSHIP BETWEEN LEAD AND CADMIUM IONS WITH DRINKING WATER (TAP AND WELL WATER) AND THE BLOOD OF DAIRY COWS IN SOME AREAS OF BAGHDAD

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Abstract

The aim of this analysis was to look into the levels of heavy metals (lead and cadmium) in tap water, well water, and dairy cattle blood in the Baghdad province (Taji, Abu Ghraib, and Youssoufia) regions. Methods: Measuring certain blood and biochemical parameters; Red Blood Cells, White Blood Cells, hemoglobin, differential white blood cells count, total cholesterol, albumin, globulin, liver enzymes, aspartate aminotransferase, and alanine aminotransferase activity are among the parameters. Results: Lead concentration in the tab and well water of the Youssoufia region was significantly higher ($P \le 0.05$) than Taji and Abu Ghraib. The Cadmium concentration of the tab water in the different regions shows a non-significant difference between the different regions. The lead and cadmium concentrations, WBCs, differential WBCs count in dairy cattle blood were recorded significant ($P \le 0.05$) increase in the cows of Youssoufia compared with other regions, a significant decrease ($P < 0.05$) in the RBCs count of dairy cattle in Youssoufia and Taji, Hb were recorded significantly higher value ($p < 0.05$) in the dairy cattle of Abu Ghraib, total protein, albumin, globulin concentration, lymphocyte, neutrophils, basophils, showed non-significant ($p > 0.05$) differences among the different regions, liver enzyme AST and ALT concentration showed a significant increase ($p < 0.05$) in the serum of dairy cows in Youssoufia regions than other regions. Conclusion: The results showed there was a significant correlation coefficient between lead in drinking water and the blood of dairy cattle, while there was no significant relationship between cadmium and lead in drinking water and blood.

Keywords: Lead and Cadmium, liver enzyme, WBC, differential WBCs count, RBC count.

Introduction

Many factors like genetics, feeding and management affect the production of bovine animals. The water and feed used must not be contaminated with heavy metals. Control of cattle raising, such as hygiene of cages, employees and machinery should be ensured and food safety standards should be satisfied. Milk bovine animals normally eat and concentrate grass. Air and water runoff, which contaminates soil, is the primary cause of Pb and Cd contaminationIn addition, metals can accumulate in all areas of all plants growing on polluted soil, (roots, stems, leaves and fruit) (**Yintao Lu et al., 2015**), Pb and Cd will accumulate in tremendous quantities in plants such as corn, hay, some feed legumes and vegetables (**Valérie Page and Urs Feller. 2015; Tahoonet al., 2020**).

The availability and quality of drinking water would have an effect on the health and development of dairy cattle in both high- and low-altitude regions. Climate quality in high-altitude areas is declining significantly as a result of global warming and an increase in tourism, potentially impacting dairy cattle reproduction and milk production. Customers of dairy products would benefit from this because it would reduce bioaccumulation of some toxic compounds in the food chain, according to Arup (**Arup Giriet al.,2020**). Milk and dairy products must be free of human, biochemical, and chemical contaminants in order to be suitable for use. The heavy metals Pb (Plumbum/Lead) and Cd (Cadmium) are commonly contaminated by the atmosphere, such as water, grass, feed ingredients, medications, and farm machinery. Contamination of milk and dairy products may have an effect on food health and protection for humans (**E Harlia, Rahmah and Suryanto 2018**). Because of the toxicity of heavy metals and their ability to accumulate in the human body, it is important to regulate their concentration in food (**Sujkaet al., 2019**).

Pollution is described as an unfavorable change in the atmosphere induced by the introduction of harmful substances or the creation of harmful conditions. Many environmental pollutants, such as heavy metals, are released into the environment as a result of a variety of natural and human processes (i.e. anthropogenic). With certain stages of exposure, all heavy metals are toxic (**Milam et al., 2017**). Shallow groundwater is an important source of drinking water in rural areas because of its accessibility, and it is often used without government oversight. As a result, this form of water supply is one of the most pollutable, particularly in areas with a lot of agricultural activity (**Soldatovaet al., 2018**). Over the globe, the majority of experiments on surface water and groundwater discovered that physicochemical, biochemical, mineral, and heavy metal levels were higher than WHO, APHA, EPA, OSHA, ISI, and ICMR guidelines (**Arup Giriet al., 2020**).

Such high levels of these heavy metals induced adverse deleterious effects in cows including "increased serumconcentrationof lead (Pb), cadmium (Cd) and potassium (K), malondialdehyde (MDA), urea,creatinine,activities of alanine aminotransferase (ALT),aspartate aminotransferase (AST) and γ-glutamyle aminotransferase (γGT) enzymes with decreasing of superoxide dismutase (SOD) enzyme activity, reduced glutathione (GSH), total protein, albumin, albumin/globulin ratio (A/G%), iron (Fe) zinc(Zn), calcium (Ca), phosphorus (P), magnesium (Mg) and sodium (Na) concentrations"**(Al-Afifiet al., 2019**).

The liver is involved in the management of trace elements, bioaccumulation, and detoxification (**Neuschwander-Tetri, 2007; Takashi Himoto and Tsutomu Masaki 2020**). Furthermore, one of the most commonly used biological materials in ecotoxicological research for quantifying patterns in medium- to long-term contaminant toxicity is the liver (**Kitowski et al., 2017**). As cadmium binds to the cystein-rich protein (metallothionein) and forms the cysteinmetallothionein complex, its concentration rises 3,000-fold. Since accumulating in renal tissue, this cysteinmetallothionein complex produces hepatotoxicity in the liver and circulates to the kidney, where it induces nephrotoxicity (**Sabolicet al., 2010; Kochanowskaet al., 2021**). Cadmium accumulation in kidneys, nephropathy, and weak bones result from long-term exposure to low-concentration cadmium (**Richter et al., 2017; Genchiet al., 2020**).

Materials and Methods

In three samples, 30 samples were taken in Baghdad city water (five tap and water well samples), and 30 blood samples from cattle in Baghdad province were taken from three regions. Thirty were obtained in three locations, Altaji, Abu Ghraib and Youssoufia. Blood samples were taken from cows in these areas after disinfecting the injection site and drawing blood from the jugular vein with a sterile syringe. Each blood sample was split into two parts: Blood was collected in an anticoagulant EDTA tube (Ethel Diamine Tetra Acetic Acid) to estimate blood hemoglobin using a Hemoglobin kit (BioSystems, Spain) and measured using a UV spectrophotometer (UV-1280 / SHIMADZU EUROPA, Italy), counting RBCs according to Jain (2013), and total white blood cells count (WBC) according to **John and Lweis**(1984), For the analysis, the differential WBC count includes five forms of WBCs (neutrophils, lymphocytes, eosinophils, basophils, and monocytes) and their percentages (**Seiverd, 1983**), and the second part of blood were collected without anticoagulant tube and kept in a refrigerator at a slant position until serum isolate then separated by centrifugation (Hettich/ Germany) at 3500 rpm for 5 minutes, sera were obtained to estimate the total serum protein (albumin and globulin) and the functions activity of alanine amino transferase enzyme (ALT) and Aspartate amino transferase enzyme (AST). Lead and cadmium concentration determination:water and bloodsamples was send to Science and Technology Ministry laboratory for detection the Pb and Cd levels by using direct method Atomic Absorption Flame (novAA 800 series-Germany).

Statistical Analysis

The Statistical Analysis System- **SAS (2012)** program was used to detect the effect of difference locations in study parameters. Least significant difference –LSD test (Analysis of Variation-ANOVA) was used to significant compare between means Estimate of correlation coefficient between variables in this study.

Results

1. Lead and Cadmium concentrations in the (well, tab water and blood) of cattle from different region in Baghdad province.

Table 1 shows that lead concentration in the tab and well water of the Youssoufia region were significantly higher (P≤0.05) than other region in Baghdad province. Cadmium concentration of the tab water in the different region shows non-significant differences between the different regions, while its concentration in the well water were significantly higher (P≤0.05) in Youssoufia regions compared with Taji and Abu ghraib. Lead and Cadmium concentration in the cattle blood of the Youssoufia region show a significant (P≤0.05) higher concentration than Taji and Abu ghraibregion as shows in the table 2.

Table 1: Lead and Cadmium concentration in the well and tab water from different region in Baghdad province (µg\dl).

Location	Mean ± SE			
	Lead in tab water	Lead in well water	Cd in tab water	Cd in well water
Taji	1.70 ±0.20 b	1.92±0.08 cd	0.136±0.013 a	0.10 ±0.01 bc
Abu ghraib	1.60 ±0.10 b	1.70 ±0.06 d	0.350 ±0.22a	0.076 ±0.04 c
Youssoufia	2.33 ±0.12 a	2.83 ±0.08 a	0.170±0.02a	0.183 ±0.01 a

Table 2: Lead and Cadmium concentration in blood of the cattle from different region in Baghdad province (µg\dl).

Location	Mean ± SE	
	Pb	Cd
Taji	18.33 ±0.55 b	0.218 ±0.01 b
Abu ghraib	17.33 ±0.88 b	0.195 ±0.02 b
Youssoufia	20.67 ±0.33 a	0.255 ±0.01 a

Table 3 shows that there is significant correlation coefficient between lead concentrations in water with lead concentration in blood, while there is no correlation between lead in blood and cadmium concentration in water, also the results shows that there are no Cadmium levels in blood and water have a correlation.

Table 3 Correlation coefficient between Lead and Cadmium in blood with Pb and Cd in water

Blood	Water	Correlation coefficient-r	Level of Sig.
Pb	Pb	0.41	*
Pb	Cd	0.29	NS
Cd	Cd	0.07	NS
* (P≤0.05), NS: Non-Significant.			

2. Effect of Lead and Cadmium pollutants in the well, tab water on some blood parameters of the cattle in different region in Baghdad province.

The effects of the lead and cadmium on the RBCs count shows in the table 4 that significant decrease (P≤0.05) are recorded in the blood cattle of the Youssofia and Taji region. However, WBCs count in the blood of the cattle in the Youssifia region (12.18 ±0.39) compared with the cattle of other regions (6.70 ±0.48, 5.98 ±0.21, 7.26 ±0.45) of the Taji, Abu ghraib, Youssoufia regions respectively. Hemoglobin concentration of the cattle in the Abu ghraib region are significantly (P≤0.05) higher than the cattle of the other region.

Table 4 Effect Lead and Cadmium concentration in BRCs, WBCs and Hemoglobin of the cattle in different region in Baghdad province.

Location	**Mean ± SE**		
	RBC	**WBC**	**Hb**
Taji	4.80 ±0.26 b	6.70 ±0.48 b	26.88 ±0.95 ab
Abu ghraib	5.23±0.57 ab	5.98 ±0.21 b	29.13 ±0.46 a
Youssoufia	4.47 ±0.47 b	12.18 ±0.39 a	23.81 ±1.54 ab
Latifia	5.10±0.35	6.46 ±0.58 b	21.63 ±2.07 b

	ab		

Table 5 shows that lymphocyte, Neutrophil, Monocyte and Basophil percentages showed non-significant differences in the cattle blood of the region of Baghdad province.While Eosinophil percentage show significant increase (P≤0.05) in the blood of the cows in the Youssoufia region compared with the other regions.

Table 5 Effect Lead and Cadmium concentration on the deferential WBCs in the blood of the cattle from different region in Baghdad province (%).

Location	**Mean ± SE (%)**				
	Lymphocyte	**Neutrophil**	**Eosinophil**	**Monocyte**	**Basophil**
Taji	59.50±0.99 A	26.67±1.40a	11.16±0.87b	2.16±0.3 b	0.50±0.22 a
Abu ghraib	58.00±1.46 A	26.67±0.88a	12.00±0.57b	3.00±0.36ab	0.33±0.21 a
Youssoufia	57.50±1.17 a	27.83±2.60a	14.16±0.60a	2.50±0.22 ab	0.166±0.16a

3. Effect of Lead and Cadmium pollutants in the well and tab water on some serum parameters of the cattle in different region in Baghdad province.

The concentration of the total protein globulin and albumin were increased significantly (p< 0.05) in the blood of the cows in Abu ghraib (7.01 ±0.28, 3.75 ±0.28, 3.75 ±0.28) compared with cows in other regions as showing in table 6. Table 7 shows that liver enzyme concentration of AST (197.91 ±18.80) and ALT (145.20 ±16.90) is significantly higher (P≤0.05) in the serum sample of the cows in Youssofiacompared with the other regions of Baghdad province.

Table 6 Effect of Lead and Cadmium concentration on the Total protein, Albumin, Globulin and Creatinine in blood of the cattle from different region in Baghdad province.

Location	**Mean ± SE**		
	Total protein	**Albumin g/l**	**Globulin g/l**

	g/l		
Taji	6.73 ±0.23 ab	3.13 ±0.24 a	3.59 ±0.29 ab
Abu ghraib	7.01 ±0.28 a	3.25 ±0.21 a	3.75 ±0.28 a
Youssoufia	6.42 ±0.29 ab	2.87 ±0.18 a	3.55 ±0.24 ab

Table 7 Effect of Lead and Cadmium pollutants on the AST and ALT in blood of the cattle from different region in Baghdad province (U/L).

Location	Mean ± SE	
	AST	ALT
Taji	130.06 ±9.46 b	136.54 ±11.62 bc
Abu ghraib	104.49 ±2.32 b	129.14 ±0.46 c
Youssoufia	197.91 ±18.80 a	145.20 ±16.90 abc

Discussion

The significant (P≤0.05) increase in the concentration of lead in tap water of Youssoufia, regions in Baghdad province may related to its dissolution from natural causes, especially from household plumbing systems where lead is found in the tubing, solder, fittings, or service connections to residences. Lead compounds are found in polyvinyl chloride (PVC) tubing, which can be leached and result in elevated lead concentrations in drinking water (**Mahmood 2016**; **Ruckart2019**).

Table 1 showed that Lead concentration in the well and ground water increased significantly (P≤0.05) in the Youssoufia region compared with other regions of Baghdad province because Euphrates rivers water deposits a high percentage of elemental lead and a higher population density than the rest of the regions in addition to the presence of factories and industrial waste. These findings were supported by (**Clausen et al., 2015; Kubier and Pichler 2019**), who examined lead geochemistry and field data and concluded that lead moved in surface and pore water over short distances. It was also discovered that water quality is deteriorating due to salt dissolution, leaching, and population increase. Inappropriate groundwater abstraction has an effect on the hydrogeochemical and biological processes in the rock–soil system. As a consequence, testing the physical and chemical properties of groundwater is important (**Hasanuzzamanet al., 2017**).

Table 2 shows that Pb and Cd concentrations were slightly elevated ($P \leq 0.05$) in the Youssoufia area, which is the only one of the sample regions that receives water from the Euphrates rivers, possibly due to high military activity in the region due to terrorist intimidation. **Fadhil et al.**, (2013) analyze the impact of heavy metals (cadmium, lead, and zinc) released from diesel generator exhausts on the health of employees in Al-Ramadi City by testing heavy metal concentrations and their impacts on blood variables and lipid profiles in serum.

Table 3 further supports our findings, indicating that there is a correlation coefficient between Lead in blood and Lead in water. Excess mineral levels, high bacterial load, prevalence of persistent organic toxins, and high levels of heavy metals were discovered to be the main causes of poor water quality in cattle due to global warming and increased anthropogenic activities (**Arup Giri. et al,.2020; Endaleet al.,2020**). In addition, barns in the Mexican province of Leon, while in Peru, **Chirinos-Peinado and Castro-Bedrinana** (2020) discovered that cadmium levels in cattle blood were (0.0160.002 mgkg). Also "in (municipalities of general Zuazua and Marin) Mexico, the concentrations of Pb and Cd in 5 dairy barns were reported to be 0.74 and 0.30 mg\kg (**Rodriguez et al., 2009**), which are greater than our results values".

Lead has long been thought to alter the hematological structure, as our results show in the tables (3, 4). A combination of heme synthesis inhibition and erythrocyte life span shortening causes microcytic and hypochromic anemia, which is caused by lead. The functions of delta-aminolevulinic acid dehydratase (ALAD) and ferrochelatase are altered by lead, which interferes with heme synthesis (**Baierleet al., 2014**). The activity of the pathway's rate-limiting enzyme, delta-aminolevulinicsynthetase (ALAS), which is feedback inhibited by heme, is increased as a result of these modifications, while heme biosynthesis is decreased. ALAD behaviour was shown to be inversely proportional to Pb in studies of lead workers (**Yuan X et al., 2016; Ogun AS et al., 2021**). Hemoglobin, MCV, and MCHC studies showed that all toxic metals cause normocytic normochromic anemia after acute exposure, according to **Mladenovic et al.,** (2014). Although heavy metals can induce basophilic stippling in white blood cells, this is due to a delay in ribonuclease catabolism in maturing cells caused by lead poisoning, which causes an accumulation of incompletely degraded ribosomal fragments (**Fadhil et al., 2013; Andjelkovic, Milena et al., 2019**).The formation of complexes with amino acids and non-protein thiols, as well as protein binding, are all reversible ligand reactions in inorganic lead metabolism. Extracellular ligands include albumin and non-protein sulfhydryls, while intracellular ligands include delta- aminolevulinic acid dehydratase (ALAD) (**Goering and Fowler, 1987; Hu X et al., 2020**).

Our results are in line with those of other researchers who have observed decreases in RBC, Hb, and hematocrit using a variety of animal models, exposure paths, and dosage regimens.

(**Sharma et al., 2010; Sharma et al., 2011; Abdou et al., 2014; Mladenovic et al., 2014; El-Boshyet al., 2015; El-Boshyet al., 2017**) Reduced RBC, Hb, and hematocrit may be due to intravascular hemolysis. (**El-Boshyet al., 2017; Cobbinaet al., 2015**). Pb also binds to the -SH groups of different proteins, like enzymes, and hence inhibits the activity of certain of them, such as SOD and CAT (**Flora, G.; et al., 2012; Matovic, V.; et al., 2015**), and produces a significant MDA and H2O2 increase in RBC accompanied with reduced glutathione levels **(Omobowaleet al. 2014**).

Changes in serum total protein values may indicate liver dysfunction because the liver is the primary site of plasma protein synthesis, especially albumin (**Burtiset al., 2001**). According to **Abdul-Sada** (2019), cattle bred and managed near industrial areas in Egypt can be exposed to cadmium and lead toxicity by pollution of their food and water, resulting in changes in the amounts of Cd and Pb in the muscle, liver, and kidney, as well as changes in the profile of plasma hormones and liver function in cows with natural exposure to Pb and Cd around. While cattle can be exposed to lead by the ingestion of lead-contaminated soils, vegetation, or water, the amount of lead present in these sources is insufficient to cause acute toxicity. These sources can contribute to chronic lead poisoning or high tissue lead concentrations, which are above regulatory limits. **(Kinuthia et al., 2020; Ali Boudebbouzet al., 2021**).

The large increase in the AST and ALT heptic enzymes of cows in Youssoufia was attributed to the high concentration in the blood of these regions of plum and cadmium heavy metals. The findings revealed that increasing cadmium and lead levels in cattle's bodies induces extreme stress in the animals, which has a negative impact on the liver, kidney, thyroid gland, ovary, and test functions, resulting in an increase in stress hormones, serum enzymes, thyroxine, triiodothyronine, and cortisol levels. The study that utilized lab studies has led to induction of liver dysfunction. **McNulty** (1999) has found higher concentrations of serum AST and ALT in milk cows exposed to lead and cadmium around different fabricating sites in the environment. The recent results of somewhat larger ALT and AST serum events clearly show that in the cows near Pb–Zn smelter the liver dysfunction is associated with higher Pb blood concentrations. The overall antioxidant state, the total oxidative condition and the stress index for rats will influence the impact of heavy metals on liver function in plasma, liver and kidneys (**Ramadhan and khudiar, 2019**; **Al-Rikabiet al., 2021**).

Conclusion

According of results obtained from the current study, the lead concentration were increased significantly ($p < 0.05$) in tap and well water, while cadmium increased significantly in the wells water of Youssoufia region.Lead and Cadmium increased significantly in the blood of dairy cattle in

Youssoufia region compared with other regions of Baghdad province. However, there was significant correlation coefficient between Lad in blood and water. Heavy metals pollutant (lead and cadmium) affect dairy cattle health by cause redaction in the Hb, RBCs, total protein, globulin and increased in the liver enzyme activity (AST and ALT) in the blood of dairy cattle in the area with significant pollution.

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