Ministry of Higher Education & Scientific Research

Erbil Polytechnic University

Shaqlawa Technical College

Department Medical Laboratory Technology

Determination of Heavy Metals(Iron, Chromium, Copper) in the Well and Waste Water in the Industrial areas in Kurdistan Region - Iraq

Graduate Project

A research submitted to the council of the Shaqlawa Technical College at Erbil Polytechnic University in partial fulfillment of the requirements for the Bachelor of technology degree in medical laboratory technology for the academic year 2023 - 2024

Prepared by:

Dlxwaz Ibrahim Bapir

Tablo Mohammed Ali

Sabiha Samad Rashid

Marwan Sherzad Sulaiman

Rawand Dler Mohammed

Supervised by:

Dr. Razhan S. Othman

Academic year (2023 - 2024)

Certification of the supervisors

I certify that this research was prepared under my supervision at the department of medical laboratory technology, shaqlawa technical college, Erbil Polytechnic University, in partial fulfillment of the requirement for the degree of Bachelor of technology.

Signature:

Name of supervisor

Date: / / 2024

Head of department of medical laboratory technology approval in view of the available recommendation for word this thesis for Bachelor

Signature:

Dr. Razhan S. Othman

Date: / / 2024

Examining committee certification

We are, the member of the examination committee certify that, after reading this thesis and examining the students **( )** in its contents, it is adequate for the award of the degree of Bachelor of technology.

Signature **Signature**

Chairman **Member**

Name: **Name:**

Date: / /2024 **Date: / /2024**

Signature **Signature**

Member **Member**

Name: **Name:**

Date: / /2024 **Date: / /2024**

Acknowledgment

We would like to thank the Department of Medical Laboratory Technology/ Shaqlawa Technical College for the continuous supports until this project was completed.

We deeply thank our supervisor, Dr. Razhan S. Othman for her valuable feedback and guidance.

Finally, we are extremely grateful to Environmental Protection & Improvement Board in Erbil for their kind collaborations and measurement of the heavy metals.

Abstract

Heavy metals are metallic elements that have a high density and can be toxic to living organisms at elevated concentrations. They include elements such as iron (Fe), chromium (Cr), and copper (Cu). In industrial areas, activities like mining, manufacturing, and waste disposal can release heavy metals into the environment, posing risks to both ecosystems and human health. This research study focuses on the determination of heavy metals, specifically iron, chromium, and copper, in well and wastewater samples collected from industrial areas in the Kurdistan Region of Iraq. The aim is to assess the levels of heavy metal contamination and evaluate the potential environmental and health risks associated with these industrial activities. Advanced analytical techniques, such as atomic absorption spectroscopy, will be employed to quantify the concentrations of these heavy metals. The findings of this study will contribute to our understanding of heavy metal pollution in the region and provide valuable insights for the development of effective environmental management strategies to mitigate the risks posed by heavy metal contamination in well and wastewater sources.

Keywords: Heavy metals, copper, environment, atomic absorption, pollution.

Table of Contents

Chapter One

Introduction

1. Introduction

Some of metal ions, such as Na(I), K(I), and Ca (II), are needed nutrients that required for human body functions, other metals can be toxic and dangerous even at a very low concentration. [1,2]. However, normally these ions play important and beneficial roles in human metabolism [3]. In enzyme pathways, heavy metal ions can function as cofactors or inhibitors. It is believed that a metal cofactor is necessary for around 50% of all enzymes in order for them to be active and functional [4].

The term of heavy metals refers to metals and metalloids with relatively high densities (more than 5 g/cm3) 5 times greater than that of water [5]. There are over 50 elements that can be classified as heavy metals, 17 of which are considered to be very toxic and relatively accessible [6] such as cadmium (Cd), lead (Pb), nickel (Ni), chromium (Cr), mercury (Hg), aluminum (Al), antinomy (Sb) and metalloids, such as arsenic (As) [7]. Heavy metals are among the most serious environmental pollutants due to their high toxicity, abundance and ease of accumulation by various plant and animal organisms [8]. Each heavy metal is associated with a specific health problem [9]. For example, mercury causes lung damage, Chronic poisoning is characterized by neurological and psychological symptoms, such as tremor, changes in personality, restlessness, anxiety, sleep disturbance and depression [10]. The World Health Organization (WHO) and the European Medical Agency (EMA) have established the acceptable values of several heavy metal ions. According to recent information on the WHO website, arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg) are among the ten chemicals that pose a serious risk to human health as of June 1, 2020[11]. The numerous technological, medicinal, and agricultural uses of these elements pose a serious risk to human health even though their toxicity is widely known[12]. Metals are not always discharged into the environment, but human industrial activities expose people to naturally existing metals. Soil pollution near a mine, for example, might result in heavy metals being present in nearby crops[13]. Certain locales and related sectors are known to be unique for the development of certain heavy metals in high quantities. For example, in China, areas around coal-fired power plants are polluted by mercury up to 10 times more than the average soil sample 55 kilometers away from these places [14].

Objectives

The specific objectives of the study were:

1. To determine the concentration of some selected heavy metals (Iron, chromium, copper) in the well and waste water in industrial areas in different locations in Kurdistan Region of Iraq.

2. To identify which of these heavy metal s (Iron, chromium, copper) clearly has a significant amount in industrial area compared to other drinking fields.

Chapter Two

Methodology

2. Methodology

2.1 Experimental site:

All the experimental activities of this research were carried out at laboratories of Environmental Protection & Improvement Board in Erbil.

2.2. Instruments and Chemicals

2.2.1. Instruments and Apparatus

The instrument used was fully automated PC-controlled double-beam atomic absorption spectrometer with fast sequential operation for fast multi element air acetylene flame AA determinations. Its features have 4 lamp positions and automatic lamp selection, operated with specter Base and pro-software versions with each six hollow cathode lamps namely Cadmium, Zinc, Chromium, Cupper, Iron and Lead were used throughout the experiment. A Microprocessor based PH-EC-Meter; Model 1615 was used for the determination of water pH and conductivity. The common laboratory apparatus which was used during the study include different sized beakers, Erlenmeyer flasks, volumetric flasks, block digester, fume hood, icebox, spatula, measuring cylinders, plastic knife, plastic net, vinyl gloves, polyethylene bags, analytical balance, crucibles, oven, mortar and pestle**.**

2.3 Sample Collection

2.3.1. Location of collecting samples

A water sampler polyethylene bottle with 1L capacity was used to collect surface water from the five different sites in Kurdistan region. One of the samples collected in Baziyan area located in Sulaymaniyah, waste waters of Twraq the others collected in industrial areas close to Erbil city.

2.3.2. Collecting and preparation of the sample

To avoid any contamination of samples , should follow the following implementing :

1. Start by selecting a clean container for collecting the water sample. Make sure it's made of a material that won't contaminate the sample, like glass or high-quality plastic.

2. Before collecting the sample, thoroughly clean the container with distilled water to remove any residues or contaminants.

3. Choose a sampling location that represents the area you want to study. It could be a river, lake, well, or any other water source.

4. When collecting the sample, make sure to follow proper safety protocols, such as wearing gloves and avoiding direct contact with the water.

5. Lower the container into the water, ensuring that it is fully submerged. Be careful not to disturb the sediment at the bottom.

6. Fill the container slowly, taking care to avoid introducing air bubbles. Fill it to the brim to minimize the amount of air in the sample.

7. Once the sample is collected, securely seal the container to prevent any leakage or contamination.

8. Label the container with important information, such as the date, time, location, and any other relevant details.

9. Store the sample in a cool and dark place to preserve its integrity. If possible, keep it refrigerated or on ice until it can be properly analyzed.

2.4 METHOD PROCEDURE:

IRON LOW RANGE

REQUIRED REAGENTS

Code	Description	Quantity
H193746-0	Iron LR Reagent	2 packets

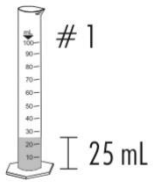
REAGENT SETS

H193746-01 Iron LR Reagent - 50 tests
H193746-03 Iron LR Reagent - 150 tests
For other accessories see ACCESSORIES section.

2.4.1 MEASUREMENT PROCEDURE OF IRON

• Select the lron LR method using the procedure described in the METHOD SELECTION section.
Note: If tutorial mode is disabled, follow the measurement procedure below. If the tutorial mode is enabled, press Measure and follow the messages on the screen.

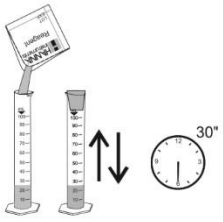
• Fill one graduated mixing cylinder with deionized water up to the 25 mL mark.

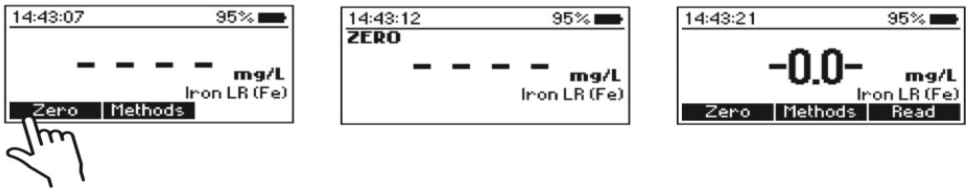


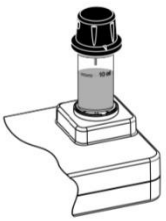
• Add one packet of H193746-0 Iron IR Reagent, close the cylinder with a rubber stopper and shake vigorously for 30 seconds. This is the blank.

• Fill a cuvette with 10 ml of the blank (up to the mark). Replace the plastic stopper and the cap.

• Insert the cuvette into the holder and ensure that the notch on the cap is positioned securely in the groove.



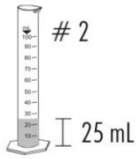




• Press Zero. The display will show "-O.0-" when the meter is zeroed and ready for measurement.

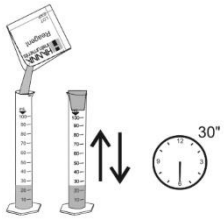
•Remove the cuvette.

• Fill another graduated mixing cylinder with the sample up to the 25 mL mark.



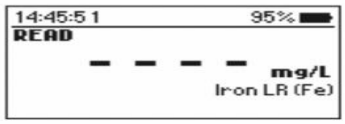
• Add one packet of H193746-0 Iron LR Reagent, close the cylinder with a rubber stopper and shake vigorously for 30 seconds. This is the reacted sample.

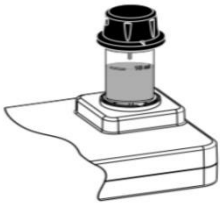
• Fill a cuvette with 10 mL of the reacted sample (up to the mark). Replace the plastic stopper and the cap.

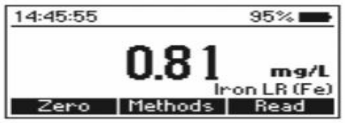


• Insert the cuvette into the holder and ensure that the notch on the cap is positioned securely in the groove.

• Press Read and the display will show a 30 second countdown prior to the measurement. To skip the timer press Read twice. When the timer ends the meter will perform the reading. The instrument displays concentration in mg/L of iron (Fe).







INTERFERENCES

Interference may be caused by:

• Manganese above 50.0 mg/L
• Cadmium, Molybdenum above 4.0 mg/L
• Cyanide above 2.8 mg/L
• Chromium (VI) above 1.2 mg/L
• Nickel above 1.0 mg/L
• Nitrite ion above 0.8 mg/L
• Copper above 0.6 mg/L
• Mercury above 0.4 mg/L
• Chromium (Ill) above 0.25 mg/L
• Cobalt above 0.05 mg/L
• Sample pH should be between 3 and 4 to avoid fading or turbidity formation

2.4.2 MEASUREMENT PROCEDURE OF COPPER:

Measuring of Copper using Kemio

- Press the power button to turn on Kemio
- Select 'Perform Test', and then select the sensor batch you are using or scan the barcode on the sensor foil.
- Follow the on-screen instructions.
- Fill the disposable sample vessel to the shoulder with sample. Do not overfill or water can splash onto the sensor contacts and interfere with the test.
- Add one Soluprep SP-A tablet into the disposable vessel.
- Crush and stir using the crushing rod until the tablet is fully dissolved.
- Lift the arm to open
- Insert the disposable sample vessel into the L-shaped vessel.
- Fill the L-shaped vessel to the line. This is so that the temperature probe is in contact with sample for temperature compensation.
- Tear each side of the sensor foil, then twist and tear the short side from the foil, Do not touch the sensor surface.
- Hold the sensor through the foil, with the white side facing up. Slide the sensor into the instrument all the way, until the end stops against the back of the slot.
- Pull the foil off the sensor. Close the arm and the test will start automatically.
- Wait 4 minutes for test result.
- Copper result will appear on-screen.
- Open the front lid to drop the sensor into the disposable vessel, then open the arm.
- Place a cap on the disposable vessel.
- Remove both vessels from Kemio. If required by local regulations, dispose of the sample, sensor and vessel in a secure manner.
- Close the lid of instrument and press the power button to turn off Kemio.
- Results can be downloaded for audit and compliance to Palin test Connect via USB.

2.4.3 MEASUREMENT PROCEDURE OF CHROMIUM:

Measuring Chromium (VI) With powder pack

0.02 – 2 mg/l Cr

Insert the adapter for 16 mm vials.

1. Fill a clean vial (16 mm O) with 10 ml of the water sample.
2. Place the vial in the sample chamber making sure that the marks A are aligned.

prepare Zero
press ZERO

3. Press **ZERO** key.

4. remove the vial from the sample chamber.

5. Add the contents **of one CHROMIUM HEXAVALENT Powder Pack** straight from the foil to the water sample.

6. Close the vial tightly with the cap and swirl several times to mix the contents.

7. Place the vial in the sample chamber making sure that the marks A are aligned.

Zero accepted
prepare Test
press TEST

8. Press **TEST** key

Wait for **a reaction period of 5 minutes**.

Countdown
5:00

After the reaction period is finished the measurement starts automatically.

The result is shown in the display in mg/l Chromium (VI)

Reagent / Accessories	Form of reagent/Quantity	Order-N0.
PERSULF.RGT FOR CR	Powder Pack / 100	537300
CHROMIUM HEXAVALENT	Powder Pack / 100	537310

Chapter Three

Results and discussion

3. Results

The five samples (S1, S2, S3, S4 and S5) represent to well deep water samples and waste waters from different locations industrial area in Kurdistan Region. From the table (3.1) clear that heavy metals (iron, copper, and Chromium) are lower than the limited range that permissible according to Environmental protection authority in the Kurdistan region. The results indicate that the industries area will not effect on the range of heavy metals by their water, it's may due to some reasons for carefully working with their wastes by applying the principles that Kurdistan regional government / Environment protection and Improvement Board give to them. That is why we can say that water in near of those industry areas is permissible to drink and have not health impact.

NO.	Parameters	results S1	results S2	results S 3	results S 4	Waste result S5	Kurdistan standard permissible range	Evaluation
heavy metals								
1	Copper (Co) mg/ L	0.091	0.014	0.07	0.018	0.08	0.2	Satisfactory
2	Chromium (Cr) mg/ L	0.005	0.0001	0.0012	0.0071	0.004	0.1	Satisfactory
3	Iron (Fe) mg/ L	1.03	0.08	0.001	1	2.1	5	Satisfactory

Table3.1. Determination of heavy metals heavy metals (Iron, Copper, Chromosome) in four water samples that we collected in different locations.
*For more information about the results check on Appendix.

Chapter four

Conclusion and Recommendation

4. Conclusion

The study determined concentration ranges of heavy metals of (Iron, Copper, and chromium) in drinking water samples (well deep) and waste waters for different industrial area locations , however the results showed satisfied but further investigation for achieving high quality of drinking water is required .

Recommendations

The following suggestions are recommended in order to monitor and protect the aquatic environment.

1- Determination of other heavy metals such as (zinc, cadmium, arsenic and lead) are highly required .

2- More advanced method should be applied for determination of heavy metals in soil and waste waters .

References

1. Marchetti C. Role of calcium channels in heavy metal toxicity. ISRN Toxicol. 2013 Jan 30;2013:184360. doi: 10.1155/2013/184360. PMID: 23724297; PMCID: PMC3658387.

2. Potocki S, Rowinska-Zyrek M, Witkowska D, Pyrkosz M, Szebesczyk A, Krzywoszynska K, Kozlowski H. Metal transport and homeostasis within the human body: toxicity associated with transport abnormalities. Curr Med Chem. 2012;19(17):2738-59. doi: 10.2174/092986712800609698. PMID: 22455583.

3. Zhang Y., Zheng J. Bioinformatics of metalloproteins and metalloproteomes. *Molecules.* 2020;25:3366. doi: 10.3390/molecules25153366

4. Andreini C., Bertini I., Cavallaro G., Holliday G.L., Thornton J.M. Metal ions in biological catalysis: From enzyme databases to general principles. *J. Biol. Inorg. Chem.* 2008;13:1205–1218. doi: 10.1007/s00775-008-0404-5.

5. Witkowska D, Słowik J, Chilicka K. Heavy Metals and Human Health: Possible Exposure Pathways and the Competition for Protein Binding Sites. Molecules. 2021 Oct 7;26(19):6060. doi: 10.3390/molecules26196060. PMID: 34641604; PMCID: PMC8511997.

6. Seema Sing1,Swati Lal1 ,Jeena Harjit1*,Sulbha Amlathe2 and H.C.Kataria3, Vol.3,2011,no.5,239-246 33-40.

7. Pietrzak S., Wójcik J., Baszuk P., Marciniak W., Wojtyś M., Dębniak T., Cybulski C., Gronwald J., Alchimowicz J., Masojć B., et al. Influence of the levels of arsenic, cadmium, mercury and lead on overall survival in lung cancer. Biomolecules. 2021;11:1160. doi: 10.3390/biom11081160.

8. WHO (World Health Organisation). (2008). Guidelines for drinking water quality, 3rd edition. Recommendations. World Health Organisation Press, World Health Organisation, Geneva, Switzerland, 1:1- 459.

9. Perrelli M, Wu R, Liu DJ, Lucchini RG, Del Bosque-Plata L, Vergare MJ, Akhter MP, Ott J, Gragnoli C. Heavy metals as risk factors for human diseases - a Bayesian network approach. Eur Rev Med Pharmacol Sci. 2022 Dec;26(24):9275-9310. doi: 10.26355/eurrev_202212_30681. PMID: 36591839.

10. Lars Järup, Hazards of heavy metal contamination, *British Medical Bulletin*, Volume 68, Issue 1, December 2003, Pages 167–18

11. World Health Organization (WHO) 10 Chemicals of Public Health Concern. [(accessed on 6 October 2021)].

12. Guerra F., Trevizam A.R., Muraoka T., Marcante N.C., Canniatti-Brazaca S.G. Heavy metals in vegetables and potential risk for human health. *Sci. Agric.* 2012;69:54–60. doi: 10.1590/S0103-90162012000100008.

13. Zhao G, Ma Y, Liu Y, Cheng J, Wang X. Source analysis and ecological risk assessment of heavy metals in farmland soils around heavy metal industry in Anxin County. Sci Rep. 2022 Jun 22;12(1):10562. doi: 10.1038/s41598-022-13977-6. PMID: 35732673; PMCID: PMC9217823.

14. Zhou S, Li W, Wan J, Fu Y, Lu H, Li N, Zhang X, Si Y, Wang X, Feng X, Tai B, Hu D, Lin H, Wang B, Wang C, Zheng S, Liu X, Rong W, Wang W, Deng X, Zhang Z. Heavy metals in drinking water and periodontitis: evidence from the national oral health survey from China. BMC Public Health. 2023 Sep 4;23(1):1706. doi: 10.1186/s12889-023-16391-3. PMID: 37667326; PMCID: PMC10476365.

Appendix

حـــــــــکومەتی هەرێمی کوردستان
سەرۆکایەتی ئـــــەنجومەنی وەزیران
دەستەی پـــــاراستن و چاککردنی ژینگە
فەرمانگەی ژینگەی هەولێر
هۆبەی تاقیگەکان

Kurdistan Regional Government- Iraq
Council of Ministers
Environmental Protection & Improvement Board

حـــــــــکومة اقـليم كـــــوردستان
رئاســـــــة مـــــجلس الـــــــوزراء
هيئة حـــماية وتـــحـــسـين البيئـــة
دائـــــرة بـــيـئـــة اربـــيـــل
شعبة المختبرات

ئەنجامی تێستی ئاو

date of test : 12/5/2024 **location: هەولێر**

NO. ز	Parameters پارامیتەرەکان	results S1 ئەنجام	results S2 ئەنجام	results S 3 ئەنجام	results S 4 ئەنجام	kurdistan standard ژمارە (٣١٤)وەقایعی کوردستانی سالی ٢٠٢٤ سنوری رێنیدراو	Evaluation هەڵسەنگاندن
heavy metals							
1	Copper (Co) mg/ L	0.091	0.014	0.07	0.018	0.2	Satisfactory (گونجاوە)
2	Chromium (Cr) mg/ L	0.005	0.0001	0.0012	0.0071	0.1	Satisfactory (گونجاوە)
3	iron(Fe) mg/ L	1.03	0.08	0.001	1	5	Satisfactory (گونجاوە)

ئێمە بەرپرس نین خۆیان ئاوەکەیان هێناوە

دەستەی پاراستن و چاککردنی ژینگە
فەرمانگەی ژینگەی هەولێر
تاقیگەی شیکاری

lab.Supervisor
Azhin Faidhala Jalal
13 / 5 / 2024