Physical and chemical properties of rain water quality in Erbil city Kurdistan region of Iraq

Research Project
Submitted to the department of (**Biology**) in partial fulfillment of the requirements for the degree of **B.Sc**. in (**Biology**)

By

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Supervisor Certificate

This research project has been written under my supervision and has been submitted for the award of the degree of BSc. in Biology with my approval as a supervisor.

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Dedication

This work is dedicated to:

To my grandfather and grandmother soul

To my Dear father

To my Dear mother and to my Dear brothers

Acknowledgement

In the name of Allah. Thanks to Allah for directing me and assisting me in completing my research project. He has been a source of comfort and support for me throughout my academic career.

I am really grateful to Salahuddin University-Erbil for providing me the chance to finish my study. A particular thank you goes out to the dean of the college of education and the head and staff of the biology department.

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My sincere appreciation to my supervisor, **Dr. Tara Mohammed Hassan** for her unfailing support and direction.

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Summury

rainwater is an important means of scavenging pollutants from the atmosphere, for both gases and the particulate phase. The composition of rainwater actually reflects the composition of the atmosphere through which it falls. has reported that more than 90% of the total amount of pollutants present in the atmosphere is lixiviated by wet deposition, being the predominant cleansing mechanism to remove pollutants from the air. Over the last twenty years, rainwater chemistry has been subject to intense research and many studies on the chemical composition and long-term temporal trends of precipitation have been conducted worldwide.

This study investigates the physical and chemical characteristics of rainwater quality in the Erbil region of Kurdistan. Sampling was conducted over a specified period to analyze parameters including PH , Alkalinity, Acidity and TDs, EC were estimated as following : The highest PH value for all the samples wsa 7.4 in Farmanbaran and minimum was 4.9 in Mantikawa. Total Alkalinity maximum value recorded In 1^{st} sampling the in Baxlumnara was 370, while Acidity maximum value recorded in 2^{nd} sampling for most locations and the maximum electrical conductivity was recorded 373 in zanko for 1^{st} sapling . Total dissolved solid in the water TDS was 206 ppm in 1st sampling maximum value among all 2 sampling recorded in Zanko, while minium value was recorded in Mantikawa was 10ppm. While the other chemical elementwas NO3 sampling the maximum value recorded in Baxlumnara was 0.263 mg/l, and for NO2 was 5.543 for Havalan and maximum value recorded for SO_4 and PO4 was1st sampling in Daratw 0.772 mg/l and 0.382 in Mantkawa respextivly.

1.Introduction

One of the main sources of water for domestic and industrial use, rainwater is a renewable resource. It serves as a substitute for a drinking water supply (Lee et al., 2017). The earth's atmosphere, seasonal cycles, and the survival of all plants and animal life all benefit greatly from rainfall. Rain has numerous positive effects on the environment, such as reviving wild plants, hydrating the air, forming streams and rivers, replenishing the water table, and producing highly beneficial negative ions. Rearranging clean, fresh water throughout the water cycle is the principal benefit of rainfall (Sakai et al., 2004; Levine and Yang, 2014). There are many households uses for rainwater, including washing clothes, cleaning the house, watering plants and lawns, and washing cars. Rainwater is also regarded as drinking water in locations where there is a high probability of a water shortage (Evans et al., 2007). In many respects, rain is really good for people, but too much of it is bad for the ecosystem. Because rainwater contains less additional contaminants than artificial irrigation systems do, including chlorine, it is typically preferred over synthetic agriculture equipment. There is one potential issue, though: the advantages of rainfall are diminished when a polluted atmosphere creates acid rain, which is exceedingly dangerous for both the environment and human health (Mehta, 2010). The majority of pollutants in rainwater come from the atmosphere being washed away, but the worst contamination happens when rainwater runs off of topography, roofs, gutters, or pipeline networks. However, the introduction of microbial pathogens, such as bacteria, viruses, and protozoa, is what leads to the most contamination (Helmreich and Horn, 2009). The pure quality of rainfall is under jeopardy due to anthropogenic activity in recent years. These operations include burning gas flares, producing chemicals, building things, fixing cars, and disposing of rubbish, among others. They discharge pollutants such as CO2, SO2, NO2, and methane, which dissolve in precipitation and cause acid rain and global warming (Mohamed et al., 2019). The quality of the water will vary when the air in the vicinity is contaminated because rain captures or traps pollutants as it falls before

they reach the ground (Amin and Alazba, 2011). Rainfall can be a source of pollution for soil, water, and terrestrial vegetation as well as a technique to lessen the number of pollutants in the atmosphere (Cerqueira et al., 2014). The chemistry of rainfall is greatly influenced by dust particles, both created by humans and naturally occurring. Cations totally neutralize the acidity of rainfall before it hits the ground (Ali et al., 2004), (Haasan,2023). rainwater is an important means of scavenging pollutants from the atmosphere, for both gases and the particulate phase. The composition of rainwater actually reflects the composition of the atmosphere through which it falls. has reported that more than 90% of the total amount of pollutants present in the atmosphere is lixiviated by wet deposition, being the predominant cleansing mechanism to remove pollutants from the air. Thus, rainwater can be a way to reduce the atmospheric load of pollutants, as well as a source of contamination for soil, water and terrestrial vegetation in this framework. Drinking water quality and human health are closely interrelated. Diseases like cholera, dysentery, diarrhea and typhoid are spread mainly due to microorganism present in water. the high contents of nitrates, phosphates, inappropriate proportions of cations and anions also have negative health impacts. The heavy metals in drinking water are mainly carcinogenic (Fareed, 2015). Although rainwater is generally considered as non-polluted, or at least not significantly polluted, it may be acidic and/or contaminated by dirt, organic micropollutants, metals, pesticides, etc., which affect the quality of rainwater runoff (Friedler et al., 2017). The physicochemical parameters of water like temperature, PH, electric conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total alkalinity, carbonates, bicarbonates, calcium, magnesium, hardness, chlorides, sulphates, nutrients like nitrates and phosphates, turbidity and total dissolved solids are important to know the trophic nature of the water body. Water bodies are generally of three types oligotrophic, mesotrophic and eutrophic. Usually, mesotrophic water bodies are highly productive in nature (Kumari et al., 2019).

The study was aimed to estimate the physical and chemical properties of the rainwater in order to indicate the type of pollution which cached from air in Erbil city.

2.Literature Review

Astudy on Rainwater samples were conducted in 2001 and 2002 from Roorkee urban area, a medium sized ‘‘town group’’ situated on the right bank of Solani River, a tributary of the Ganga River, near the Himalayan foothills and analyzed for EC, pH, TSS, TDS and major ions. The median value of pH was 7.05, well above 5.6, which is the reference pH.

Investigation on ratio of TA/TC was carried and results shows quite below 1.0, indicating alkaline nature of rainwater. The concentration of ions in rain water have been observed to follow the pattern Ca2+4HCO3 4Cl4NO3 4Na+4Mg2+4SO4 24K+. In order to estimate the marine and non-marine contribution, sea salt fraction has been calculated taking Na+ as reference. All ionic ratios have been found to be higher than the recommended sea water ratios in all three types of land use, viz. residential, commercial and industrial, suggesting a significant contribution of non-marine origin for these components. A comparison with the data of the other Indian sites validates the inverse relation of Cland Na+ with distance from the sea and highlights higher Ca2+ concentration and lower SO4 2concentration. The assessments of the air pollution for Erbil city were carried out by collecting samples of rain from different regions and test them in a lab to find out their pollutant effect on human health and investigate their suitability for domestic use. The acidity of the rain was tested as well; the concentration of each of TDS, NO3, CL, Ca, and turbidity were measured for many stations in Erbil city. The study conducted the quality of rain water for drinking and irrigation purposes by using Water qualityindex (WQI) and Irrigation water quality index (IWQI). Both indexes are used to make our data easier and understandable by the public. The most important variables such as turbidity, pH, electrical conductivity, total dissolved solids, alkalinity, total hardness, calcium,

chloride andnitrate were taken for calculation of WQI and IWQI for a 1st and 22thNovember- 2014 to 1st and 20th February- 2015. Four sites were chosen within Erbil city (Zhian Q, Qaratapa Q, Karizan and Mamostian Q) with three replications for each sample. The higher index value, WQI, for rain water samples of 2014 was 49.852 while the lowest which means excellent and good for drinking purposes respectively, The assessments of the air pollution for Erbil city were carried out by collecting samples of rain from different regions and test them in a lab to find out there pollutant effect on human health and investigate their suitability for domestic use.

A study was examined the rainwater yields of some of the three regions, namely the inhabited cities of Duhok and Zaho, and the Kowashe area of Iraqi Kurdistan, which is considered to be an industrial area with many factories for many different industries. Compiled in a study of chemical and physical properties. This is in an agricultural area where different types of crops are grown and this was done by conducting several tests. For example, pH TDS, Ca and Mg concentrations.

3. Materials and methods

3.1. Sample collection

The samples were collected tow Times in 3 November 2023 at Eight different spots and in 15 November 2023 at Ten different spots were selected for Rain Water collection from Erbil city, the locations were divided in four directions north Est, north west, south east and south west of four main circle of streets around the city (30, 60.100,120) after sieving samples were stored in refrigerator at 4 ºC till the tests were conducted.

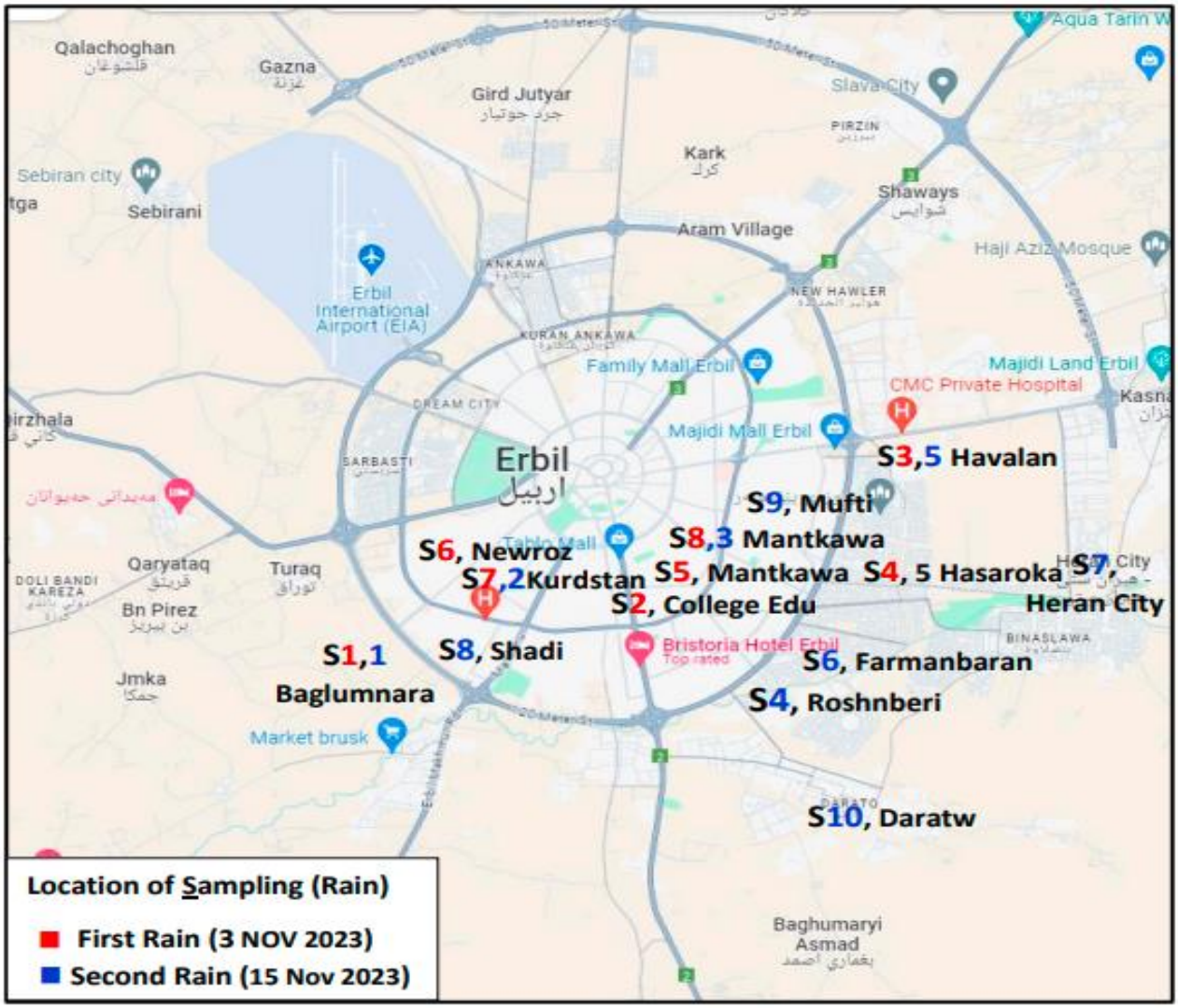

Figure 1. Map of Erbil city indicating the location of the study.

3.2. Physical Properties Analysis Includes:

1. Electrical Conductivity (EC)

It was measured using a portable conductivity meter model (HI 9811, HANNA instruments, 2000) calibrated with (0.01M) standard potassium chloride solution, the results were expressed in µS.cm-1 as described by (APHA, 2012).

2. Turbidity

It was measured by Nephelometric method using HACH turbidimeter model (2100A, U.S.A), calibrated by using of manufacture standard solutions of 0.61, 1, 10, 100, and 1000 NTU, and the results were expressed as NTU (8).

3.3. Chemical Properties Analysis Includes:

1. Hydrogen ion concentration (pH)

It was measured by Electrometric method using a portable pH-meter model (HI 9811, HANNA instruments, 2000) accurate up to 0.01 pH unit with a range of 0 to 14. The instrument was calibrated using buffer solutions of (pH= 4, 7 and 9) as described by (APHA 2012).

2. Sulfate - SO4

Sulfate was determined by Turbidimetric method using Barium chloride, buffer solution, and HACH turbidimeter model (2100 A, U.S.A), as described by APHA (2012). Sulfate values were determined from the calibration curve and the results were expressed as mg SO4-2 l-1.

3. Nitrogen - Nitrite N-NO2

Determined by Spectrophotometric method using color reagent composed of a mixture of Phosphoric acid, Sulfanilamide and N-(1- naphthyl)-ethylenediamine dihydrochloride using wavelength of 543nm in 1cm cuvette cell the results were expressed in mg l-1 (APHA, 2012).

4. Nitrogen - Nitrate N-NO3

Nitrate was determined by Ultraviolet Spectrophotometric Screening Method using hydrochloric acid solution 1N and Ultraviolet spectrophotometer (model Genway 1400) with a quartz 1 cm cuvette cell at a wavelength of 220 nm for nitrate reading and a wavelength of 275 nm to determine interference due to the dissolved organic matter. The results were expressed in mg l-1 (APHA, 2012).

5. Reactive Phosphorus - PO4

Reactive phosphorus was determined by Stannous Chloride Method using stannous chloride and ammonium molybdate to form molybdenum blue. The absorbance was measured in 1cm cuvette cell at the wavelength of 690 nm. The results were obtained through a standard curve and expressed in mg P-PO4 l-1 (APHA, 2012).

6. Total Alkalinity

It was determined by Titration method using standard sulfuric acid titrant (0.1 N) as described by APHA (2012), the results were expressed in mg CaCO3 l-1 using the Formula bellow: Alkalinity as mg CaCO3 l-1 = A x N x 50000/ml of sample. Where: A= ml of standard acid used. N= normality of standard acid.

7. Total Acidity

Acidity was determined by Titration method using standard sodium hydroxide titrant (0.1 N) as described by APHA (2012), the results were expressed in mg CaCO3 l-1 using the following formula: Acidity as mg CaCO3 l-1 = A x B x 50000/ml of sample. Where: A= ml of standard NaOH titrant used. B= normality of standard NaOH.

8. Total Hardness

It was determined by EDTA Titrimetric method as described by APHA (2012), using Eriochrome Black T as indicator and buffer solution of PH 10, the results were expressed in mg CaCO3 l-1using the formula bellow:
Hardness as mg CaCO3 l-1 = A x B x 1000/ml of sample.

Where: A= ml titration for sample. B= mg CaCO3 equivalent to 1ml EDTA titrant.

4. Result and Discussion

4.1 Hydrogen ion concentration- pH:

In 1st sampling the maximum value recorded in Zanko was 7.32, while minimum value recorded at Mantkawa was 4.9 In second sampling the maximum value recorded at Farmanbaran 7.42, while the minimum value recorded at Baghlumnara was 5.84, as shown Table (1). in previous studied shows typical surface waters have PH ranging from 6.5 to 9. The pH level of most drinking water is between 6.5 and 8.5 degrees. If the water is at 7, it means that the distilled water is completely pure, with a neutral pH, but if it is less, it has the most acidity, and if the acidity is above 7, it means that the water is alkaline.

4.2 Electrical conductivity – EC:

Is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentrations, mobility, and on the temperature of measurement Abdulla (2014) EC: In 1st sampling the maximum value recorded in Zanko was 373 While minimum value recorded at Nawroz was 19 In second sampling the maximum value recorded at Daratu 158 while the minimum value recorded at Heran city was 20, as shown Table (1)

4.3 Total dissolved solid in the water- TDS:

The 1st sampling maximum value recorded in Zanko was 206 _ppm_ while the minimum value recorded at Nawroz was 8 _ppm_ in 2nd sampling The maximum value recorded in Daratu was 84 _ppm_ while the minimum value recorded at Heran city was 8 _ppm_ Total dissolved solid in the water, as shown Table (1)

Table (1) Shows physical properties Rain water for both sampling

Location of First Sampling	**PH**	**EC (µs/cm)**	**TDS (ppm)**
1. Baghlumnara	6.67	360	180
2. Zanko	7.32	373	206
3. Havalan	7.05	114	57
4. 5 Hasroka	5.86	30	15
5. Mantkawa	4.9	39	19
6. Nawroz	5.27	19	8
7. Kurdistan	5.96	69	35
8. Mantkawa	6	21	10
Location of Second sampling			
1. Baghlumnara	5.84	75	35
2. Kurdistan	7.37	74	37
3. Mantkawa	6.45	52	26
4. Roshnberi	6.16	129	64
5. Havalan	6.07	21	10
6. Farmanbaran	7.42	90	45
7. Heran City	6.4	20	8
8. Shady	5.98	68	32
9. Mufty	6.26	75	37
10. Daratu	6.58	158	84

4.4 Sulfate - SO4

Sulfate was determined by Turbidimetric method using Barium chloride, buffer solution, and HACH turbidimeter model (2100 A, U.S.A), as described by APHA (2012). Sulfate values were determined from the calibration curve and the results were expressed as mg SO4-2 l-1. SO4: In 1st sampling the maximum value recorded in Baghlumnara 0.0766

While minimum value recorded at Mantkawa 0.0745 In second sampling the maximum value recorded at Heran city 0.0745, as shown in Figure (2)

4.5. Reactive Phosphorus - PO4

The PO4 of 1st sampling the maximum value recorded in Mantkawa was 0.3825 and Havalan 0.34 while minimum value recorded at Balghumanara was 0.34 In second sampling the maximum value recorded at sampling Roshnberi was 0.3475 while minimum value recorded at Mantakawa was 0.35 and Nawroz was 0.35 and also in Kurdistan was 0.35 as shown in Figure (2).

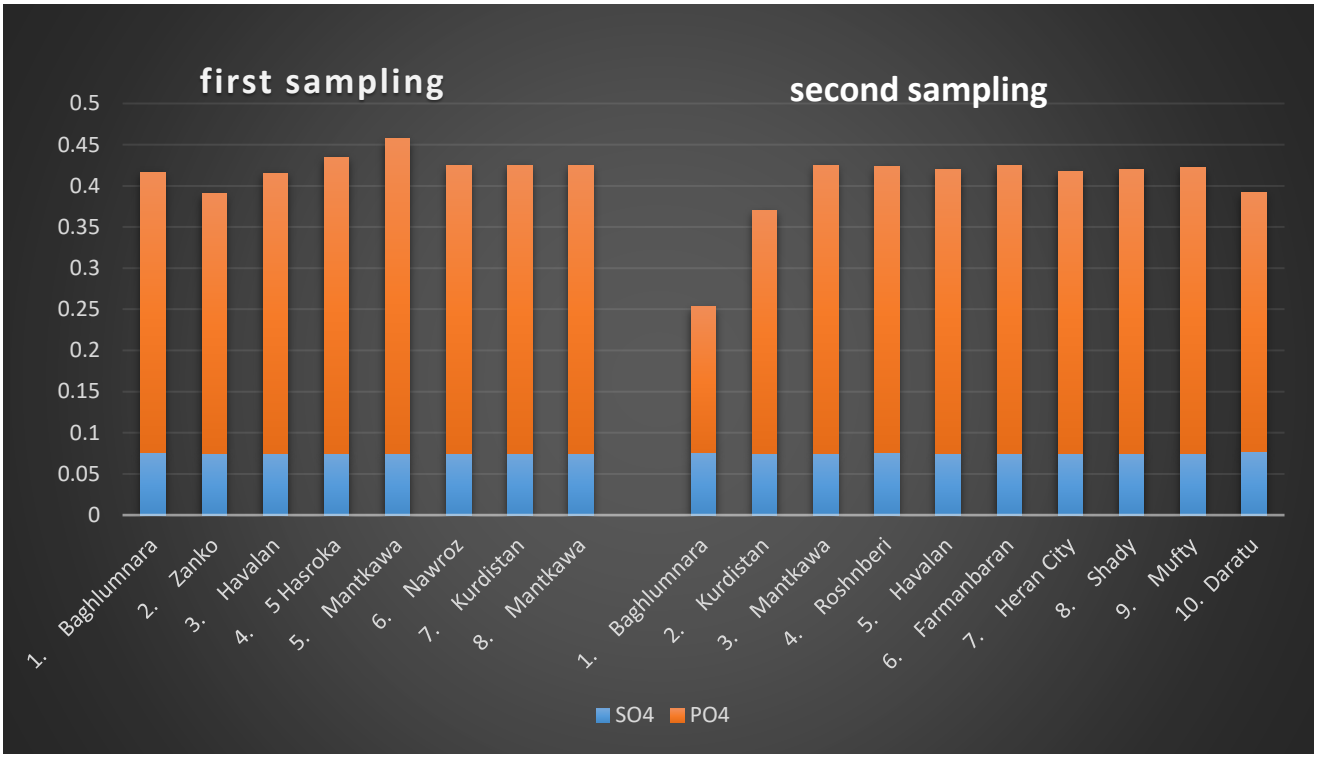

Figure (2): Shows SO4 & PO4 recorded during the study period

4.6. Nitrogen - Nitrite N-NO2

NO2: 1st sampling the maximum value recorded in Kurdistan 0.481825 while minimum value recorded at Mantkawa 0.42712 In second sampling the maximum value recorded at Baghlumnara 6.8197 while minimum value recorded at Heran 0.4792, as shown in figure (3).

4.7 Nitrogen - Nitrate N-NO3

Nitrate was determined by Ultraviolet Spectrophotometric Screening Method using hydrochloric acid solution 1N and Ultraviolet spectrophotometer (model Genway 1400) with a quartz 1 cm cuvette cell at a wavelength of 220 nm for nitrate reading and a wavelength of 275 nm to determine interference due to the dissolved organic matter. The results were expressed in mg l-1 (APHA, 2012). NO3: 1st sampling the maximum value recorded in Havalan 0.17155 while minimum value recorded at 5-hasroka 0.1033 In second sampling the maximum value recorded at Second sampling Roshanberi 0.24835

While minimum value recorded at Farmanbaran 0.1033, as shown in figure (3).

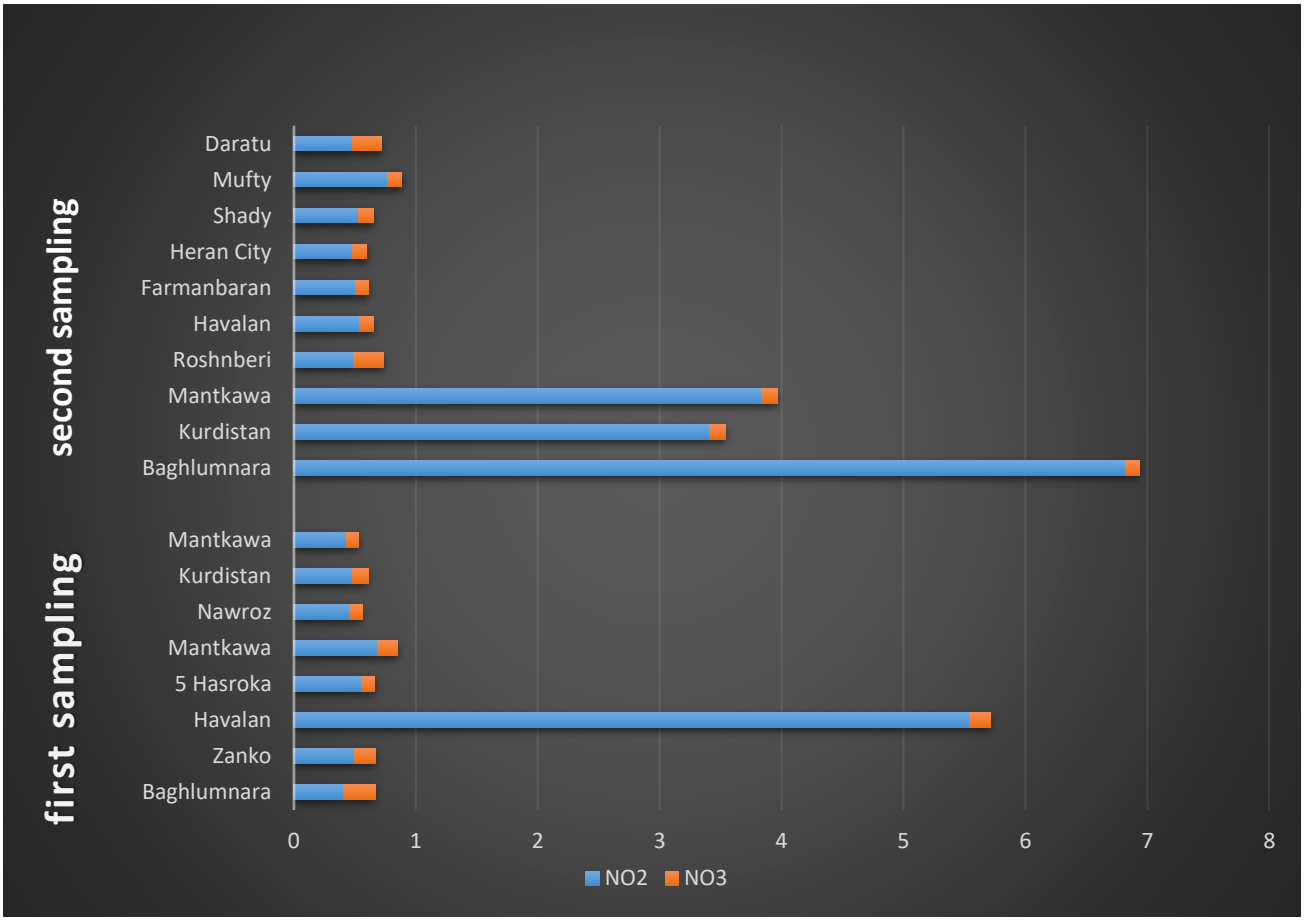

Figure (4): Shows NO2 & NO3 recorded during the study period

4.8 Total Alkalinity

TOTAL ALKALINITY: 1st sampling the maximum value recorded in Baghlumnara was 370 while 5-Hasaroka while the minimum value recorded at 5-Hasaroka was 5 In de sampling the maximum value recorded at sampling Roshnberi was 150 while minimum value recorded at Havalan was 10, as shown in figure (5)

4.9 Total Acidity

Total acidity: 1st sampling the maximum value recorded in Kurdistan was 0.7 while while the minimum value recorded at 5Hasarok was 0.15, as shown in figure (5)

4.10 Total Hardness

It was determined by EDTA Titrimetric method as described by APHA (2012), using Eriochrome Black T as indicator and buffer solution of PH 10, the results were expressed in mg CaCO3 l-1using the formula bellow:

Hardness as mg CaCO3 l-1 = A x B x 1000/ml of sample.

Where: A= ml titration for sample. B= mg CaCO3 equivalent to 1ml EDTA titrant.

TOTAL HARDNESS: 1st sampling the maximum value recorded in Zanko was 72 while the minimum value recorded at mantkawa was 12 In the second sampling the maximum value recorded at sampling Roshnberi was 64 while minimum value recorded at Havalan was 4, as shown in figure (5)

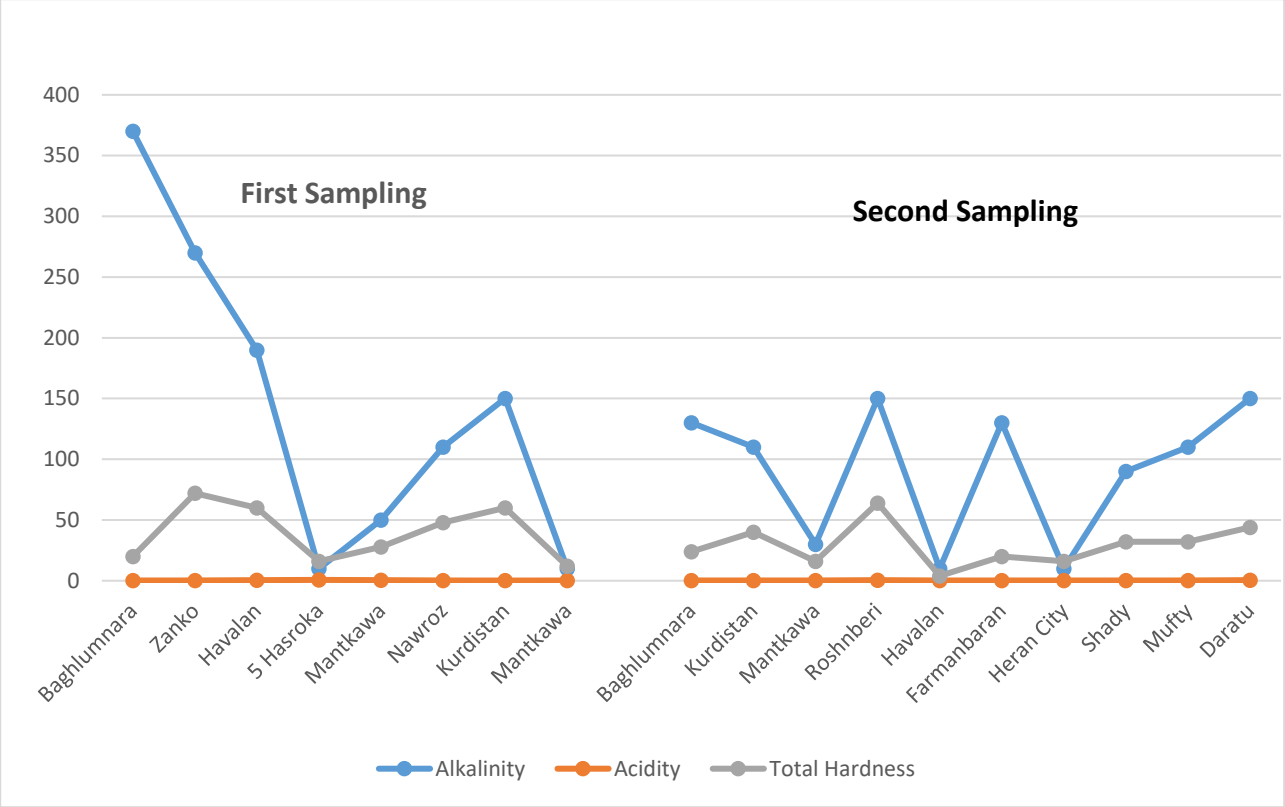

Figure (4): Shows Alkalinity, Acidity and Total Hardness recorded during the study period

5. Conclusion

1. The conclusion of a study on the physical and chemical properties of rainwater quality in the Erbil region of Kurdistan would likely summarize the key findings and implications of the research.
2. This could include insights into the sources of pollutants, variations in water quality over time, potential impacts on the environment and public health, and recommendations for mitigating any identified risks or improving water quality management practices
3. The highest PH value for all the samples wsa 7.42 in Farmanbaran and minimum was 4.9 in Mantikawa.
4. The maximum Electrical conductivity was recorded 373 in Zanko and lowest value was 19 in Nawroz.
5. Total dissolved solid in the water TDS was 206 ppm in 1st sampling, while minium value was recorded in shadi was 8 ppm in Nawroz.
6. The maximum value NO2and NO3 sampling recorded in Baxlumnara was 6.819, and 0.2635 mg/l respectivly.
7. maximum value recorded for SO_4 and PO4 was1st sampling in Daratw 0.772 mg/l and 0.3825 in Mantikawa respextivly.
8. Total Hardness maximum value recorded In 1^{st} sampling the in Zanko was 72, while minimum value recorded in Havalan.

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