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Assessment of Well Water Quality for Drinking Purposes Within Selevania District, Zakho City, Kurdistan Region / Iraq

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ABSTRACT:
The world's major sources of drinking water are groundwater particularly wells water. In the present study, the quality of the wells in the 10 villages nearby the city of Zakho were selected for investigation and their suitability for drinking purposes. All the well water samples were analyzed for 11 chemical and physical analysis including dissolved oxygen, total hardness, chloride, total dissolved solids, electrical conductivity, pH, sulfate, and four heavy metals, such as Cu, Fe, Pb, and Zn using standard methods. The results showed that the value of heavy metals in well water samples were in these ranges: Zn (0.027± 0.004 to 0.005 ± 0.007) mg/L; Fe (0.0109 ± 0.035 to 0.183 ± 0.061) mg/L; Cu (0.001 ± 0.022 to 0.025 ± 0.023) mg/L; Pb (0.045 ± 0.015 to 0.069 ± 0.096) mg/L. The range of physical and chemical parameters were; pH (7.1 to 8.3), EC (411 to1579 µS/cm), TDS (263 to 1010 mg/L), Total Alkalinity (287 to 584 mg/L), Total hardness (176 to 848 mg/L), Chloride (11.6 to 56.9 mg/L), calcium (80 to 673 mg/L), dissolved oxygen (6.1 to 8.7 mg/L), sulfate (10.3 to 42.5 mg/L) and temperature (17.0 to 23.4°C). The results were compared with international standards and showed that the mean values of total hardness and TDS in locations betas, Bezehe and Dolla are ranged from (827.13 ± 5.330), (544.25 ±3.178) ,(782.63 ± 3.257), (930.38 ± 3.545), (675.75± 3.639) ,(996.25 ± 3.245) mg/L respectively, were found to be higher than WHO water standards, and unsuitable for drinking use. The results have proven the presence of heavy metal as especially lead, Zn, Cu, and Fe have been containing in the study area. Other parameters were within (WHO) drinking water standards. In conclusion, the other sites of well water sources of the Selevania region are suitable for drinking purposes.

KEYWORDS: Heavy metals, well water, drinking water quality, Zakho city

1. INTRODUCTION

Water especially for drinking and domestic purposes is expected to be of suitable quality and without contaminants. As well water moves through differents geological layers in the sub-surface, it dissolves impurities of both inorganic and organic origin (Tajinder et al, 2016) Domestic water was exposed to dissolved metals, derived from natural and anthropogenic originates. The main sources of the poisonous metals in well water can be released from agricultural soil and chemical weathering of heavy metals, as well as anthropogenic action (Jabal et al , 2015).The anthropogenic sources involved the industrial effluent, domestic effluent, agriculture, landfill leachate, and mining activities.(Baskoro et al., 2019).Trace metals are natural components of the layers of earth, and cannot be destroyed. Some trace elements likes (e.g. Zn and Cu) are important for the physiological process and have a toxic effect (Adam et al ., 2019). Groundwater is type of fresh water that used to supply for urban and rural area ,90% of freshwater source in the earth are coming from groundwater. Groundwater can be found in two type of storage that called hardrock aquifers and alluvial aquifer. (Mohamed et al., 2017). Water is responsible for about 86% of the major diseases in human. The chemical installation of well water is a measure of its suitability for animal and human consumption, Groundwater contain the dissolved ions which can affect the water's uses depending on their concentration and types of cations and anions found in wellwater contained Chromium, Manganese, Cadmium, Calcium, Cobalt, Sulfate, Copper, Zinc, Chloride Bicarbonate and Nitrate. Non-ionic such as oxides, synthetic detergents phenols, dissolved CO_2 and O_2 are also found in well water (Yousra et al ., 2019). These criteria determine the quality of well water in terms of anions and cations. If it is present in above allowed limits of value, it may cause health hazards because of contamination and, the well water may need to be treated before utilization (Mohamed et al., 2017). The objectives of this study is to evaluated the chemical and physical characteristics of well water seasonly in the Zakho district and made comparison with WHO,standards of potable quality to ensure the quality of well water

2. MATERIALS AND METHODS

2.1 Study area: The research wells are located in selevania are near the Zakho district northern Iraq. The study area falls within Latitude: 37° 08' 55.36" N and Longitude: 42° 41' 9.28" E and lies about 55 km north of Duhok city. The climate of the study area is hot, dry in summer and cold wet in winter

2.3 Statistical analysis. Data for chemical and physical parameters of well water samples were presented as mean values, standard deviation. Data collected were analysed for simple descriptive and inferential statistics using variance (ANOVA) was the statistical tool used together with computer SPSS 16.0 windows application.

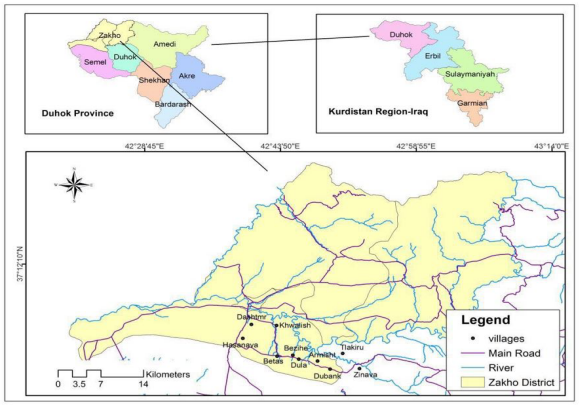

Figure 1: Map of Zakho district showing sampling locations, inflowing selevania well water

2.2 Samples collection and analysis. 80 well water samples were collected from different sites of the study area. The depth of wells in the study area are between 77 to 85 meters. The well water samples were collected in 1-liter polythene bottles. The well water samples were collected from 10 different sites around Selevania subdistrict during the summer and winter seasons from August 2019 to March 2020. Well water samples were immediately transferred to the laboratory for chemical physical and physical analysis. The water samples were kept in a refrigerator at a temperature below 4◦C, and analyzed within 3 day. The various water quality parameters like (TH, pH, TDS, Mg^{2+}, , Ca^{2+} ,Cl−, SO^{-}_{4}, EC, TA, Fe. Zn, Cu, and Pb) were assessed by American Public Health Association standard methods (APHA, 2017). Drinking water quality analyzers were studied for temperature (T°C), electrical conductivity (EC), total dissolved solids (TDS), Hydrogen ion concentration (pH).were determined in the field due to their unstable nature, and , Dissolved oxygen (DO), total hardness (TH) , total alkalinity (TA) Chloride (Cl-), and Sulfate (SO4 2-).The water samples were digested primarily in a mixture solution of HNO3, HCl (1:3), then added HClO4 for further digestion. The total concentrations of Zn, fe, Pb, and Cu, in the digested samples were determined using flame atomic absorption spectrophotometry, the modle of AAS.

3. RESULTS AND DISCUSSION

TEMPERATURE (T°C): Temperature is the main parameter for the study of well water. Temperature is a major factor of chemical and physical transformations in the water body and plays a main role in the metabolic activities of the organism. The value of well water temperature was found to be in the range from (17.0 to 23.4°C) during the study period. Maximum standard for temperature for drinking water is 25°C.

Electrical conductivity (EC) in µS/cm: Electrical conductivity is a major parameter in assessing water quality for agriculture purposes and is used for indicator of salinity. In this work, the concentrations of electrical conductivity in all sampling sites were ranged from (411 to1579 µS/cm). The higher well

The variation in the well water temperature may be due to the well depth and the influence of seasons. The higher well water temperature was observed in November at the Ashanke site, while the Lower water temperature was observed in March at site Dolla. These values were within the world standards. Similar results reported by (Snehalata et al ., 2018).

Total dissolved solids (TDS) in mg/L: In the present investigation, the values of **total dissolved solids** are found in the range of (263 to 1010) mg/l for the well water samples in the summer and winter seasons respectively (Figure 4). While the total mean value and standard error of mean values were (348.63 ± 3.625 mg/L).

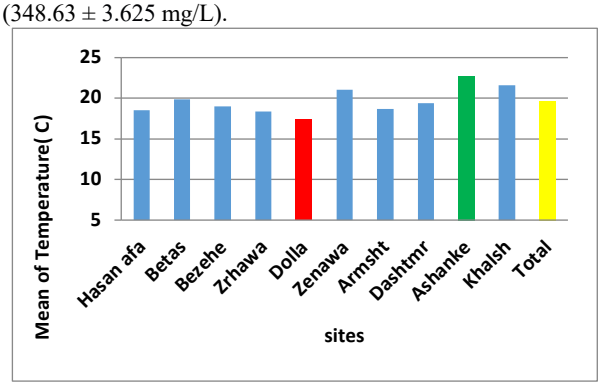

Figure (2) Mean of temperature (◦C) among selected well water

water conductivity were recorded in March at Dolla site, while the Lower water conductivity was observed in August at location Dashtmr. In Selevania District in all seasons electrical conductivity were higher in Winter (Table 2). This might be due to the presence of inorganic dissolved solids such as sulfate, chloride, magnesium, sodium, calcium, and iron cations. The concentrations observed in all sampling sites were within the standard value of (WHO 2012) drinking water quality which is 1000 µS/cm except the locations Betas, Bezehe and Dolla.While the mean value and standard error of mean values was (545.25± 5.618 µS/cm).These findings are lower than those reported by (Mustafa et al ., 2019).

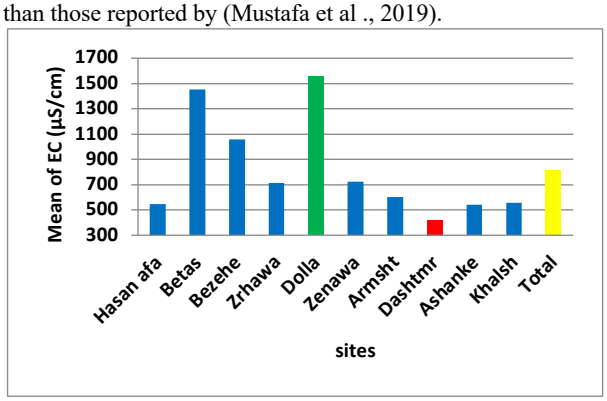

Figure (3) Mean concentration of Electrical conductivity (µS/cm) among selected well water

The High value of **total dissolved solids** in this area may be due to the discharge from agriculture and untreated wastewater. According to (WHO., 2011), the maximum permissible limiting concentration of **total dissolved solids** for drinking water is 500 mg/L. The TDS values were exceeded the permissible limit of 500 mg/l (WHO 2011) in three sites (Betas, Bezehe, Dolla) of the well water sampling sites in the winter and in the summer seasons. The higher concentration is due to the leaching of solid wastes from the ground surface as well as agriculture and animal waste. While the rest sites lied within the standard limits of drinking water. This paper are significantly higher than those reported by,(Neelam et al ., 2019).

Hydrogen Ion Concentration (pH): In the present study, the value of hydrogen ion (pH) ranges between (7.1 to 8.3), for the well water samples during the summer and rainy seasons respectively (Figure-5) While the total mean value and standard error of mean values was (7.4461± 0.02750) and all the well water samples have value within the safe limit of 6.5 to 8.5 standard set by (WHO ., 2012). In the present study in most sites observed that pH is alkaline.The general increase of pH in well water is related to weathering of plagioclase feldspar in sediments. pH showed significant variations ($p < 0.05$). Similar results reported by,(Mustafa et al ., 2018).

Dissolved oxygen (DO) in mg/L: In this work the values of dissolved oxygen are found in the range of 6.6 to-8.7 mg/l for the well water samples in the summer and winter season respectively (Figure 6). While the total mean value and standard error of mean values were (7.369 ± . 0724) mg/L.The permissible limit of the DO in drinking water should be ≥ 5 mg/L (WHO, 2011).The DO values are above the permissible limit of 6.0 mg/L (WHO 2011) in most of the sampling in three sites (Betas, Bezehe, Dolla) of the well water sampling sites in the winter and in the summer seasons. The higher concentration is due to the leaching of solid wastes from the ground surface as well as agriculture and animal waste. While the rest sites lied within the standard limits of drinking water. This paper are significantly higher than those reported by,(Neelam et al ., 2019).

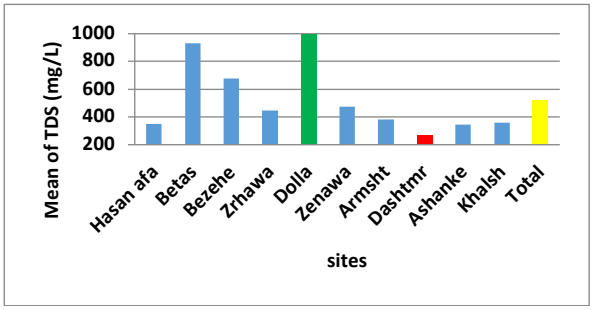

Figure 4: Mean concentration of TDS mg/L, among selected well water

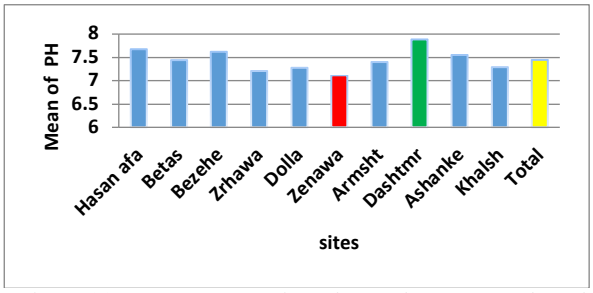

Figure (5) Mean concentration of pH value among selected well water

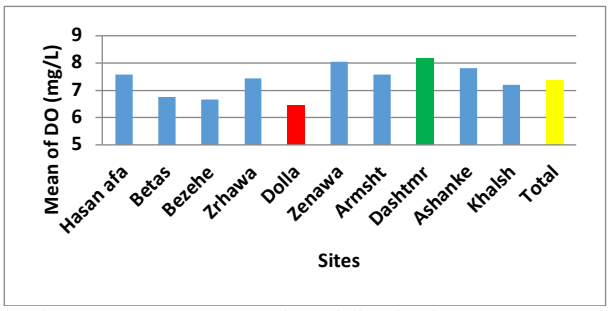

Figure 6: Mean concentration of dissolved oxygyn (DO) mg/L, among selected well water

sites. Whereas the (DO) is found to be higher in all the well water samples .The oxygen content of natural waters varies with salinity, temperature, turbulence and atmospheric pressure. DO concentrations showed significant variations at ($p < 0.05$). This paper are lower than those reported by (Onuorah et al ., 2019).

Total hardness as $CaCO_3$ in mg/L: Hardness of water mainly depends on the amount of calcium and magnesium ions. The values of total hardness are found to be in the range of (176 to 848) mg/L for the well water samples in the summer and winter seasons respectively (Figure 7). While the total mean value and standard error of mean values were (427.19 ± 23.491) mg/L.The higher concentration of total hardness of 848 mg/L was observed in March, while the minimum value of 176 mg/L was found in August. When the well water is in contact with dolomite or limestone the hardness value tends to be very high, may be due to the addition of magnesium and calcium salts

Chloride (CL-) in mg/l: .The value of Chlorides ion of well water sample ranges from (11.6 to 56.9) mg/L,in the summer and winter seasons respectively. And the mean values were ranged (12.550 ± 0.3185) to 54.950 ± 0.5127) mg/L. (Figure 8). While the total mean value and standard error of mean values were (28.651±1.6803) mg/L The chloride values of wells water samples were below the permissible limit of 250 mg/l (WHO 2011). High concentration of chloride in well water may result from both natural and anthropogenic sources. In this paper are higher than those reported by (Durgasrilakshmi.,2019) was (6.7 to 33.1) mg/L.

Total alkalinity (TA) in (mg/L): In the present study the total alkalinity value ranged between (287 to 584) mg/L, respectively in the summer and winter seasons. (Figure 9).While the total mean value and standard error of mean values were (423.65 ± 0.9.019) mg/L. The high total alkalinity is due to the When the well water is in contact with dolomite or limestone the hardness value tends to be very high ,may be due to the addition of magnesium and calcium salts. The permissible limits of total hardness in drinking is 300 mg/L as given by (WHO 2012) standards for drinking water .The total hardness concentration exceed the permissible limit of 300 mg/L at sampling sites. Betas. Bezehe, Zrhawa, Dolla, Zenawa and Armsht in summer and winter Season. According to these results.The permissible limits of total hardness in drinking is 300 mg/L as given by (WHO 2012) standards for drinking water .The total hardness concentration exceed the permissible limit of 300 mg/L at sampling sites. Betas. Bezehe, Zrhawa, Dolla, Zenawa and Armsht in summer and winter Season. According to these results, the well water in the study area was generally very hard. This paper are lower than those reported by (Wajid et al ., 2019).

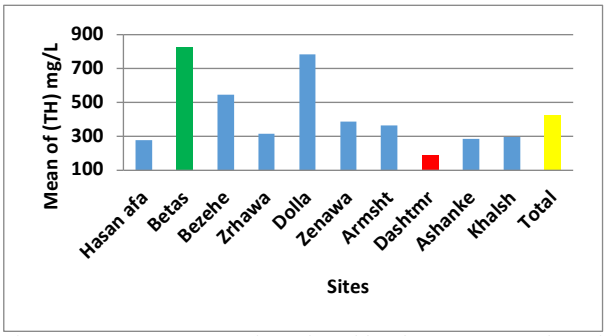

Figure 7: Mean concentration of total hardness among selected well water, (mg/L)

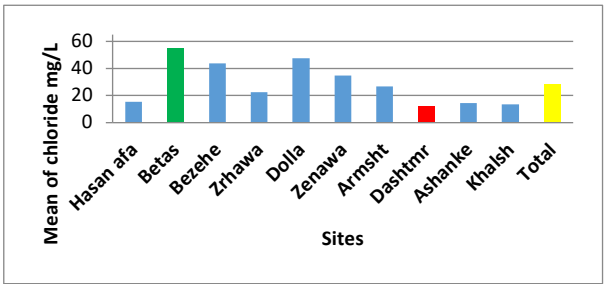

Figure 8: Mean concentration **of Chloride among selected well water mg/L**

presence of hydroxide, bicarbonates,and carbonates of potassium ,calcium, sodium, magnesium, sodium, and salts. According to (WHO., 2012) the desired limit and the maximum permissible limit for total alkalinity in potable water is 200 and 600 mg/l, Seasonal variation influenced the values at different sites with alkalinity being higher in the winter season (584 mg/L). An increase in alkalinity during winters may be due to agricultral discharge, as well as high rainfall, Total alkalinity have been found to be high as compared to desired limit concentration, but alittle lower compared to the maximum permissible limit values of (WHO 2011) standards. In this paper are higher than those reported by (Aniqa et al 2019).

(Sulfate (SO_4^{2-}) in mg/L: Seasonal variations of sulfate at various sites are shown in (Figure 10).The lowest value (10.3 mg/L) was found in August and the highest value (42.5mg/L) in winter showing the influence of seasons on values. Normally wellwater travels through rocks and soils a part of the sulfate-containing minerals are dissolved. The sulfate values are well within the permissible limit of 250 mg/L (WHO 2011) While the total mean value and standard error of mean values was (22.729 ± 1.2312) mg/L, in all sampling sites. The sulfate values are higher in the winter than the summer season. This

paper are lower than those reported by (Hanumantharao et al ., 2019).

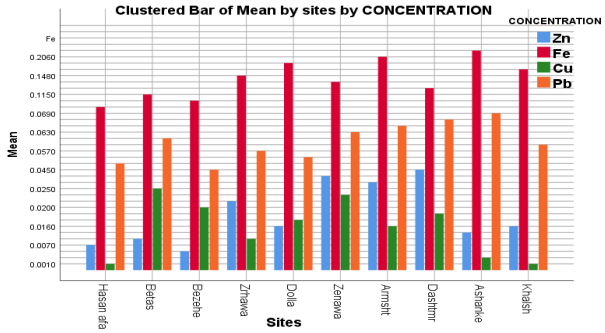

Figure (11) Mean concentration of Pb, Cu, Zn, and Fe in well water samples mg/L.

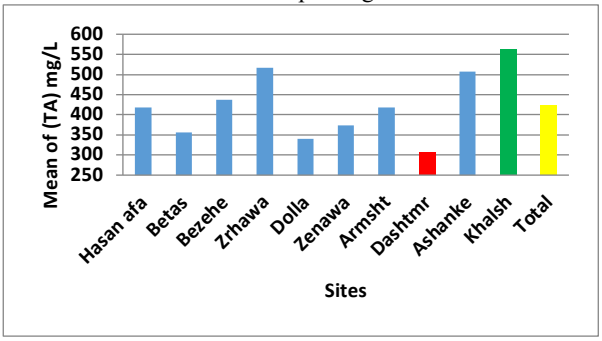

Figure (9) Mean concentration of total alkalinity among selected well water mg/L.

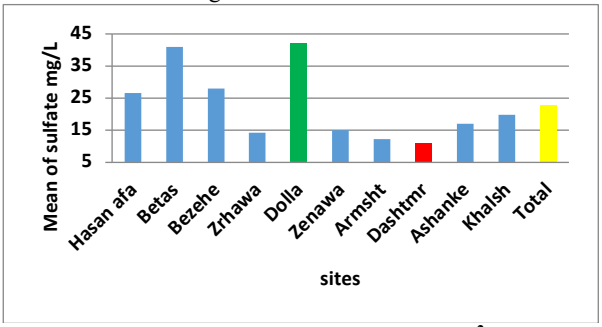

Figure (10) Mean concentration of sulfate SO_4^{2-} a mong selected well water mg/L.

Mean concentration of pb, Cu, Zn, and Fe in well water samples mg/L: In this study, the mean concentrations of Zinc in well water samples ranged from (0.027 ± 0.004 to 0.005± 0.007) mg/L,which within the permissible limit of 3.0 mg/L for drinking water. Set by (WHO., 2011). While the results obtained for the concentration of Fe ranged from ((0.0109 ± 0.035 to 0.183 ± 0.061) mg/L. According to (WHO ., 2011), the permissible limit of Fe in drinking water is considered 0.3 mg/L. The mean concentration of Cu in well water samples ranged from (0.001 ± 0.022 to 0.025 ± 0.023) mg/L. High concentration of Fe in well water occurs mainly through geological formation. These values were observed to be below the maximum permissible limits of (2.0 mg/L) according to (WHO.,2011). And the mean concentration of Pb in wells water samples ranged from (0.045 ± 0.015 to 0.069 ± 0.096) mg/L. High concentration of Pb in natural water occurs mainly through anthropogenic activities.

The permissible limit of Pb for drinking water is 0.05 mg/L, (WHO ., 2008). The mean concentrations of the metals of all the drinking water samples were significantly lower than the permissible limits set by (WHO., 2011) standard for drinking water. The value of heavy metals are ranked as Pb > Zn > Fe > Cu. In this paper are lower than those reported by (Nushe et al ., 2019).

4. CONCLUSION

The present work is conducted to evaluate chemical and physical properties of well water in the selevania region /Iraq. Most of the well water samples are permissible limits for drinking purpose recommended by the (WHO., 2012) . Results suggest that the well water quality in the study area is slightly alkaline and very hard in nature. It was found that TDS and total hardness in the sites Betas, Bezehe and Dolla were exceeding recommended limits in the water samples, which might prove to be harmful for health in the long term .The long-term of drinking water with higher concentrations of TDS and total hardness. It is suggested that such water should be used for drinking only after applying necessary treatments. Generally, most of the parameters in the waters samples were found to be within the limit of drinking water quality standards and are safe for dirking and other domestic purposes

Table 1: Physical-chemical properties of well water, data represented as mean± S.D, during studied period

Sites		T°C	EC	TDS	pH	DO	TH	Ca^{2+}	CL-	TA	SO_4^{2-}
Hasan afa	Mean±SE	18.525 ±0.186	545.25± 5.618	348.63± 3.625	7.6763± 0.017	7.575±0 .1485	279.00± 3.901	152.25± 6.244	15.450± 0.4040	418.63± 6.425	26.575± 0.161
Betas	Mean±SE	19.838± 0.169	1454.25 ±5.596	930.38± 3.545	7.4363± 0.019	6.750±0 .0423	827.13± 5.330	640.88± 8.490	54.950± 0.5127	356.63± 4.330	40.925± 0.3968
Bezehe	Mean±SE	19.013± 0.199	1056.63 ±5.388	675.75± 3.639	7.6238± 0.019	6.662±0 .1413	544.25± 3.178	352.12± 5.300	43.825± 0.5284	437.13± 4.015	28.063± 1.5879
Zrhawa	Mean±SE	18.363± 0.092	715.38± 11.915	448.13± 11.200	7.2038± 0.017	7.438±0 .1068	316.00± 3.713	196.50± 6.003	22.675± 0.3774	516.38± 5.186	14.313± 0.2837
Dolla	Mean±SE	17.375± 0.153	1557.12 ±5.037	996.25± 3.245	7.2725± 0.021	6.438±0 .1051	782.63± 3.257	238.25± 6.035	47.538± 04044	340.13± 4.055	42.275± 0.2366
Zenawa	Mean±SE	21.013± 0.201	721.13± 4.015	472.00± 11.273	7.1163± 0.019	8.038±0 .1101	388.88± 1.856	205.50± 5.982	34.675± 0.4511	373.25± 2.896	15.038± 0.2314
Armsht	Mean±SE	18.662± 0.129	602.88± 4.533	383.00± 2.212	7.4050± 0.014	7.587±0 .0766	363.13± 3.232	235.38± 4.829	26.913± 0.4397	417.75± 3.825	12.313± 0.2955
Dashtmr	Mean±SE	19.400± 0.119	421.63± 3.151	269.25± 1.980	7.8850± 0.082	8.175±0 .1206	188.25± 3.342	92.75±5 .675	12.550± 0.3185	307.13± 4.980	10.987± .2503
Ashanke	Mean±SE	22.750± 0.157	541.38± 3.505	344.75± 2.782	7.5575± 0.042	7.813±0 .1394	285.88± 12.604	198.13± 9.604	14.388± 0.2837	507.38± 6.305	17.050± 0.2493
Khalsh	Mean±SE	21.600± 0.224	558.00± 22.770	358.75± 14.447	7.2850± 0.027	7.213±0 .1445	296.75± 4.750	195.63± 4.747	13.550± 0.3240	562.12± 5.296	19.750± 0.3737
Total	Mean±SE	19.654± 0.184	817.36± 42.9	522.69± 27.520	7.4461± 0.027	7.369±0 .0724	427.19± 23.491	250.74± 16.353	28.651± 1.6803	423.65± 9.019	22.729± 1.2312
WHO		-	1400	-	6.5-9.5			200	600	200	400

Table 2: Physical-chemical properties of well water, data represented as mean± S.D, during studied period

Months		T°C	EC	TDS	pH	DO	TH	Ca^{2+}	Cl	TA	SO_4^{2-}
Aug.	Mean± S.E	19.840± 0.5327	814.20± 123.944	520.70± 79.31	7.3650 ±0.068	7.110± 0.18	414.60±6 9.355	232.40 ±47.62	27.650 ±4.946	409.00 ±25.84	21.50± 3.5276
Sept.	Mean± S.E	20.020± 0.5274	801.50± 7.849	511.70± 82.03	7.3840 ±0.068	7.130± 0.18	418.40±6 9.418	232.10 ±45.63	27.720 ±4.947	411.90 ±26.42	21.510 ±3.542
Oct.	Mean± S.E	19.950± 0.5408	808.00± 27.038	519.30± 81.90	7.4000 ±0.070	7.120± 0.17	420.90 ±69.453	240.50 ±49.92	27.880 ±4.894	413.50 ±25.50	21.540 ±3.540
Nov.	Mean± S.E	20.130± 0.5496	809.10± 126.987	517.40± 81.35	7.4030 ±0.068	7.210± 0.18	418.80±6 9.777	244.60 ±48.52	28.100 ±4.998	418.00 ±26.00	22.560 ±3.681
Dec	Mean± S.E	19.780± 0.5206	814.50± 127.428	520.60± 81.54	7.4260 ±0.070	7.250± 0.18	435.50±6 8.274	249.30 ±48.65	28.340 ±4.979	422.50 ±26.57	22.970
Jan.	Mean± S.E	19.320± 0.5316	823.80± 127.899	527.30± 81.82	7.4760 ±0.074	7.510± 0.20	431.20±7 0.173	259.60 ±48.27	29.240 ±4.925	431.70 ±26.77	23.600 ±3.696
Feb.	Mean± S.E	18.830± 0.4879	830.80± 128.089	530.40± 82.11	7.5420 ±0.092	7.740± 0.20	436.30±6 9.656	268.30 ±48.41	29.880 ±4.973	438.00 ±27.03	23.910 ±3.676
Mar.	Mean± S.E	19.360± 0.5319	837.00± 127.706	534.10± 81.88	7.5730 ±0.102	7.880± 0.20	441.80±7 0.080	279.10 ±48.11	30.400 ±5.070	444.60 ±27.05	24.290 ±3.684
Total	Mean± S.E	19.654± 0.1843	817.36± 42.927	522.69± 27.52	7.4461 ±0.027	7.369± 0.07	427.19±2 3.491	250.74 ±16.35	28.651 ±1.680	423.65 ±9.019	22.729 ±1.231

Table 3: WQI values for Khabur River during studied period

Canadian WQI	Hasanafa	Betas	Bezehe	Zrhawa.	Dolla	Zenawa	Armsht	Dashtmr	Ashanke	Khalsh
Drinking	Good	Poor	Poor	Good	Poor	Good	Good	Very good	Very good	Very good
Irrigation	Excellent	Good	Good	Very good	Good	Excellent	Very good	Excellent	Excellent	Excellent

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