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Investigating the concentration of sulfate, phosphate, iron, TDS (Total Dissolved Solids), and EC (Electrical Conductivity) parameters in drinking water sources of Ilam city from 2019 to 2023

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ABSTRACT

Introduction: Access to safe and hygienic drinking water is indeed one of the most important and vital issues in many countries around the world. According to the regulations of the Ministry of Health of Iran, safe drinking water must be clear and its various physical and chemical parameters must be within the approved standard and its consumption should not cause any complications in humans. Therefore, the present study was conducted with the aim of determining the concentration of sulfate, phosphate, iron, electrical conductivity (EC), and total dissolved solids (TDS) parameters in the drinking water sources of Ilam city from 2019 to 2023.

Materials & Methods: This descriptive-analytical study was conducted with the aim of determining the concentration of sulfate, phosphate, iron, TDS and EC parameters in drinking water sources of Ilam city from 2019 to 2023. The studied community of drinking water supply sources in Ilam city includes the treatment plant and underground sources, as well as the water obtained from these sources. The samples are collected from the drinking water supply sources, specifically wells and springs, of Ilam city. All tests are conducted in the laboratories of Ilam City Health Center and the Water and Wastewater Company, following the standard methods for water and wastewater testing. The results are then compared with the latest national water standards of Iran. Finally, the data are analyzed using SPSS software and employing statistical tests.

Results: The findings indicate that the levels of sulfate, iron, TDS, and EC parameters in the groundwater and surface water sources of Ilam city are within the standard range. The average values of sulfate, iron, TDS, and EC parameters are 210, 0.155, 829, and 1290.4, respectively. However, the phosphate parameter in the drinking water of the Haft-Cheshmeh rural well under the coverage of the county is above the maximum desirable standard, while in other sources, the levels of this parameter are within the desirable range. The average of this parameter in all drinking water sources of Ilam city is within the standard range, amounting to 0.177.

Conclusion: Considering that the levels of most physical and chemical parameters in Ilam city are below the global standard limits, it can be said that the physicochemical quality of drinking water in Ilam city is not health-threatening and is safe.

Keywords: *Lucilia sericata*, Larval Therapy, Sterilization, Temperature, Time

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Introduction

Maggot debridement therapy (also known as larval Water in nature does not exist in a completely pure form; rather, it always contains small amounts of salts such as sulfate, suspended materials, and dissolved gases (1). A person drinks approximately 2 to 2.5 liters of water daily, and this amount of water accounts for about one-third of an individual's weight (3). For this reason, access to safe drinking water sources is one of the vital issues in many countries around the world. According to the latest statistics from the World Health Organization, 1.1 billion people lack access to safe drinking water each year, and approximately 80% of child mortality is due to gastrointestinal diseases caused by the lack of access to safe drinking water and the consumption of contaminated water (4). Given the increasing public awareness and the attention that people pay to the qualitative and aesthetic aspects of water, in addition to the quantity of water, the quality of water is also an indicator that requires more attention. Therefore, the physical, chemical, and microbial properties of water are among the parameters that play a very important role in the health and safety of drinking water, as well as in the level of consumer satisfaction (7). Therefore, the presence of safe drinking water in society is very vital and ensures the health of the community. For this reason, the first step in understanding water is to examine the parameters of drinking water (10).

One of the common and non-toxic compounds that are naturally found in water and wastewater is sulfates. The presence of sulfates in water is due to natural or human sources such as atmospheric precipitation or industrial effluents. High concentrations of sulfates can lead to the mineralization of water, corrosion of metal equipment, harm to living organisms, production of toxins, and the generation of hydrogen sulfide gas in wastewater systems (9-12). The undesirable taste of water varies with the nature of the corresponding cation, with the taste threshold for sodium sulfate ranging from 250 mg/L to 1000 mg/L for calcium sulfate (1,10,13). The maximum permissible and desirable sulfate levels in the Iranian national water standard are 400 mg/L and 200 mg/L, respectively, while the World Health Organization standard sets these levels at 500 mg/L and 250 mg/L (9-11). The increase of iron in drinking water sources leads to the occurrence of taste, color, odor, and turbidity issues. At concentrations above 0.3 mg/L, iron can cause staining of clothes during washing and also change the color of the water (2,10). For this reason, continuous monitoring and control of iron concentration in water sources is essential to improve drinking water quality in accordance with national and global standards, to enhance public health, and to minimize public dissatisfaction (6). The maximum desirable and permissible iron levels in the national water standard of Iran are 0.1 and 0.3 mg/L, respectively, while the maximum permissible iron level according to the World Health Organization standard is 0.3 mg/L (10,11).

Another highly influential parameter in creating taste in drinking water is TDS, or total dissolved solids. The report from the International Water Management Institute (IWMI) indicates that TDS does not play a direct role in creating health hazards, but it disrupts the absorption and excretion of soluble salts in the human body, potentially leading to the formation of kidney stones. Water with a TDS level of less than 500 mg/L is considered very good from the perspective of drinking water standards. TDS levels between 500 to 600 mg/L are desirable for drinking, while levels between 1000 to 1500 mg/L are permissible for drinking. However, water with a TDS level exceeding 1500 mg/L is not acceptable for drinking. According to Iran's national standards, the maximum permissible TDS level in drinking water is 1500 mg/L, and in situations of water scarcity, a level of 2000 mg/L is also permissible. The World Health Organization (WHO) also sets the maximum permissible TDS level at 1000 mg/L for drinking water (2,8,10). Phosphate is a common form of phosphorus that is relatively soluble in water. The presence of phosphate in water is one of the parameters that can lead to a decrease in the quality of water resources. Although phosphates are not toxic substances and do not pose a direct threat to humans, they can indirectly cause issues such as unpleasant taste and odor, reduced dissolved oxygen in water, and interference in the treatment processes. Phosphates have widespread applications as additives in chemical fertilizers in agricultural lands. They can enter surface water resources through leaching or infiltrate into groundwater. Another significant pathway for phosphates to enter water resources is through urban wastewater (14,15,16). According to the World Health Organization, the maximum allowable concentration of phosphate in drinking water is 1 mg/L. The National Health Agency of Canada has set the maximum allowable phosphate level at 0.2 mg/L, while the European Economic Community has established it at 0.54 mg/L. The Environmental Protection Agency of the United States has also set the maximum allowable phosphate concentration at 0.2 mg/L (14,16). In the national water standards of Iran, the maximum allowable and desirable phosphate concentrations are set at 0.2 mg/L and 0.1 mg/L, respectively (3,5).

Considering the significance and substantial impact of the aforementioned chemical parameters on the quality of drinking water in all countries, national standards have been developed and approved to ensure the health and well-being of individuals. In this context, the present study aims to determine the concentrations of sulfate, phosphate, iron, TDS (Total Dissolved Solids), and EC (Electrical Conductivity) anions in the drinking water sources of Ilam city and compare them with national and global standards from 2019 to 2023.

Materials and methods

This study has been conducted in a descriptive-analytical manner with the aim of determining the concentrations of sulfate, phosphate, iron, TDS (Total Dissolved Solids), and EC (Electrical Conductivity) parameters in the drinking water sources of Ilam city from 2019 to 2023. The study population consists of the sources supplying drinking water for Ilam city, including treatment plants and groundwater sources, as well as the water derived from these sources. The drinking water sources of Ilam city include 13 sources, and samples are collected from these water supply sources (wells and springs) in Ilam County. For each sample, the chemical variables of sulfate, phosphate, electrical conductivity, iron, and TDS are examined. Samples are collected using manual sampling methods and are sent to the reference laboratory for water and wastewater of the province under standard temperature conditions. The instrumental tests conducted in the provincial water and wastewater laboratory include measuring the concentrations of sulfate, phosphate, and iron ions using the Hach DR/6000 spectrophotometer, as well as measuring electrical conductivity and Total Dissolved Solids (TDS) using the Hach HQ30d conductivity meter. All the aforementioned tests are conducted in the laboratories of the Health Center of Ilam County and the Water and Wastewater Company, following the methods outlined in the Standard Methods for Examination of Water and Wastewater. The results are compared with the latest edition of the National Standard of Water in Iran, and finally, the data are analyzed using SPSS software and statistical tests.

Results

By analyzing sulfate, phosphate, iron, Total Dissolved Solids (TDS), and electrical conductivity (EC), we can understand the story behind what is present in our water and its impact on us. Five parameters were examined in 13 drinking water wells in the city of Ilam, and after comparing them with the provided standard levels, it was determined that most parameters in the groundwater resources of the region were in a suitable condition for drinking (1,2).

Table 1. Examination of Iron (Fe) Concentration in Drinking Water Sources of Ilam City from 2019 to 2023

Resources	Fe								
	2019	2020	2021	2022	2023	Mean	SD	Min	Max
Assyrian screw well	0.3	0.21	0.16	0.14	0.08	0.175	0.074	0.08	0.3
Ghochali Well 1	0.25	0.17	0.08	0.21	0.25	0.173	0.078	0.08	0.25
Ghochali Well 2	0.09	0.13	0.29	0.06	0.29	0.191	0.109	0.06	0.29
Ghochali Well 3	0.04	0.19	0.08	0.23	0.09	0.118	0.074	0.04	0.23
Ghochali Well 4	0.023	0.02	0.241	0.18	0.1	0.134	0.101	0.02	0.241
Taavoni Well	0.17	0.17	0.13	0.17	0.07	0.14	0.039	0.07	0.17
Haft Cheshmeh Rural Well	0.23	0.15	0.23	0.13	0.282	0.209	0.057	0.13	0.282
Haft Cheshmeh Urban Well	0.19	0.07	0.12	0.19	0.291	0.163	0.077	0.07	0.291
Gol Spring	0.12	0.13	0.03	0.22	0.19	0.12	0.078	0.03	0.22
Dampezeshki Well	0.24	0.29	0.02	0.047	0.024	0.106	0.123	0.02	0.29
Municipality Transport Well	0.29	0.35	0.08	0.15	0.05	0.166	0.124	0.05	0.25
Khormoroudi Boulevard	0.15	0.12	0.28	0.132	0.25	0.202	0.075	0.12	0.28
Terminal Well	0.12	0.08	0.04	0.2	0.27	0.125	0.092	0.04	0.27

However, In Table 1, the three-year average concentration of iron in the drinking water sources of Ilam city is shown. As observed, the three-year average concentration of iron in the Haft Cheshmeh rural well (0.208) and Khoramroudi Boulevard (0.202) is higher than in other sources, while the concentration of iron in the veterinary well (0.106) is the lowest among all. The maximum iron concentration in the Assyrian screw well is 0.35, while the minimum iron concentration in the veterinary well and Qoochali 4 is 0.2. It is noteworthy that the measured iron levels in the Haft Cheshmeh rural sources and Khoramroudi Boulevard, which are the highest, are lower than the national and global standards of 0.2 and 0.3, respectively. Therefore, the iron parameter levels in these sources do not pose a risk to human health. The results of this study indicate that the drinking water from the sources covered in this county is acceptable for consumption concerning the maximum recommended iron levels set by national and global standards, and it does not pose a health threat to consumers. The average iron concentration in the water sources of Bushehr city in 1391 was 0.115 mg/L, ranging from 0.046 to 0.366, which is below the national and global standard range, consistent with the results of this study. The research by Alighadri et al. in 2007 on the concentration of heavy metals, including iron and manganese, in the drinking water sources of Ardabil city showed that in all samples, the iron concentration was below the national and global standards. In the present study, the iron concentration was also found to be below the standard limit at all stations, indicating that the results of the two studies are consistent(13).

Table 2. Examination of sulfate concentration in drinking water sources of Ilam city from 2019 to 2023.

Resources	sulfate								
	2019	2020	2021	2022	2023	Mean	SD	Min	Max
Assyrian screw well	149	66	174	107	79	105.3	47.3	57	174
Ghochali Well 1	286	154	254	143	387	228.3	98.73	143	387
Ghochali Well 2	56	134	256	234	142	153.1	77.7	56	256
Ghochali Well 3	176	198	197	211	42	173.1	65.69	42	215
Ghochali Well 4	158	321	247	385	21	217.1	154.3	21	385
Taavoni Well	83	39	168	287	64	149	103.8	39	287
Haft Cheshmeh Rural Well	443	254	540	122	231	278.5	179.8	81	540
Haft Cheshmeh Urban Well	186	139	135	237	376	201.3	94.5	135	376
Gol Spring	125	156	225	191	179	162	46.6	96	225
Dampezeshki Well	316	345	198	320	310	286.6	58.1	198	345
Municipality Transport Well	163	152	171	252	271	193.1	53.8	150	271
Khormoroudi Boulevard	373	176	243	135	180	231	65.5	135	373
Terminal Well	311	612	287	403	323	176	352	146.9	176

As shown in the results of Table No. 1, the highest three-year average sulfate concentration is related to the terminal well with a value of 352, while the lowest value is associated with the Pich Ashouri well at 105.3. Considering that the average measured sulfate concentration in the terminal well is lower than the maximum allowable national and global standards, which are 400 and 500, it does not pose a health risk to consumers. Additionally, in this table, the maximum sulfate concentration in the Haft Cheshmeh rural well during the second half of the years 2021 and 2022 is 540, which is above the global and national standards. Based on the results, potential factors contributing to the high sulfate concentration in these sources may include the geological structure of the water supply sources, increased rainfall and runoff resulting from it, reduced water quantity, and a decline in the groundwater table, in other words, an increase in the depth of the groundwater level, agricultural activities, and the use of chemical fertilizers(5). In this study, the sulfate anion levels in most water supply sources were close to the maximum allowable and desirable limits. Very high levels (over 500 mg per liter) may cause laxative effects and gastrointestinal impacts in some individuals(11). A study in Wisconsin found that well water with high sulfate levels (over 250 mg per liter) is associated with diarrhea in infants. In the study by

Kalantari and colleagues in 2008, which examined the quality of groundwater sources in the Abadan plain of Khuzestan, it was determined that sulfate anions and calcium cations were predominant in the studied area, which is not consistent with the results of this study(13). Additionally, the results of the study by Shabankareh Ard and colleagues in 1391, which examined the physical, chemical, and microbial characteristics of drinking water in Bushehr, showed that TDS and sulfate levels in this city were above the national and EPA standards at some stations, which could partially lead to laxative effects for consumers and also cause corrosion in the water supply network. This finding is not consistent with the results of this study(12). Sadeghi and Rouhollahi, in their study of the physical and chemical indices of drinking water sources in Ardabil in 2007, stated that the sulfate levels in 9% of the samples and phosphate levels in 71% of the samples exceeded the national and global permissible limits, which is not consistent with the results of this study(13).

Table 3. Examination of Phosphate Concentration in Drinking Water Sources of Ilam City from 2019 to 2023.

Resources	Phosphate								
	2019	2020	2021	2022	2023	Mean	SD	Min	Max
Assyrian screw well	0.04	0.12	0.06	0.11	0.02	0.058	0.04	0	0.12
Ghochali Well 1	0.15	0.09	0.04	0.239	0.19	0.124	0.08	0.04	0.239
Ghochali Well 2	0.01	0.13	0.08	0.129	0.02	0.065	0.05	0.01	0.13
Ghochali Well 3	0.17	0.08	0.021	0	0.187	0.091	0.07	0	0.187
Ghochali Well 4	0.13	0.093	0.008	0.14	0.13	0.098	0.04	0.008	0.14
Taavoni Well	0.18	0.16	0.07	0.05	0.18	0.111	0.06	0.03	0.18
Haft Cheshmeh Rural Well	0.49	0.54	0.64	0.42	0.71	0.54	0.11	0.42	0.71
Haft Cheshmeh Urban Well	0.66	0.71	0.132	0.033	0.39	0.324	0.3	0.02	0.61
Gol Spring	0.35	0.45	0.17	0.021	0.52	0.276	0.19	0.021	0.52
Dampezeshki Well	0.19	0.14	0.14	0.19	0.092	0.137	0.04	0.07	0.19
Municipality Transport Well	0.09	0.19	0.43	0.098	0.101	0.161	0.13	0.057	0.43
Khormoroudi Boulevard	0.01	0.09	0.07	0.13	0.061	0.064	0.04	0.13	0.13
Terminal Well	0.26	0.39	0.51	0.04	0.0.24	0.251	0.18	0.51	0.51

As shown in Table 3, the average concentration of phosphate in the Ghouchali 2 and Ghouchali 4 wells and the Haft Cheshmeh rural and urban wells are 0.65, 0.98, 0.54, and 0.324 mg/L, respectively. These values are above the maximum national standard (0.3 mg/L) and below the maximum global standard (1 mg/L). The maximum level of this parameter in the drinking water of the Haft Cheshmeh rural well under the coverage of the county is above the maximum permissible national standard and below the maximum permissible global standard. The values of this parameter in the drinking water of the other covered wells were below the maximum permissible global standard. Possible reasons for the elevated levels of this parameter in the drinking water of some sources may include industrial activities near water supply sources, the entry of wastewater and cleaning agents, and phosphate compounds present in agricultural chemical fertilizers used in upstream areas(3). Phosphates indirectly cause the development of taste and odor, reduce dissolved oxygen in water, and interfere with the treatment process. A case study in Lake Erie demonstrated how agricultural runoff leads to toxic algal blooms that impact human health and the environment. Phosphate is an inorganic compound and a salt of phosphoric acid that, in the form of calcium and magnesium phosphates, contributes to non-carbonate hardness in water. The numerical range of this parameter in the tested samples was from 0 to 0.7 mg/L (Figure 2). The results of the study by Panahi et al. in Qazvin in 2017 and the study by Do Brothers et al. in 2015 in Bushehr were reported to be consistent with the national standard values, which does not align with the results obtained from this study(7,8). Sadeghi and Rouhollahi, in their study of the physical and chemical indicators of drinking water sources in the city of Ardabil in 2007, stated that the sulfate parameter exceeded the national and global permissible limits in 9% of the samples, while phosphate exceeded the limits in 71% of the samples. These findings do not align with the results obtained from this study.

Figure 4. Examination of TDS concentration in drinking water sources of Ilam city from 2019 to 2023.

Resources	TDS								
	2019	2020	2021	2022	2023	Mean	SD	Min	Max
Assyrian screw well	440.7	326.95	1717.9	419.25	243.75	566.04	570	243.7	1717.95
Ghochali Well 1	284.5	289.25	464.75	1295.5	520	499.7	392	180.7	1295
Ghochali Well 2	453.7	611	503.75	477.75	309.4	435.8	130	259.35	611
Ghochali Well 3	513.5	423.15	411.45	487.5	163.8	372.5	140.9	163.8	513.5
Ghochali Well 4	2100.5	1964.9	1496.3	495.3	165.1	1139.3	821.2	165.1	2100.1
Taavoni Well	486.65	377.65	346.45	390	325	368.7	58.2	305	468.6
Haft Cheshmeh Rural Well	1632.8	1983.6	2535.65	1723.15	1559.35	1847.6	367.3	1559.35	2535.6
Haft Cheshmeh Urban Well	1544.4	332.8	2016.3	644.3	670.8	909.2	710.9	247	2016.3
Gol Spring	583.05	1641.4	507.65	1536.6	606.45	1065.5	550.1	507.65	1641.2
Dampezeshki Well	1957.15	1869.4	152.75	510.25	614.9	891.8	809.4	152.75	1957.1
Municipality Transport Well	1654.25	1652.95	152.75	716.3	513.5	497.25	864.5	637.4	152.75
Khormoroudi Boulevard	374.4	500.5	644	412.1	373.75	421.85	454.4	103.7	373.75
Terminal Well	1710.15	2158.65	2086.5	495.95	1708.8	800	1493.3	687.5	495.95

As shown in Table 4, the highest average TDS concentration in the three studied sources, namely Ghouchali 4 well, Gol-Gol spring, and Terminal well, are 1139, 1065, and 1493.3 respectively. These values are lower than the maximum national standard of 1500 but higher than the global standard of 1000.

Additionally, the results of this study indicate that the TDS concentration in the Haft-Cheshmeh rural well, with a value of 1847, exceeds both the national and global maximum standards. The maximum TDS related to the Haft-Cheshmeh rural well is 2535.6, while the lowest value is associated with the Cooperative well. Given these findings, this level of TDS may cause issues related to taste and odor in the drinking water sources of Ilam city, leading to consumer dissatisfaction and a tendency to use alternative drinking water sources, such as private and household water purification systems or bottled water(10). Additionally, high TDS levels can affect taste and flavor and cause problems such as pipe scaling. Major reasons for the discrepancies in the drinking water values from the aforementioned sources compared to national and global standards include the influence of water supply sources, rainfall, flooding of water supply sources, and the infiltration of agricultural wastewater into water sources. In the other studied stations of this city, the TDS levels did not exceed the limits set by this organization. Possible reasons for the favorable levels of this parameter in other sources of the county may include continuous monitoring of water supply sources, the suitability of the geological structure of the water supply locations, appropriate distances of the supply sources from agricultural lands, and the prevention of agricultural wastewater from entering the water supply sources(5). In a study conducted by Davoudi and colleagues (2018), which examined the physicochemical characteristics of 8 wells in the Taybad county, the results indicated that some of the wells had TDS levels exceeding the permissible standard limits, which aligns with the findings of this study(10,11). Additionally, the results of the study by Shabankareh Fard and colleagues (2016), which examined the physical, chemical, and microbial characteristics of drinking water in Bushehr city, showed that the TDS and sulfate levels in some stations of the city were above the national and EPA standard limits. This can lead to laxative effects for consumers and corrosion of the water supply network, which is consistent with the findings of this study(12).

The measurement of this parameter by Azarpira and colleagues in Saveh, Dinarloo and colleagues in Bandar Abbas, Doobradran and colleagues in Bushehr, and Ranjai and colleagues in Birjand and Qaen in the year 2011 was reported to be inconsistent with national standards, which aligns with the findings of this study(5).

Figure 5. Examination of EC concentration in drinking water sources of Ilam city from 2021 to 2023.

Resources	EC								
	2109	2020	2021	2022	2023	Mean	SD	Min	Max
Assyrian screw well	678	503	2643	654	375	872.3	877	375	2643
Ghochali Well 1	437	445	715	1937	800	768.6	604	278	1937
Ghochali Well 2	698	940	775	735	476	670.5	200	399	940
Ghochali Well 3	790	651	633	750	252	573.1	216.9	252	790
Ghochali Well 4	3231	3023	2302	762	254	1752.8	1263.3	254	3231
Taavoni Well	721	581	533	600	500	562	97.3	437	721
Haft Cheshmeh Rural Well	2512	2541	3901	2651	2399	2842.5	565.2	2399	3901
Haft Cheshmeh Urban Well	2376	512	3102	1022	1032	1404	1091.4	380	3102
Gol Spring	897	2525	781	2364	933	1639.3	846.3	781	2525
Dampezeshki Well	3011	2876	235	785	946	1372	1245.2	235	3011

Municipality Transport Well	2545	2543	1102	790	765	1330	980.7	235	2545
Khormoroudi Boulevard	576	940	634	575	649	690.6	141.3	575	940
Terminal Well	2631	3321	763	2629	1231	2297.5	1016.8	763	2630

EC measures the ability of water to conduct electric current, which is largely determined by TDS (Total Dissolved Solids). It is an important indicator of salinity that can affect both human consumption and irrigation use. High levels of EC can lead to poor taste, pipe corrosion, and reduced crop yield(13). As observed in Table No. 5, the highest three-year average EC concentration is found in the Haft Cheshmeh rural well and the terminal well, with values of 2842.5 and 2297.5, respectively, which exceed the maximum permissible and desirable standards of 2000 and 1500 microsiemens per centimeter. The lowest average is related to the Cooperative well, with a value of 562. Additionally, according to Table No. 5, the maximum electrical conductivity corresponds to the Haft Cheshmeh rural well, with a value of 3921. The lowest electrical conductivity is associated with the Qoochali No. 1 well, with a value of 278 microsiemens. EC levels above the desirable maximum of 1500 and the permissible maximum of 2000, along with their variations in the examined locations, may be due to a pollution source, particularly industrial pollution in the area. When electrical conductivity exceeds 1500 microsiemens per centimeter, it can lead to corrosion in urban water distribution network structures. Research by Zazooli and colleagues in 2012 regarding the physical, chemical, and microbial parameters of water in the city of Khoy showed that the concentration of nitrate and electrical conductivity in the water of this city is significantly lower than the national standard, which is inconsistent with the results obtained from this study(7). Similarly, the study by Samiei and colleagues (1982) showed that the average electrical conductivity of drinking water in Yazd city is at an acceptable level, which is inconsistent with the results obtained from this study(7).

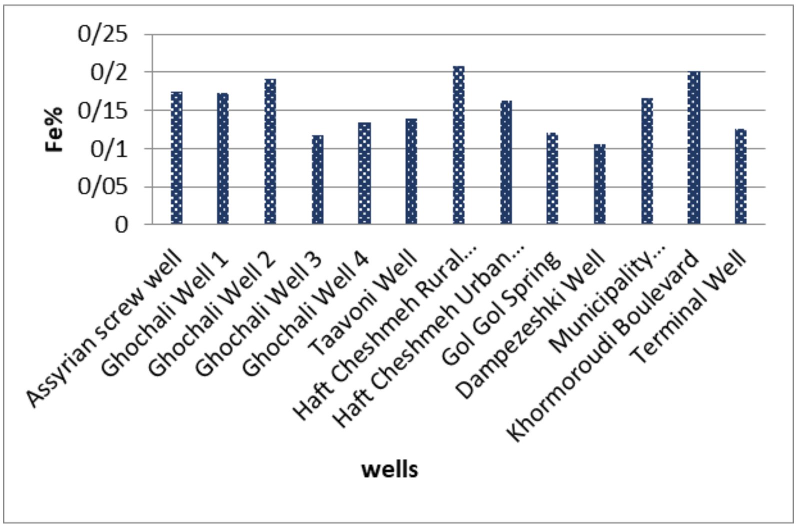

Figure 1. Examination of iron concentration in drinking water sources of Ilam city from 2019 to 2023

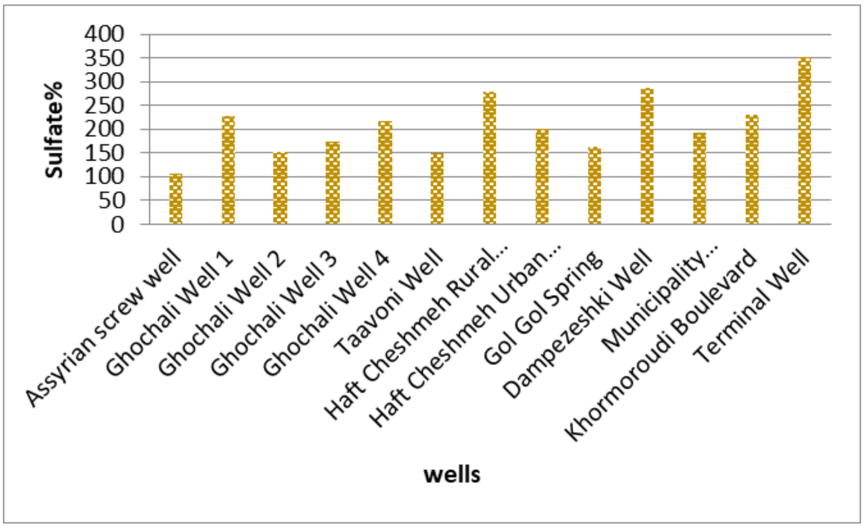

Figure 2. Examination of sulfate concentration in drinking water sources of Ilam city from 2019 to 2023

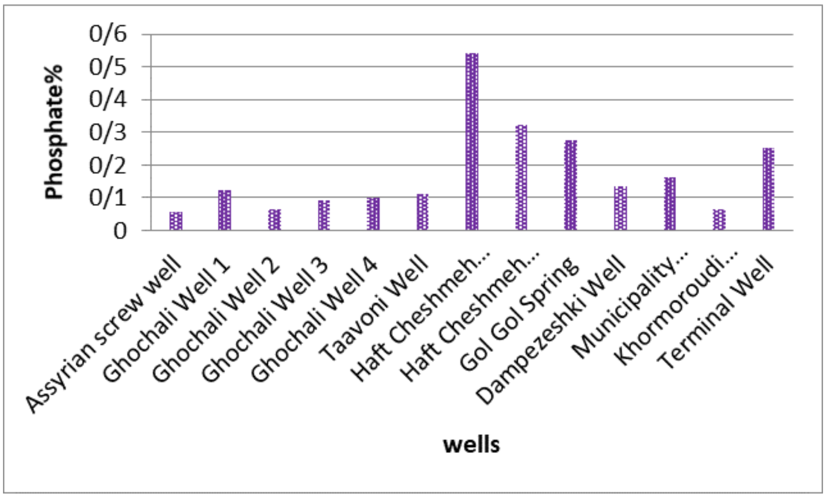

Figure 3. Examination of phosphate concentration in drinking water sources of Ilam city from 2019 to 2023

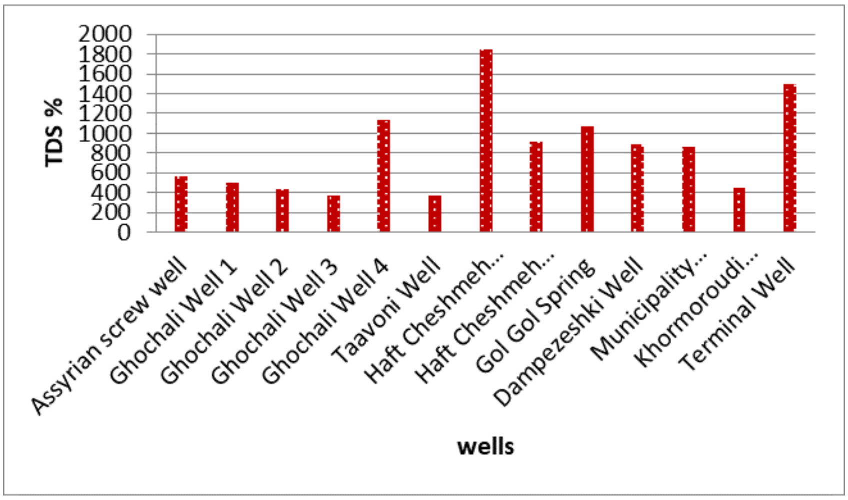

Figure 4. Examination of TDS concentration in drinking water sources of Ilam city from 2019 to 2023

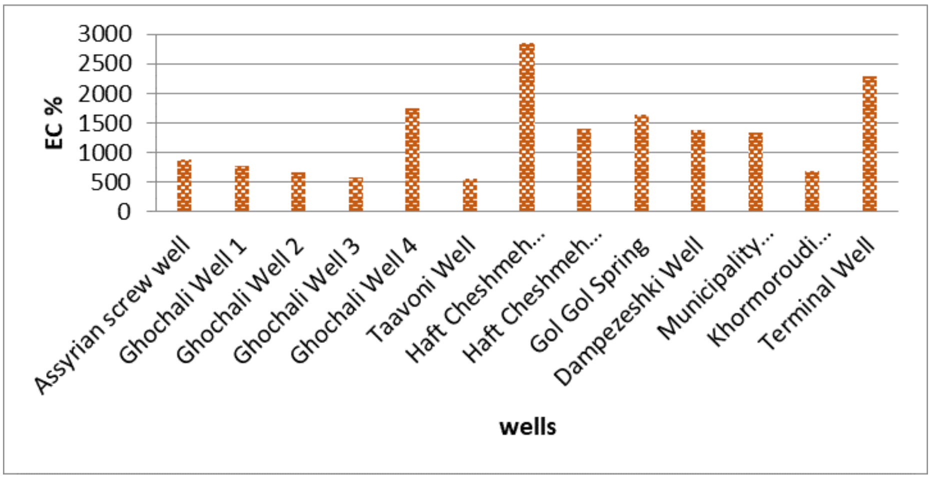

Figure 5. Examination of EC concentration in drinking water sources of Ilam city from 2019 to 2023

Conclusion

A comprehensive analysis of sulfate, phosphate, iron, TDS, and EC levels in drinking water sources is essential for maintaining water quality standards and ensuring community welfare. By understanding and monitoring these anions, authorities can implement targeted interventions to address pollution issues and improve overall water quality. Ongoing research and monitoring efforts are crucial for informing policy decisions and interventions aimed at protecting valuable water resources.Prioritizing water quality improvement plans based on the findings of such analyses will be vital for promoting sustainable access to clean and safe drinking water for current and future generations. These findings provide valuable insights into the spatial variability of water quality in the studied area, which can be critical for water resource management, environmental monitoring, and public health considerations.

Suggestions

Conducting qualitative studies of groundwater is a fundamental and practical step to obtain quality information from water sources. Therefore, in order to prevent further pollution of groundwater and surface water resources, it is essential to carry out extensive and comprehensive studies to monitor their chemical quality and to provide practical programs such as accelerating the implementation of sewage collection and treatment networks and determining the sanitary protection zones of wells.

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Ethics approval

Ethics approval Ethical approval for this study was obtained from Deputy of Public Health for Ilam University of Medical Sciences.

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Conflict of interest

The authors declare no conflict of interest.

Authors' contributions

Designing the study and data gathering were done by YK, EH, AA and ZG. Analyses and interpretation were done by MA. SV prepared the draft of the paper. All authors read, revised, and approved the final manuscript.

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