Quality Aand Nutritional Investigation of Some Water Sources in Sulaimani City

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Abstract

Several water treatment and distribution station in Sulaimani city has been investigated to discover their safety, quality and nutrition. This is to ensure public health protection. In this regard, water samples were collected from certain sites (underground and surface water). Water analysis was conducted in terms of several parameters, such pH, total dissolved solids (TDS), electric conductivity (EC), total hardness, calcium, magnesium, potassium, sodium and chloride content. The results were compared to universal standards (World and health organization (WHO) & national drinking water quality standard) and local standard (Iraqi standards). It was found that the majority of results within a safe range by both universal and local standards. However, water samples from some sites (in one or two parameters) were only acceptable by local standard, this includes some sites that was out of safe limit by both standards. Apart from acceptability and quality, the impact of drinking water from selected distribution tanks on a possible long-term health risk has been found. This investigation was confirmed data just for year 2019. Continuous analysis needs to be conducted and other water treatment and distribution stations have to be investigated to ensure full public health protection of Sulaimani city.

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1. Introduction

One of the most basic human rights is clean water. It must be potable or has a high acceptable quality. It should be help maintain and promote a good health. [1]. It was discovered that millions of people die annually caused by water-related diseases and disasters, which inadequate sanitation might be the main reason [2]. To reduce or prevent this tragic numbers, establishing water security might be the case [3, 4]. In this study. It has been focused on main source water supplies to homes in terms of quality, toxicity and water related health issues. Quality means water supplies should be acceptable or at least meet the minimum quality standards. Nutrition means, water can deliver nutritional benefits beyond its acceptable quality. For example, water should contain some beneficial elements and minerals within the acceptable standard range that enhance and maintain a good health in a long term. After food, water is considered as a second rich and reliable source of some micronutrients such as minerals, elements and heavy metals. This means high quality water can provide and satisfy a great portion of recommended daily intakes of some essential mineral. However, low quality water can have an adverse effect on human health through taking some required minerals above standard limits. Studies show that in a long term the quality of water and its chemical content directly related to some chronic diseases, such as cardiovascular diseases [5]**.** Sulaimani city is located in the south part in Kurdistan map and north of Iraq (**Fig.1**). It has a medium population density (around one million). The city has two types of water sources, surface water, which is coming from dukan lake, and underground water, which is extracted through wells. These two sources of water supply to homes, public places, hospitals and universes…etc. through water treatment and distribution stations. It is really important to investigate the quality of water in these stations. This is by comparing to standard limits that has been set by WHO [4], and other regulatory organizations [6]. The result of this investigation will provide information about sickness and diseases related the quality of water. Nowadays in Sulaimani chronic diseases, such as hypertension, kidney diseases and other cardiovascular diseases has increases dramatically. Since water, after food, is a second source of some elements and essential minerals and people drinks in a great amount in a daily bases, poor water quality may link to undesired and serious health issues [4,7]. In 1997 WHO announce that poor quality of water, inadequate sanitation, polluted water and water unavailability cause as high as 80% of all sickness and diseases worldwide [8, 9].

Fig.1: map of Sulaymaniyah city, it is located in north part of Iraq-Kurdistan regional district.

Furthermore, a review of 28 studies revealed that quality, quantity and water sanitation supplies to homes directly related to water-borne diseases [10]. In this study, water sources from both surface water (Sarchnar water treatment and distribution station) and underground water (Other water treatment and distribution stations) have been investigated in terms of chemical component, such as pH, electric conductivity, TDS, calcium (Ca), magnesium (Mg), chloride (Cl), sodium (Na) and potassium (K). The results then compared to standard safe limits to discover the level of the quality of the water. After that depends on the comparison it has been discussed whether supplied water by mentioned stations is a risk or nutritionally beneficial to Sulaimani population who receives water from these stations. The investigation also covers the effect of environmental change in different season on the quality of water in terms of its chemical component.

2. Material and methods

Proper tools have been used to collect water samples. Water samples has been collected by a highly trained staff throughout the year of 2019. Each sample had three replicates for accuracy purposes, making sure accuracy as high as possible and contamination as low as possible. After collecting samples from different places, they delivered them to laboratory for analysis purposes in a special box considering providing required environment, such as temperature, humidity and sanitation. Sample collection and storage has been done according to United statue environmental protection agency quick guide to drinking water samples collection [37].

Since different water component have been determined, different methods were used. magnesium and sodium are determined using flame photometry device (FP6450). The determination of pH is carried out using high accuracy pH meter (pH700). EKOMOLK BOND was used to determine electric conductivity (EC). TDS value has been recorded using 151 benchtop TDS meter. Chloride content is determined using quantitative titration method (Mohr's method). Furthermore, Magnesium and Calcium content were determined using EDTA titration procedure (38, 39)

3. Statistical analysis

Each result than mention in recent study came from at least 3 replicates. After discovering the mean, the least significant difference (LSD) test was used to differentiate the significance of data. Correlation relationship used to detect the relationship between the parameters.

4. Results and discussion

The pH is one of the main indicators of water quality. Its range show the level of acidity and alkalinity of the water. pH also implies that water either corrosive or toxic, soft or hard. Acidic water can lead to corrosion of metal pipes and plumping system. Meanwhile, alkaline water shows disinfection in water [4]. For the water to be acceptable for drinking it should meet at least World and Health Organization (WHO) standards or Iraqi standards. Ideal pH for pure water should be 7.0 [11]. However, surface water (water on the surface of earth, such as lakes and streams) has pH limit of 6.5-8.5, while undergoing water has pH range of 6.0-8.5. [9, 11, 12]. As shown in figure 2, samples were taken from Sarchnar water management and distribution station throughout the year of 2019. After analyzing data statistically, it was found that from January to December the pH was fluctuating between 7.0-7.3, in cold and cool seasons (January to April) the pH was slightly greater or least than 7.0, in which march had exactly the pH of 7.0. This indicates in the acidity view point the water was totally acceptable and healthy. As the temperature raised during hot seasons, from May to beginning of November (it should be mentioned that due to Sulaimani's geographical confirmation area hot seasons usually last until the end of October) the pH also raised gradually until peaked 7.8 in October and then gradually fall in November and December. This result may due to the fact that during spring and summer carbon dioxide (CO_2) is highly under saturated in the atmosphere as a result of Algae and other plant reproduction. However, during winter production is usually low and respiration dominant. [13, 14]**.** Despite the fact that CO_2 is a weak factor contributor, high concentration results oblivious incline of water acidity. [15]**.** Other possible errors may due to a poor treatment process, poor accuracy in sampling or bad or outdated tools and equipment. Nevertheless. Even at highest pH vale (pH 7.8) it still inside the acceptable range, which is 6.5-8.5.

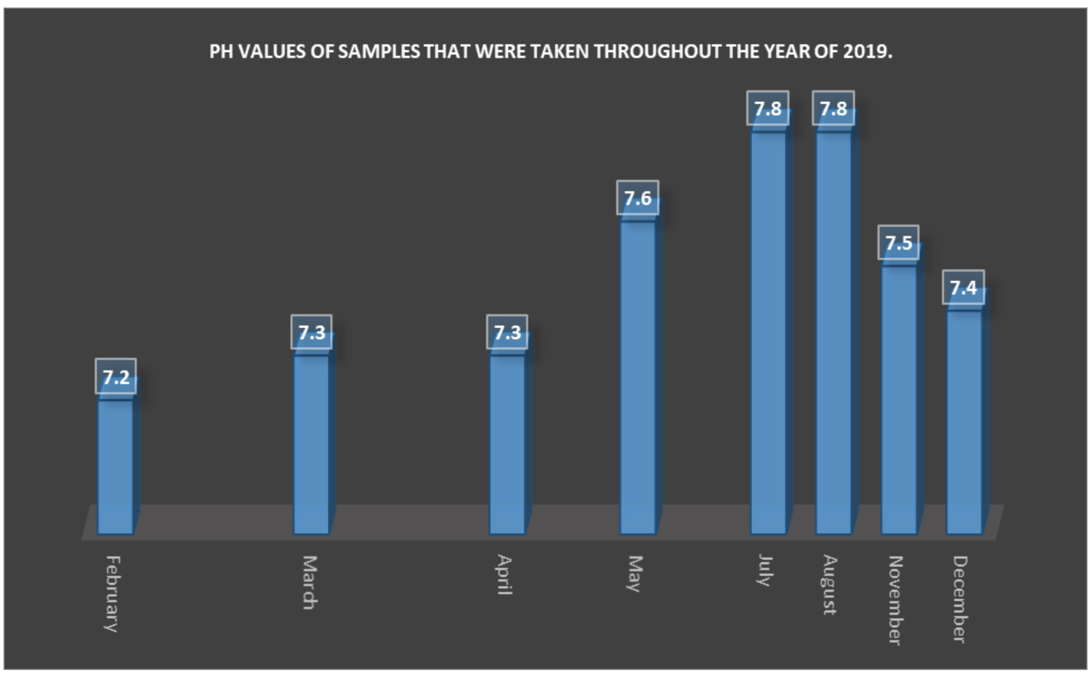

Figure 2: Samples were taken from Sarchnar water treatment and distribution station each month to reveal the effect of seasons on water pH. (cold & cool seasons, February- March), (optimal temperature seasons, April & May) (hot seasons, May- August), (cool seasons, November & December).

Other water treatment plants have also been taken into account (Figure 3). These sites also provide drinking water for a great number of houses in Sulaimani city. Unlike Sarchnar treatment and distribution plants, the water source from these plants is underground water. As it can be seen from the chart No.2 most of the treated drinking water was an alkaline water. As their pH greater than 7.0, in which some of them even reach pH above 7.5, such as Ashty well and the main tank of university of Sulaimani. Furthermore, one of them even reach pH 8.0, namely Azadi well. This high level of pH could return to a number of factors. One reason might be the nature of the water source itself, since the source is underground water, it has high mineral concentration, especially those has negative charges. Another reason is temperature. Hight temperature, in hot seasons, causes high pH level, as decreases oxygen solubility and increases the dissolution of a basic salt, such as bicarbonate. [8]. this is, as a result water becomes hard water. However, the alkalinity of water has claimed to have some health benefits [16].

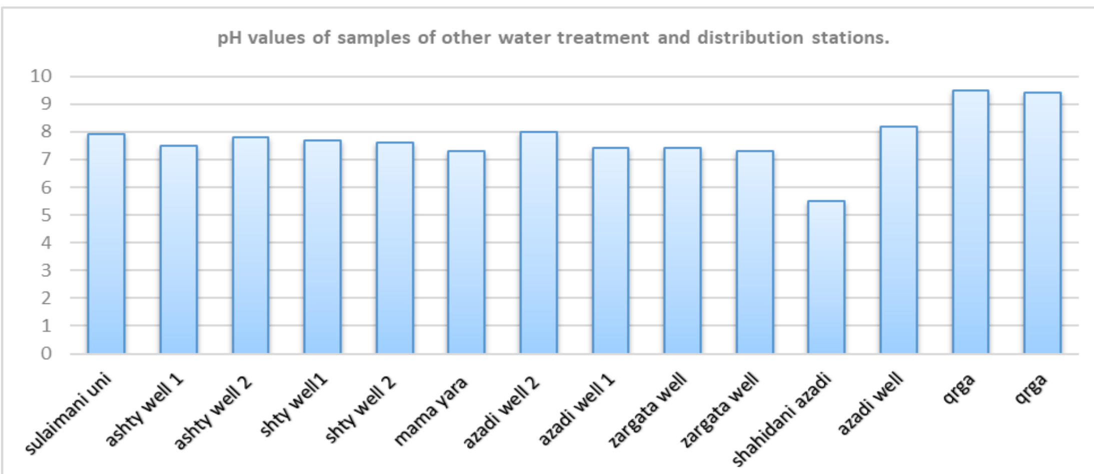

Figure 3: pH values of samples of water treatment and distribution plants

4.1 Electrical conductivity

Electrical conductivity (EC) is another parameter for the quality of water, it also can be used as a secondary parameter to accept or reject drinking water. EC is a physiochemical property of water that conduct electric current. This is due to the presence of some inorganic dissolved solid metals that can carry positive (sodium, magnesium, calcium, iron, and aluminum cations) and negative charges (chloride, nitrate, sulfate, and phosphate anions) and can pass electric current.

[2]. EC like other drinking water parameters has a limit in term of drinking water acceptability (Table 2). The value of ≥1000 has been set for drinking water to be inside the acceptable range. [2]. However, according to Iraqi standards the acceptable limit should be <1500 μS/cm. regarding this WHO had newest guidelines released about the upper limit of EC of drinking water, which is <400 μS/cm. It can be said that according to these different standards upper limit of EC is vary. Upper limits have been set to reduce or prevent disadvantages; it is either health or other disadvantages that mentioned above. Samples that were taken from Sarchnar water treatment and distribution plants throughout the year of 2019 have different vales of EC (figure 4). They all had values least than the acceptable limit, which was around 500 μS/cm, except one that had the value above 600 μS/cm. The lowest and highest EC value belongs to the samples that were taken in February and November respectively. The average EC values was just above 500 μS/cm. according to Iraqi standards these values were totally acceptable. This acceptability might be due to well treatment technique. Reverse osmose is one of the techniques that can remove heavy metals, total dissolved solids, turbidity and colloidal matters [2]. According to WHO standards, on the other hand, all samples in different seasons exceeds the upper limit, which is 400 μS/cm. this is obviously due to substances that can carry charges, which can be seen in mineral waters. Statistical analysis show that seasons have minor impact of changing EC of water. This result is in line with the result that shows in a study by [2]. Since, inorganic substances (nitrate, phosphate and chloride) and other sources (agriculture, industrial activity, land fill and other activities) are responsible for rising EC, long-term-health issues and occurrence of other health implications should be reduced to minimum [17]. For example, apart from health issues, some undesired outcomes might be seen in the water that exceeds the upper limit of EC >1000 μS/cm, such as metallic or mineral taste. Moreover, in terms of agriculture and household use, high level of EC can cause corrosion of water lines, boilers, taps and metal containers. It also can cause effect of soap and other detergents as they cannot react properly due to high level of dissolved solids. [18, 19].

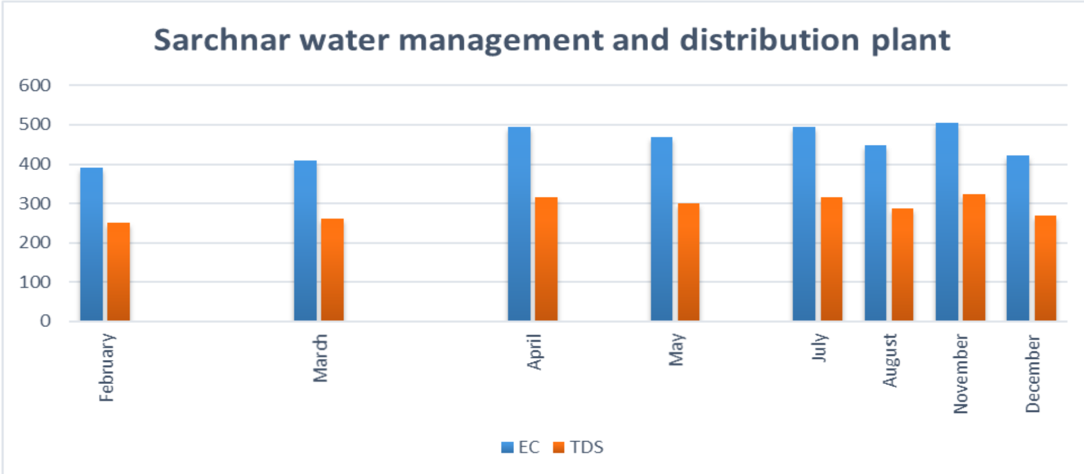

Figure 4: Electrical Conductivity(EC) and Total Dissolved Solids(TDS) of water sources during different periods ,2019. Note: EC & TDS have been recorded using different methods and devices as mentioned in Materials and Methods section.

4.2 Total dissolved solids (TDS)

TDS represent the combination of inorganic and a small portion of organic dissolved substances in the form of solution. Figure 4 shows TDS values for all samples in Sarchnar water management and distribution station throughout the year of 2019. Like other parameters, TDS also has a limit for drinking water to be allowable and potable (**Table 1**). This is set by WHO, which is around 1000mg/L [19]**.** As it can be seen data shows that TDS values from January to March were around 250mg/L. In the remaining seasons of the year TDS values were fluctuating around 300mg/L. Water sources from other locations has been also tested in terms of EC and TDS quality (figure 5). Statistical analysis shows the seasons may have slight impact on TDS values, especially in February and November.

Table 1: WHO and Iraqi standard parameters for potable water.

Parameter	WHO standards	Iraqi standards
PH	6.5–8.5	6.5–8.5
Conductivity (µs/cm)	600	1500
TDS (mg/l)	1000	1000
Alkalinity (mg/l $CaCO_3$)	600	--
Turbidity (NTU)	5	5
Free Chlorine (mg/l)	5	5
Hardness (mg/l $CaCO_3$)	500	500
Calcium (mg/l Ca)	75	50
Ammonia (mg/l NH_3)	1.5	--
Fluoride (mg/l F)	0.7–1.5	--
Chloride (mg/l Cl)	250	250
Nitrate Nitrogen (mg/l N)	10	--
Nitrate (mg/l NO_3)	50	50

All water sources mentioned in chart figure 5 are underground water (well water source with different depth). From the chart, it can be seen that just three of water management and distribution stations have EC below 400 μS/cm, and four of them (Qrga well 1&2, Azadi well and Zargata well) have EC between 600-800 μS/cm. despite differences in EC values all inside the safe zone, which is less than 1000 μS/cm (according to Iraqi standards). However, only two of them have EC values above 1000 μS/cm, which is totally unacceptable according to guidelines [2, 4]. The difference of TDS between Sarchnar (figure 4) and other locations (figure 5) has also analyzed. Despite different values all of them have EC and TDS under 500, except for Ashty well 2 and Shahidani azadi well have TDS values over 600mg/L, which is totally acceptable. New guidelines and other studies recommend that TDS values for drinking water of $<$ 400mg/L is better and safer for health. Beyond this range, between 400-1000 should be suitable for irrigation [20]**.** However, there are not clear results from studies to date proves TDS over 400mg/L cause health complication.

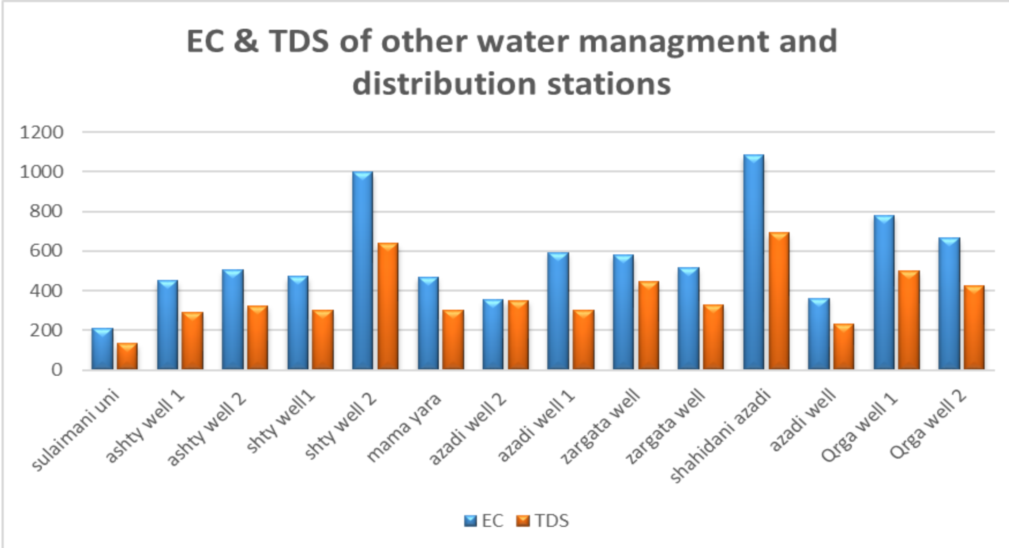

Figure 5: EC and TDS of underground water as water management and distribution plants

4.3 The effect of TDS level on health.

As mentioned before TDS is one of the most important parameters for drinking water quality. The level of TDS indicates the acceptability of drinking water through the concentration of either some dissolved solids, such as calcium and magnesium or the level of nitrate. In the other words, both of them can elevate TDS level in drinking water. (WHO determined the upper acceptable limit for TDS which should be less that 1000mg/L). the source of elevated nitrate due to inorganic fertilization, other agricultural activities and animal manure in the area. [21]. If the reason for elevated TDS in drinking water is ions (calcium and magnesium) it can only affect its aesthetic property, such as undesirable taste. However, if the reason for elevated TDS is nitrate, possible serious health issues may be resulted. Since drinking water provide 15-20 of dietary nitrate daily intake, drinking water should be strictly monitored. Like other micronutrients, nitrate in usually produced by our body [40], doing some crucial biological function, such regulate cardiovascular system and prevent cardiovascular disfunction, blood pressure reduction and prevent platelet aggregation. Endogenous nitrate (not dietary nitrate) is produces by intestine mucosa tissues. [22]. However, nitrate intake beyond standard guidelines might cause serios health implications. According to the WHO the upper limit and lower limit for daily nitrate intake are 3.7mg/kg and 0.006-0.007mg/kg respectively. Table 2 show the TDS level of different water treatment and distribution plant in Sulaimani city. it was found that Sarchnar water treatment and distribution plant has different TDS level through the year but all located under acceptable limit, which is 500mg/L (WHO). Nevertheless, among other stations (table1) three of them had the level of TDS more than the standard limit, namely Ashty station 639 mg/L, Shahidani azadi station 693 mg/L and Qrga station almost 500mg/L. studies in this area mentioned that in long-term this elevates amount of TDS might cause undesired health issues. [23].

Table 2: Show by date and location of samples of Sarchnar and other water management & distribution stations of some quality values.

Location	Date	pH	EC	TDS
Sarchnar water management & distribution Station	14/2/2019	7.1	400	256
	14/2/2019	7.2	397	254
	14/2/2019	7.3	381	243
	19/3/2019	7	427	273
	19/3/2019	7.3	399	255
	24/3/2019	7.6	406	259
	10/4/2019	7.5	378	242
	10/4/2019	7.1	610	390
	9/5/2019	7.5	429	275
	30/5/2019	7.7	512	328
	15/7/2019	7.8	495	317
	22/8/2019	7.8	449	287
	26/11/2019	7.5	505	323
	24/12/2019	7.4	423	270
Sulaimani uni	16/4/2019	7.9	209	134
Ashty well 1	5/5/2019	7.5	451	289

Ashty well 2	5/5/2019	7.8	504	323
Ashty well3	5/5/2019	7.7	471	301
Ashty well 4	5/5/2019	7.6	998	639
Mama yara	15/5/2019	7.3	470	300
Azadi well 2	28/5/2019	8	355	350
Azadi well 1	28/5/2019	7.4	592	302
Zargata well	28/5/2019	7.4	579	444
Zargata well	27/10/2019	7.3	516	330
Shahidani azadi	28/5/2019	5.5	1084	693
Azadi well	12/9/2019	8.2	363	232
Qrga	13/10/2019	9.5	780	499
Qrga	13/10/2019	9.4	666	426

4.4 Total hardness (TH): calcium (Ca) & magnesium (Mg)

Total hardness (T.H) is usually referring to the contribution of dissolved solids in water, especially the concertations of calcium and magnesium. This means, both of which exist in a high amount in water [24]. regarding this, the correlation has been conducted between the concentration of both calcium and magnesium in both Sarchnar (figure 6) and other water management and distribution plants (chart 6). With the support of data analysis, it was found that calcium concentration moderately related to hardness of water. However, there is a strong positive correlation of (r=0.8) between concentration of magnesium and the total harness of Sarchnar water management and distribution plant (figure 6). Correlation has also been conducted for other water management and distribution plants regarding the same relationship. It was discovered that there is a strong positive correlation of (r=0.9) between the concentration of both calcium and magnesium and total water hardness. According to guidelines for classification of waters are: “0 to 60 mg/L (milligrams per liter) as calcium carbonate is classified as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and more than 180 mg/L as very hard”. [19]. It is well known that calcium is primary compound leading to produce calcium carbonate.

The range of calcium content in Sarchnar water treatment and distribution plant was between 71-105 mg/L throughout the year of 2019. A minimum and maximum calcium concentration were recorded in December and August. Comparing to the standards, all water samples that taken in different seasons can be classified as moderately hard (figure 6). Regarding (figure 7), representing total hardness for other water management and distribution plants, they can be classified into three groups; out of 14 stations only 4 of them had calcium concentration equal and less than 60mg/L, which can be classified as a soft water. 9 of them had calcium concentration inside a range of moderately hard water. and only one of them (Shahidani azadi station) had calcium concentration at 160mg/L which considered as hard water. It can be concluded that, apart from that one station all stations supply soft and moderately hard water to homes. Furthermore, Magnesium in all station was in a suitable range that in line with a study that has been done by WHO. “The mineral contents of water from most Asian drinking-water supplies are generally in the range of 2–80 mg/l for calcium (Ca^{2+}) and below 20 mg/l for magnesium (Mg^{2+})”.

Despite the classification of water total hardness, soft water might be better than hard water regarding the quality and acceptability of water. It turns out moderately hard and hard water might be more beneficial for human health than soft water. Since calcium and magnesium are two abundant menirals and perform crucial biological function in human body, their concentration in drinking water might be considered interesting. [25]**.** Guidelines set recommended daily intake for calcium and magnesium for healthy adults should be 1000mg and 400mg respectively (USDA). Epidemiological studies in some major countries (US, Europe and Russia) raveled the possible beneficial link between the concentration of calcium and magnesium and cardiovascular diseases. They suggest that the concentration at least 29-30mg/L calcium and 10mg/L in drinking water might serve a good human health [26]**.** The balance of calcium and magnesium are a key to a healthy cardiovascular system. A balance and adequate recommended intake have an inverse relationship with cardiovascular diseases [27-30]**.** One study claimed that there was a protective effect of magnesium from hypertension in drinking water [31-34]. Data from this study show that water supplies from all stations (figure 6&7) can provide a good amount of both calcium and magnesium to homes, in an average amount of 60-70mg/L of calcium and 40-50mg/L of magnesium. This can satisfy a great portion of both recommended calcium and magnesium daily intake just from drinking water. However, these contributions can be vary depending the amount of drinking water per person in different seasons and food preparations.

4.5 Excess amount of Calcium and Magnesium

As mentioned before water, after food is a second main source of minerals. It also has been mentioned that water supplies in this study might be a good source of calcium and magnesium though drinking water. However, taking excess amount of both minerals should be taken into account. Although all water treatments and distribution plants in this study provides an acceptable amount of both minerals, except for 2-3 of them (out of standard range), it would be a great knowledge for people to know their drinking water covers how much of their recommended daily intake. Studies show that excess calcium intake above standard limits might not be a big concern, in a way that a hormone form of vitamin D which is called dihydroxyvitamin D automatically restrict or regulate excess amount of absorbed calcium in kidney and secreted though urine. This process is happening in a healthy people who do not have any kidney diseases or complications. However, for people who prone to milk alkali syndrome (people who have hypercalcemia, metabolic alkalosis and renal insufficiency at the same time), calcium intake should be strictly regulated [25]. In term of excess magnesium intake. Renal insufficiency or disfunction might be as a result of hypermagnesemia, which in turn caused by taking excess magnesium in a long term. This is possible for who is taking magnesium over 250mg/L. However, this might not be a concern for people who have healthy kidney. Another outcome of excess magnesium intake would be the change of bowel function habit (diarrhea).

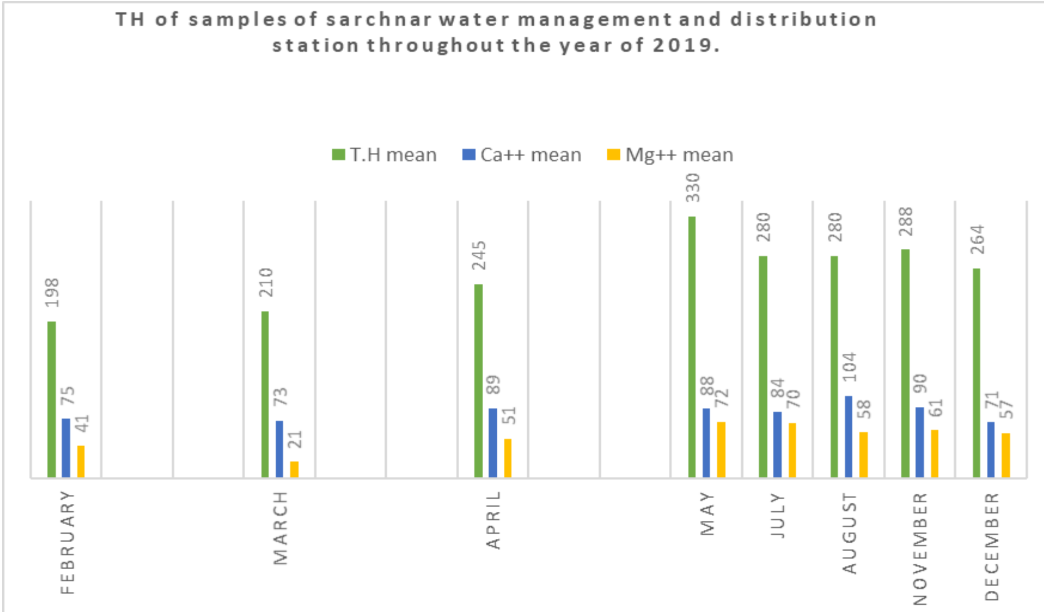

Figure 6: Total hardness, calcium and magnesium concentrations (mg/l) in water samples.

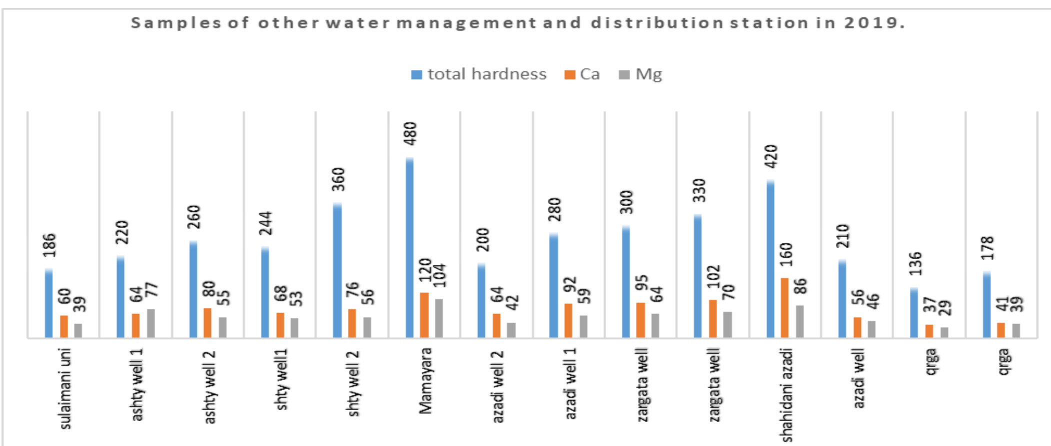

Chart 6: Total hardness of samples of other water management and distribution station in 2019.

4.6 Chloride, Sodium and Potassium

Chlorination is a process is done for drinking water to make it safe from microbes, parasites and viruses. This is because water has different sources. It may contain microorganisms cause water borne-illness. Usually, chlorine is used to clarify water. it can be totally safe when used in a small amount up to 4mg/L. In this study, chlorine concentration was determined in all samples belongs to all water treatment and distribution stations (**Table 3**). After statistical analysis, data show that supply water from all stations had a chloride level way above allowed limit. The minimum concentration was 10mg/L and goes up to as high as 31mg/L. apart from undesired smell and taste, studies warn some serious health issues at this level of concentration, such as Airway irritation, Wheezing, Difficulty breathing, Sore throat, Cough, Chest tightness, Eye irritation, Skin irritation. [35]. Potassium is another seldom elements that can be found in water. because it is abundant and human body desperate for proper functioning. It worth mentioning to discuss its level in drinking water and reveals water can contribute how much of recommended requirements. This study determined potassium for all samples (**Table 3**). It was discovered that, water supplies from all stations provide a minor amount to homes as low as less than 2mg/L [26]. Furthermore, High potassium content water can be used to soften hard water, as potassium can exchange with calcium and magnesium ions [26].

Table 3: Some chemical and nutritional values of both water management and distribution plants.

Sarchnar water treatment & distribution station

Date	**T.H mean**	**Ca++ mean**	**Mg++ mean**	**Cl- (mg/L) mean**	**Na^+ mean**	**K^+ mean**
February	198	75	41	17	7	2
March	210	73	21	15	4	11
April	245	89	51	15	2	1
May	330	88	72	15	5	1
July	280	84	70	17	5	0
August	280	104	58	7	3	0
November	288	90	61	10	3	1
December	264	71	57	20	8	2

Other water treatment & distribution station	Sulaimani uni	186	60	39	10	2.6	1.4
	Ashty well 1	220	64	77	21	4.4	1.5
	Ashty well 2	260	80	55	20	4.1	1.6
	Ashty well 3	244	68	53	17	4.1	1.6
	Ashty well 4	360	76	56	23	2.1	1.4
	Mamayara	480	120	104	20	9.7	1.5
	Azadi well 2	200	64	42	20	7.7	1.8
	Azadi well 1	280	92	59	19	18.9	1.9
	Zargata well	300	95	64	22	21.9	2
	Zargata well	330	102	70	15	32	1.2
	Zhahidani azadi	420	160	86	18	9.1	1.6
	Azadi well	210	56	46	23	4.9	0.1
	Qrga 1	136	37	29	31	70	0.4
	Qrga 2	178	41	39	27	69	0.1

Note: Although the analysis of some heavy metals, such as Nitrate, phosphor and boron are crucial, selected parameter values in this table can have a great impact on quality and potability of drinking water.

Sodium is one of the common mineral constituents in food and water, its deficiency might be rare. Although sodium is considered as an essential element and it is a great contributor to body fluid volume and hypertension, taking sodium above limited daily requirement can cause acute and long-term health issues, such as blood pressure and cardiovascular related diseases. [36]. To prevent or reduce these possible health issues the dietary guidelines set a limit of 2.4g/day. This a reasonable strategy to minimize sodium-linked hypertension diseases [36]**.** In this study, the concentration of sodium in all samples were compared to standard limits for the sake of avoiding overdose sodium intake (**Table 3**). It was found that the majority of stations that supply drinking water to homes have sodium concentration between 5-10mg/L. only two of them contain sodium ions around 20mg/L. These are all acceptable ranges. However, only two have a sodium concentration above standard limit by two-fold (Qrga 1&2 water treatment and distribution plant). In a long term this amount of sodium intake from these two stations might cause sodium related hypertension.

5. Conclusions

A number of main water management and distribution plants were tested for their potability. Chemical and nutritional properties are directly related to long-term people's health to whom the water supply. It was discovered that, generally, water from those main distribution tanks is not just drinkable, but also, they are in a good quality. However, water supply from some of water management and distribution plants were above standard universal limits. For example, pH, total hardness, electrical conductivity and chloride. Furthermore, seasonal change might have a minor impact on some chemical properties of supply water, such as pH and electrical conductivity. It can be said that water supply from those main tanks is acceptable according to both universal and Iraqi standards. Nevertheless, some chemical components that affect human health, such as chloride and sodium concentration in some main tanks should be adjusted, controlled and in line with standard qualities.

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البحث عن الجودة والحالة التغذوية لبعض مصادر المياه في مدينة السليمانية

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المستخلص

من اجل حماية الصحة العامة تم التحقيق من الناحية السلامة , الجودة و الحالة الغذائية لمجموعة من محطات توزيع المياه في محافظة السليمانية, تم اخذ العينات من مصدرين مختلفين و هما المياه الجوفية و المياه السطحية. تم فحص المياه من الناحة pH, TDS,EC,Total hardness (TH), و محتوي المياه من الكالسيوم , المكنسيوم , بوتاسيوم , صوديوم و كلورايد. بعد التحليل تم مقارنة النتائج بالمعايير العالمية WHO, Nation drinking water quality standards و المعايير العراقية Iraqi standards. من خلال المقارنة تم اكتشاف ان نسبة كبيرة من العينات مطابقة للمعاير العالمية و العراقية و نسبة من النماذج مطابق للمعيار العراقي وغير مطابق للعالمي و هناك بعض من النماذج غير مطابق لكلا المعيارين العالمي و العراقي. اما من الناحية التغذوية للمياه تم تحقيق من احتمالية حدوث الأمراض المزمنة من خلال استخدام هذا المياه بشكل يومي , او انها مياه صالحة للشرب و تزود الجسم بالمكونات الغذائية المفيدة مثل الكالسيوم.النماذج المأخوذة تضمن سنة 2019 فقط,من الضروري جدا اخذ سنوات و محطات توزيع مياه اخرى في محافظة السليمانية لضمان حماية الصحة عامة لكافة المحافظة.