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ISSN: 2278-1862

Journal of Applicable Chemistry

2021, 10 (1): 42-48

(International Peer Reviewed Journal)

Study of Some Physical and Chemical Characteristic Properties of Ground Water in Sug al Juma'a area in Tripoli, Libya

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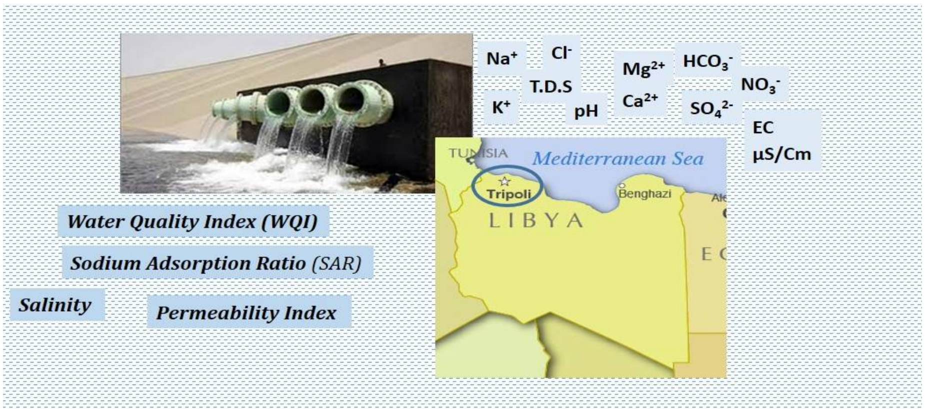
Accepted on 11th January, 2021

ABSTRACT

The physical and chemical properties of ground water from thirty wells in Sug al Juma'a area in Tripoli, Libya were analyzed using standard methods. Ground water samples were collected from three locations (Al-Shat Road (A), Sug al Juma'a Road (B) and Arada Road (C)). The physical and chemical parameters such as pH, Total Dissolved Solids (TDS), Total Hardness (TH), Electrical Conductivity (EC), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}), Chloride (Cl^{-}), Sulfate (SO_4^{2-}), Bicarbonate (HCO_3^{-}), Nitrate (NO_3^{-}) were analyzed to study the present status of the ground water quality. The results were compared to the Libyan Standard No. 82 for Drinking Water and the World Health Organization (WHO). The understudy samples showed significantly higher values of TDS and EC than Libyan Standard and WHO. Permissible limits which may greatly influence the health conditions of the residents of this area. It is concluded from this study that the ground water of the area needs a substantial degree of purification treatment before using for drinking and domestic purposes.

Graphical Abstract



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Keywords: Water quality, Ground water, Drinking water, Tripoli.

INTRODUCTION

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological information of the particular region. Groundwater is less susceptible to contamination and pollution when compared to surface water [**1, 2**]. In Libya, groundwater is one of the main sources of water used intensively for domestic and agricultural purposes. The addition of different kinds of pollutants through sewage, industry and agriculture into the ground water main stream causes a series changes in the physical and chemical properties of ground water [**1, 3, 4**].

The ground water used for human consumption should be safe and free from toxic elements, living and non-living organisms and any substance on mineral that harmful to health. A sustainable monitoring of ground water quality becomes essential for reducing ground water contamination and controlling pollution causing materials. Several investigations of physical and chemical properties of ground water in Libya were carried out [**5-8**].

The growth of the city leads to high consumption of water, therefore many people are using ground water without any control. The objective of this study is to evaluate some of the parameters that can cause contamination and in what concentration present, and comparing it with set standards of World Health Organization and Standard Organization of Libya.

MATERIALS AND METHODS

Study Area: The water samples were collected from the following three locations in the Sug al Juma'a area in the Libyan capital Tripoli. Al-Shat Road, 400-900 meters from the sea coast. Sug al Juma'a Road, 1750-2500 meters from the sea coast. Arada road, 2600-3200 meters from the sea coast.

Chemicals and Reagents: All the chemicals and reagents used for the analyses were in the analytical grade.

Samples Collection and Preparation: The samples were collected in polyethylene bottles (1.0 liter capacity) which have been thoroughly washed with distilled water. The bottles were emptied and rinsed several times with the water to be collected after leaving the pump faucet open for five minutes and then close the package immediately after taking the sample. Few drops of nitric acid have been added until pH = 2.

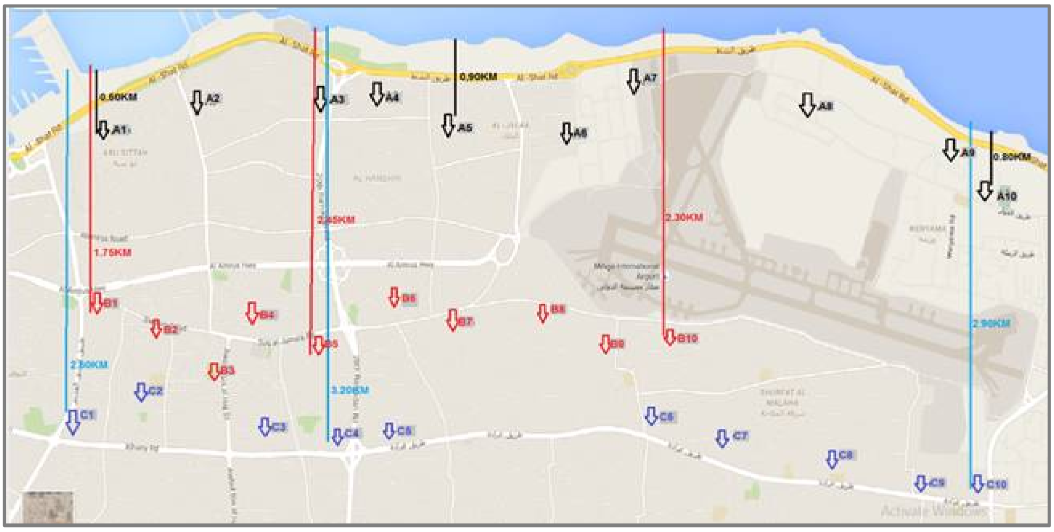

Figure 1. Locations of Three Blocks (Al-Shat Road (A), Sug al Juma'a Road (B) and Arada Road (C).

RESULTS AND DISCUSSION

The results obtained are illustrated in tables 1, 2 and 3.

Table 1. Physico-chemical analysis of ground water of Al-shat road

Sr. No.	Depth of well, m	pH	EC µS/Cm	T.D.S	TH	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	Na^+	K^+	NO_3^-	Tur NTU
				mg L^{-1}										
A1	13	7.79	1626	863.7	220	48.6	41	195.2	297.7	220	182	9.0	56.9	5.5
A2	6	7.67	3110	1695	400	80	76.8	427	655.8	280	480	24	9.1	2.0
A3	11	7.64	3062	1667	400	88.6	74.7	427	602.6	316	455	4.3	85.5	4.5
A4	12	7.68	2865	1555	390	80	74.4	305	638.1	248	415	4.3	9.1	4.0
A5	14	7.52	3592	1970	400	84	75.8	305	797.6	420	550	3.0	7.4	9.1
A6	31	6.90	741.5	384.9	220	56.2	39.3	244	106	30	55	4.3	25.2	3.6
A7	12	7.39	3414	1868	520	120	96	427	691	316	415	90	2.2	9.0
A8	8	7.09	5625	3135	900	320	139.2	732	1418	250	760	23	5.7	6.5
A9	9	7.05	10750	6176	1400	240	278.4	427	3208	450	1300	30	9.3	4.9
A10	5	7.17	10580	6076	1380	240	273.6	341.6	3190	440	1300	73	4.8	3.5

Table 2. Physico-chemical analysis of ground water of Sug al Juma'a Road

Sr. No.	Depth of well, m	pH	EC µS/Cm	T.D.S	TH	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	Na^+	K^+	NO_3^-	Tur NTU
				mg L^{-1}										
B1	25	7.58	2512	1354	500	60	105.6	390.4	460.8	240	400	3.0	129.4	9.0
B2	20	7.76	1622	861.4	280	48	55.6	195	297.7	210	200	9.0	62.5	3.6
B3	20	7.82	1878	980.7	400	48	84.4	219.6	358	204	240	9.0	68.5	3.4
B4	23	7.97	1625	863.6	280	40	57.6	219.6	297.7	144	200	9.0	60.8	2.9
B5	18	7.70	1783	950.4	380	64.8	75.6	207.4	319	236	240	14	73.5	3.6
B6	18	7.77	1719	915.4	300	40	62.4	231.8	319	190	240	9.0	79.3	2.6
B7	14	7.67	2424	1304	270	56	51.3	366	425.4	308	450	5.8	118.7	2.4
B8	16	7.78	1619	860	370	76	70.5	195.2	304.8	220	180	9.0	70.3	7.1
B9	16	7.44	2645	1430	550	160	93.6	244	549	300	310	9.0	144.8	9.5
B10	16	7.60	1615	857.6	360	68	70	207.4	301	220	200	9.0	66.9	2.4

Table 3. Physico-chemical analysis of ground water of Arada Road

Sr. No.	Depth of well, m	pH	EC µS/Cm	T.D.S	TH	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	Na^+	K^+	NO_3^-	Tur NTU
				mg L^{-1}										
C1	16	7.58	2356	1267	510	48.6	110.7	353.8	389.9	156	275	17	109.6	3.9
C2	12	7.62	3322	1816	540	136	96.9	366	726.7	242	415	43	140.9	8.6
C3	8	7.65	1654	881.9	370	88.6	67.5	219.6	322.5	195	166	9.0	66	4.1
C4	6	7.89	1652	878.3	270	40	55.2	195	322.5	160	166	8.1	64.6	3.1
C5	6	7.45	1871	979	360	52.4	73.8	280.6	336.7	225	200	17	39.8	9.9
C6	16	7.54	2535	1367	490	28.6	110.7	109.8	659.3	65	310	5.1	82.2	10
C7	12	7.18	3588	1967	530	40	117.6	353.8	886	245	620	6.5	8.9	4.5
C8	8	7.25	5365	3001	1000	200	192	366	1435	150	690	5.8	3.2	5.0
C9	14	7.19	5721	3193	970	200	184.8	475.8	1595	206	760	10	126	4.0
C10	10	7.11	6084	3402	1100	208	213.9	268	1861	137	760	8.1	66	4.0

Water Quality Index (WQI): WQI is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of ground water [9].

It is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water [10]. It is commonly used for the detection and evaluation of water pollution [11].

The water quality index was calculated depending on fourteen parameters. It has been calculated by using the drinking water quality standard recommended by the World Health Organization (WHO, 2011)to assess the suitability of groundwater quality for drinking purposes [12]. It is calculated from the point of view of human consumption according to [9].

The quality of water are classified into five types, "excellent water" to "water unsuitable for drinking" Table (4) according to the value of WQI.

Table 4. Water quality classification based on WQI value

WQI value	water quality	Percentage of water samples (%)
< 50	excellent	3.33%
50-100	good water	33.33%
100-200	poor water	53.33%
200-300	very poor	10 %
>300	unsuitable	0%

The WQI for 30 samples ranges from 37.84 to 262.37. The high value of WQI at these stations have been found to be mainly from the higher values of total dissolved solids, hardness, potassium, sodium, chloride, calcium and manganese in the groundwater.

Groundwater Quality for Agricultural Use: The suitability of water for irrigation is determined not only by the total amount of salt present but also by the kind of salt [13].

Quality evaluation for agriculture: The irrigational parameters like; salinity, SAR, Na%, residual sodium carbonate (RSC), Kelley's ratio, Mg hazards, and permeability index have been worked out to know the suitability of the groundwater for irrigational purpose [14].

Salinity: Water with high salinity is toxic to plants and poses a salinity hazard. Electrical Conductivity, as an irrigation quality index, measures total salinity of the soil [15]. EC play a vital role in suitability of water for irrigation. Higher EC in water creates a saline soil harmful effect of irrigation water increases with the total salt concentration, irrespective of the ionic composition [16]. A high salt concentration present in the water and soil will negatively affect the crop yields, degrade the land and pollute the groundwater [13], the samples are classified into four types as in table 5.

Table 5. Spatial Distribution Result of specific Electrical Conductivity Classification for Irrigational Purpose

S .No.	Conductivity (μScm-1)	Zone	Spatially Area
1	< 250	Low Salinity Zone	A9, A10,
2	250-750	Medium Salinity Zone	A6
3	750-2250	High Salinity Zone	A1, B2, B3, B4, B5, B6, B7, B8, B10, C3, C4, C5
4	2250-5000	Very High Salinity Zone	A2, A3, A4, A5,A7, B1, B9, C1, C2, C6, C7

Sodium Adsorption Ratio (SAR): The sodium or alkali hazard limit for irrigation is determined by the absolute and relative concentration of cations and is expressed in terms of sodium adsorption ratio (SAR).

There is a significant relationship between SAR values of irrigation water and the extent to which sodium is absorbed by the soil. If groundwater used for irrigation is high in sodium and low in calcium, the cation exchange complex may become saturated with sodium. This can destroy the soil structure owing to dispersion of the clay particles [14].

There is a close relationship between SAR values in irrigation water and the extent to which Na^+ is absorbed [17].

The sodium adsorption ratio is calculated as:

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}]+[Mg^{2+}]}{2}}} \quad \dots (1)$$

In this study, **SAR** values range from (1.371 to 13.555 meq L^{-1}) about 83.33 % samples are classify as Excellent for irrigation, 16.66 % of samples are classify as Good, (Table 6).

Table 6. Classes according to Sodium Adsorption Ratio

SAR	Class	Samples
0-10	Excellent	A1, A2, A3, A4, A6, A7, A8, B1, B2, B3, B4, B5, B6, B8, B9, B10, C1, C2, C3, C4, C5, C6, C8, C9,C10
10-18	Good	A5, A9, A10, B7,C7
18-26	Doubtful	Nil
>26	Unsuitable	Nil

Permeability Index: It's used to assess probable influence of water quality on physical properties of soils [15]. The soil permeability is affected by long term use of irrigation water. It is influenced by sodium, calcium, magnesium and bicarbonate contents of soil irrigation based on Permeability Index (PI): [14]

$$PI = (Na^+ + (HCO_3^-)^{1/2}) \times 100 / (Ca^{2+} + Mg^{2+} + Na^+) \quad \dots 2$$

PI values range from (52.48% to 82.73%) about 96.66 % samples are classified as injurious and 3.33% as unsatisfactory quality for irrigation are in Table 11. WHO uses a criterion for assessing the suitability of water for irrigation which is based on its PI [16].

Table 11. Permeability Index for groundwater

PI%	Water Class	Samples
<20	Excellent	Nil
20-40	Good	Nil
40-80	Injurious	all except B7
>80	Unsatisfactory	B7

APPLICATION

The data obtained in this study are very useful for public health officials and in order to mitigate the health risk and to improve the municipal services

CONCLUSION

The present study of the assessment of groundwater in Sug al Juma'a area in Tripoli, Libya for drinking and irrigation has been evaluated on the basis of standard guidelines. According to the value of water quality index (WQI), more than 60% of the samples are not suitable for drinking purpose. Based on parameters such as EC, salinity, sodium adsorption ratio (SAR), permeability index (PI), groundwater in the studied are in Tripoli city was found to be vary in suitability for irrigation purposes. A continuous monitoring water quality is required to check the quality of water for the required purposes.

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