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RESEARCH ARTICLE

SUITABILITY ASSESSMENT OF DEEP WELLS WATER FOR DRINKING AND DOMESTIC USES IN AL-BEWANEES REGION, SOUTH OF LIBYA

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ABSTRACT

This work was conducted to assess chemical composition of deep wells water, in Al-Bewanees region, south of Libya, to clarify its suitability for drinking and domestic uses. Obtained results indicate that all studied samples have been neutral to very slightly acid pH, within the optimum range for drinking water. Most samples had high salt content. Sodium was the dominant cation in the entire samples, and its concentrations in most samples were above than the upper critical limit suggested by WHO and Libyan guidelines for drinking water. Potassium was found in high concentrations, presenting second cation, followed by calcium then magnesium, which was the lowest. Sulphate was the dominant anion in all samples, except one which showed chloride dominancy. Trace ions and phosphate were found in low concentrations. Ammonium and nitrate were undetectable. Only one sample showed high hardness, while the rest were soft. Langlier index values suggest that some samples have potential for corrosion. Apart from samples No.5 and 12 which can be used after correction of calcium and magnesium concentrations, the rest were unsuitable for drinking and household uses.

INTRODUCTION

Drinking water is the most essential material for human life. So receiving safe water, free of pathogens, as well as acceptable in respect of color, taste, and odor is the priority of consumers and suppliers. Degree of water suitability and its acceptance for drinking and other domestic uses depend on its physical, chemical and microbiological properties. Chemical properties include; pH, total dissolved solids (TDS), ionic composition, and proportion of chemical pollutants. Water acceptance also depends on many local community factors, such as: culture and development of the community, type of water addicted to be consumed and environmental conditions.

Studies dealing with public health and water suitability for drinking have been emphasized that drinking water is the main source for many mineral ions essential for human health, so it could be important for those who don't intake these minerals from diet in adequate quantity. Some of these minerals may be present in more or less than the convenient concentration or at imbalance with the other ions, which may be hazardous for public health. Also corrosion of piping materials and/or scaling, which related to chemical composition of water, can cause adverse effect on community health and environment.

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Calcium and magnesium are well known as essential ions for human health. Sufficient evidence is now available to confirm the health risk from drinking water deficient in calcium or magnesium. Intake of soft water low in calcium is associated with higher risk of fracture in children, pre-term birth and low weight at birth (Yang *et al.,* 2002 a), certain neurodegenerative diseases (Jacqmin *et al.,* 1994), and some types of cancer (Yang *et al.,* 1997, 1998), whereas excess calcium in drinking water may increase risk of kidney and bladder stones (WHO, 2006, 2011). Also, high water calcium may create problems for domestic and industrial uses. Some studies have been suggested a significant protective effect of calcium intake from drinking water on the risk of colon and gastric cancer (Yang *et al.,* 1997, 1998) and risk of delivering a very low birth weight baby (Yang *et al.,* 2002 a), in addition to possible protection effect from stomach cancer (Yang *et al.,* 1998).

As compared with hard water and water with high magnesium content, intake of soft water and water low in magnesium significantly increase dying from cardiovascular disease or stroke, (Sauvant and Pepin 2002; Donato *et al.,* 2003; Cotruvo and Bartram, 2009), increase contraction of some types of cancer (Yang *et al.,* 1997, 1999), higher risk of motor neuronal disease (Iwami *et al.,* 1994; Kozisek, 2005), and seems to be associated with pregnancy disorder (Melles and Kiss, 1992; Kozisek, 2005) and having a child of low birth weight (Yang *et al.,* 2002 b). Magnesium has the same protection approach from cancer as calcium, but only at high concentration

(Yang *et al.,* 1998). Association correlations between magnesium drinking water and protection from heart vascular diseases have been reported by WHO (2011). Other results indicate a significant protective effect of magnesium intake from drinking water on the risk of cerebrovascular disease (Sengputa, 2013). High magnesium in drinking water may have laxative effect for those who are not addicted for its presence in drinking water (WHO, 2006).

Epidemiological studies have shown a significant positive association between drinking water nitrate exposure and gastric, bladder, stomach and rectal cancers mortality (Yang *et al.,* 1998; Chiu, 2007; Kuo, *et al.,* 2007). Although no firm conclusion was found between diseases and sodium in drinking water (WHO, 2003), but high intake of sodium water above than the upper permissible level can cause imbalance in physiology of human body, therefore person with cardiovascular or heart disease, kidney problems and high blood pressure, who are on no-salt diets should be aware when its concentration in drinking water exceeded 20 mg l^{-1} (AEPA, 2003). Excess intake of sodium can result in depletion of potassium (WHO, 2009). In addition, high sodium > 200 mg l^{-1} may affect water taste. Although potassium in drinking water does not pose a health risk for healthy people, but excess intake of potassium can interfere with magnesium uptake, and could result in significant health effect in people with certain conditions, such as heart disease, coronary artery disease, hypertension and diabetes (WHO, 2009). Other studies have indicated importance of chlorine drinking water concentration as one cause of heart diseases (Watts, 1986). Versari *et al.* (2002) reported that chloride concentration greater than 200 mg l^{-1} considered to be risk for human health and may cause unpleasant taste of water. Also, high chloride concentrations accelerate mineral corrosion of water distribution systems and appliances and may damage concrete structure and foundations.

Wells are the mere source of water in Al-Bewanees region and all other parts of southern Libya. For more than three decades, no study has been published dealing with chemical assessment and water quality of deep wells in Al-Bewanees region (Temenhent, Semnew and Al-Zeigan cities). So, this study was carried out to clarify the mineral constituents and to assess the suitability of water of these wells for drinking and other domestic uses.

MATERIALS AND METHODS

Water samples were collected from 12 deep wells used for drinking and domestic usage, and located at Al-Bewaness region (Temenhent, Semnew and Al-Zeigan cities), south of Libya, Fig.1. Aquifer in this region is part of Murzuk basin. These wells have variable depth (80-160 m) (Table 1). Water was pumped from wells to distribution lines directly without filtration and disinfection. Study area is characterized by dry climate, scarce rainfall, hot summer, mild winter and low relative humidity. Water samples per well were collected in duplicate at January 2012 in clean sampling containers after water pumping for 45 minutes. Each container was rinsed thrice with the sample water before sample collection. One sample for each well was acidified with 2 m/l concentrated nitric acid and used for trace metals analysis. The second was used for the other analyses. Samples were kept cooled during transport and storage at 4° C until analysis. Some physical properties of water samples (i.e. color, odor and taste) were checked immediately to be sure of its suitability and acceptance for drinking and domestic usage. Water temperature, pH and electrical conductivity were determined in situ after collecting each sample immediately.

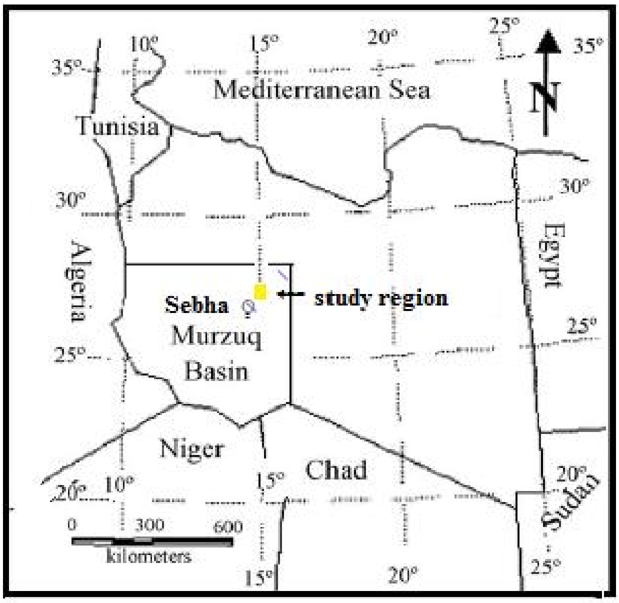

Fig. 1-Location of sampling region.

Sodium and potassium have been determined by atomic emission spectrophotometry method using flamephotometer. Calcium, magnesium, chloride, bicarbonate have been determined by titerametric methods. Sulphate was determined by gravimetric method. Ammonium and nitrate were determined by optical spectrophotometry. Trace elements have been determined using flame atomic absorption spectrophotometry. All previous chemical analyses were carried out after Rump (1999). Soluble orthophosphate was determined by modified method of Murphy and Riley, as was described by Watanabe and Olsen (1965). The accuracy of major ions analysis was checked by calculating electroneutrality (E.N.) since positive and negative charges in water must be in balance. Electroneutrality percentage was calculated after Appelo and Postma (1999) using this equation:

$$\%\ E.N. = \frac{sum\ of\ cations - sum\ of\ anions}{sum\ of\ cations + sum\ of\ anions} \times 100$$

Where ions concentration was in meq/l. The accepted limit or certain is between 0-5 %, 5-10 should be probable certain and >10 % is uncertain and should be not useful for interpretation. Accuracy analysis explained that major ions analysis was within the acceptable limit. Total solid (TS) has been determined by weighing, after evaporating 100 of each sample to dryness using vapor bath, and then dried at 105℃ for 24 hrs using electrical oven. Total dissolved solid (TDS) has been determined in the same manner but after filtrating the samples using a What man papers no. 42. Total suspended solid (TSS) was calculated by subtracting TDS from TS. Total hardness (TH) was calculated using this equation:

$$TH = [Ca^{++}] \times 2.497 + [Mg^{++}] \times 4.117$$

Where, TH is in mg equivalent/l calcium carbonate, and Ca^{2+} and Mg^{2+} concentration in mg l^{-1}. Water hardness classes were determined according to WHO guidelines. Water aggressive was determined using Langlier index (*LI*) to assess its corrosivity and precipitation ability. It was calculated using this formula:

$$LI = pH_a - pH_c$$

Where pH_a and pH_c are the determined and calculated pH respectively.

RESULTS AND DISCUSSION

Physically, all studied samples were clear, colorless, odorless, and some of them have sweet taste, while others have weak to moderate salty taste. No abnormal temperature has been recorded (Table 1).

Table 1. Some physical and chemical properties by the location of the studied samples

Sample No.	Sample location	Well Depth, m	Temp. °C	pH	EC_{25} dS m^{-1}	TS	TDS	TSS
						mg l^{-1}		
1	Temenhent-1	92	24.2	6.62	2.47	1574	1514	60
2	Temenhent-2	85	23.5	6.78	2.63	1638	1622	61
3	Temenhent-plant	85	16.6	8.18	2.30	1417	1403	41
4	Temenhent-residential group	89	21.0	7.01	1.07	0632	0632	0
5	Semnew-electrical station	140	21.0	6.99	0.69	0428	0424	04
6	Semnew-agric. project	80	24.2	6.80	5.59	4221	4210	11
7	Semnew -public land	157	25.0	6.54	2.28	1526	1521	50
8	Semnew -sport club	90	26.2	6.67	3.22	2082	2066	16
9	Al-zeigan- farms	90	26.0	6.78	2.10	1258	1248	10
10	Al-zeigan-new houses	105	26.0	6.74	1.26	0670	0670	0
11	Semnew -Abu bakr farm	60	24.2	6.58	1.72	1096	1096	0
12	Semnew -Abu Isha farm	160	23.5	6.74	0.77	0469	0466	03

pH

The pH values for all water samples were in the optimum range proposed by WHO and Libyan guidelines for drinking water quality (6.5-8.50). Apart from sample No.3, which were alkaline (pH: 8.18), other samples were very slightly acid to neutral (pH: 6.54-7.01) (Table 1).

Electrical Conductivity (EC)

The electrical conductivity of the studied groundwater samples are presented in table 1, while mineralization of the samples in relation to EC according to Detay (1997) presented in Table 2. Two water samples (5 and 12) were moderately mineralized, and two others (4 and 10) reflect highly mineralized water, and the rest were excessively mineralized.

Total Dissolved Solids (TDS)

Studied samples showed wide variation in TDS content, and can be placed in three groups depending on optimum and upper permissible TDS value suggested by WHO (i.e. 500 and 1500 mg l^{-1} respectively). First one had TDS less than 500 mg l^{-1} and includes wells No. 5 and 12, which contained 424 and 466 mg l^{-1} respectively. These wells are good for drinking and suitable for all domestic uses and many industrial purposes, from view of salinity.

Table 2. Relation between water electrical conductivity and Mineralization (After Detay, 1997)

EC, µS/cm	Mineralization
< 100	Very weakly mineralized water
100-200	Weakly mineralized water
200-400	Slightly mineralized water
400-600	Moderately water
600-1000	Highly mineralized water
>1000	Excessively mineralized water

The Second group contained TDS in the range of 500 to 1500 mg l^{-1} and included wells No. 3, 4, 9, 10 and 11. This group is suitable for all domestic uses and few industrial purposes. Although TDS content of this group were within the upper permissible limit of Libyan and WHO guidelines for drinking water suitability, i.e. 1500 mg l^{-1}, but our advice is that the wells which contain TDS between 500 to 900 mg l^{-1} (wells no.4, and 10) could be used for drinking in critical situations, while the wells No. 3, 9 and 11 which had TDS more than 900 mg l^{-1} could be used for drinking for short period, only if it was absolutely necessary. Salty taste and negative impact on community health would be expected if water of the last division consumed for a long period. The third group includes wells contains TDS more than 1500 mg l^{-1}. This group includes wells No. 1, 2, 6, 7, and 8, and it's unsuitable for drinking or domestic uses.

Total Suspended Solid (TSS)

The results in Table 1 indicate that wells water differ in their content of total suspended solid. Lowest values were found in wells No. 5, 6, 8, 9, and 12, and highest values were found in wells No. 1, 2, 3 and 7. The rest samples were free of suspended solid, which mainly consist of mineral colloids reaches the water because of the weakness of wells lining. This result indicates that suitable conservation for some wells walls will be necessary, and water must not pumped directly to distribution pipes before filtration as happens now.

Major Ions

Obtained results have shown that sodium was the dominant ion in all samples (Table 3). Two samples only (No. 5 and 12) contained sodium (184 and 196.6 mg l^{-1}) less than the optimum value (200 mg l^{-1}) suggested by WHO and Libyan guidelines for drinking water suitability. Two others (4 and 10) had sodium (287 and 268.4 mg l^{-1}) less than the upper permissible value, whereas the rest had high sodium concentrations (412.6-1197.6 mg l^{-1}) exceeding the upper recommended permissible value (Table 3). So except samples No. 5 and 12, the rest are unsuitable for drinking and may cause health problems for local community especially with increase consuming of these water. WHO, 2009 reported that long consuming of high sodium drinking water may cause blood pressure and calcium lost with urine. The source of sodium ion in the studied samples could be from clay minerals found in the geological formation of the aquifer. Potassium was the second component, and its concentrations were between 16.5-89.5 mg l^{-1}. Two samples (6 and 8) had potassium above than the upper permissible value suggested by Libyan and WHO guidelines for drinking water, but all samples had potassium much above than the optimum value suggested by WHO (Table 3). High potassium concentration in the studied samples in comparison to other ground water is due to abundance of potassium bearing minerals like feldspars orthoclase and microcline, and micas in the geological material of the aquifer.

Table 3. Major ions concentrations and K:Na ratio in the studied samples

Sample No.	Cations, mg l^{-1}				Anions, mg l^{-1}			K:Na
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	$SO_4^{=}$	HCO_3^{-}	
1	11.9	2.4	554.3	34.3	425.7	547.7	83.2	0.06
2	11.5	3.0	556.6	34.2	425.4	537.6	123.2	0.06
3	6.0	3.4	526.0	37.9	380.3	507.8	112.4	0.05
4	3.7	1.4	287.0	18.8	181.1	274.6	110.9	0.06
5	2.0	0.9	184.0	16.4	110.0	171.4	86.25	0.03
6	81.3	8.9	1197.6	89.5	988.7	1180.8	255.7	0.07
7	13.0	3.9	542.8	38.7	384.2	571.2	103.2	0.07
8	13.8	4.1	805.0	57.7	601.9	757.9	215.6	0.07
9	9.8	2.9	520.7	31.3	419.7	452.4	89.3	0.06
10	7.76	2.2	268.4	17.8	253.3	160.3	104.7	0.07
11	7.9	3.6	412.6	27.8	310.5	385.4	94.0	0.07
12	3.92	1.6	196.6	16.5	129.4	168.5	84.7	0.08
WHO guide Opt.	50	25	200	12	250	250	-	-
WHO guide Max	200	150	400	40	500	400	-	-
Libyan guide	200	60	200	40	350	300	400	-

Calcium was the third cation in all samples. Its concentrations were very low and ranged between 2.00-13.8 mg l^{-1}, except for sample No. 6 which had 81.3 mg calcium l^{-1}. Low calcium is due to geological formation of aquifer, while high calcium in sample No. 6 was related to its high salinity. Calcium concentrations in all studied samples were less than the minimum concentration for calcium taste occurrence (100 mg l^{-1}). Apart from sample No. 6, the rest samples had calcium far below than the optimum and minimum concentrations suggested by WHO, 2011 for drinking water (50 and 20 mg l^{-1} respectively). Low calcium drinking water may be associated with higher risk of fracture in children, pre-term birth and low weight at birth, and certain neurodegenerative diseases.

Concerning magnesium content, our results confirmed low concentration in all samples, which were between 0.9-8.9 mg l^{-1}. Its concentrations were far below than the optimum concentration suggested by WHO, 2011 (25 mg l^{-1}), which advised that minimum magnesium concentration must not be less than 10 mg l^{-1}. Apart from sample No. 6, the rest had magnesium much less than the minimum concentration (10 mg l^{-1}) suggested by WHO, 2011. Low concentration of magnesium ion is due to sedimentary formation of the aquifer which consists mainly from clays stone and siltstone. Previous many studies have mentioned that water with low magnesium or low calcium or both can cause some health problems to local community. So magnesium and calcium concentrations correction will be necessary to reduce or to avoid infection risk with these diseases if any of these wells water used for drinking, especially with community don’t intake adequate calcium and magnesium from diet (Cotruvo and Bartram, 2009). All soils in south of Libya have low calcium and magnesium, and high available potassium, and irrigation water in these regions are characterized by low magnesium, high sodium and potassium content, which negatively affect magnesium content in crops and vegetables produced in these regions, and led to low diet magnesium intake by people of these regions.

Apart from sample No. 10, results indicate that sulphate was the dominant anion in the rest groundwater samples. Its concentrations were between 160.3-1180.8 mg l^{-1}.

Although sulfate hasn’t critical concentration threshold for determining drinking water suitability, but high sulphate concentration may give unpleasant taste, change bowel habits (diarrhea), dryness, and contagious and intestinal irritation (Cotruvo and Bartram, 2009). According to WHO and Libyan drinking-water guidelines suitability, sulphate concentration mustn't exceeded 250 and 300 mg l^{-1} respectively. Sulphate at concentration of 250 mg l^{-1} or more can impart a bitter to salty taste to the water and not recommended to be used for mixing for concrete preparation, while concentration over than 500 mg l^{-} can have laxative effect, and can cause mild gastrointestinal irritation when exceeded 1000 mg l^{-1}. Apart from samples No. 5, 10 and 12, the rest could cause weak to sever corrosion to concrete foundation and mineral pipes used for water distribution, in accordance to sulphate content.

Results indicate wide variation in chloride concentration of the studied groundwater samples (Table 3). Its concentrations were between 110.0-988.7 mg l^{-1}. Three samples only fit chloride concentration value suggested by WHO guidelines (250 mg l^{-1}) (i.e. Samples No. 4, 5 and 12), as well as sample No. 10 which had 253 mg l^{-1}. In addition to these four samples, sample No. 11 fit chloride concentration according to Libyan guidelines for drinking water suitability (350 mg l^{-1}) (Table 3). Chloride concentrations greater than 250 and 350 mg l^{-1} (in samples No. 1, 2, 3, 6, 7, 8, 9, and 11) marks a disqualification of these wells for drinking according to WHO and Libyan guidelines respectively, and could damage metallic pipes, pumps, water heaters and concrete structure. Source of chloride in the studied groundwater is attributed to geological conditions. Obtained results showed also that all studied groundwater contains low concentrations of bicarbonate and free from carbonate.

Trace metals ions

Results in Table 4 confirmed very low concentrations of Mn, Cu, Zn, Fe, Pb, Cd, and Cr ions in all studied samples, which were much less than acceptable limits suggested by WHO guidelines for drinking water.

Manganese concentrations in all studied samples were very low, and most samples don't show detectable Cu, Cr and Pb ions, and some others don't show detectable Zn, Fe and Cd. So Mn, Zn and Cu content in community diet of these regions must be in account to complete human body demand, if any of these wells used for drinking.

Nitrate, Ammonium and Phosphate

Nitrate and ammonium were undetectable in the entire studied groundwater samples, while phosphate was very low as shown in Table 5.

This result confirmed that these samples were uncontaminated with organic wastewater or sewage. This conclusion was coincide with the value of K:Na ratio which were between 0.03–0.08 (Table 3). According to Daly (1994) this ratio is a good indicator of water pollution, especially those caused by organic wastewater and solid water. He suggested a ratio of >0.3 as an indicator for such that pollution.

Table 4. Trace metals ions concentration in mg l^{-1} in the studied samples

Sample No.	Mn $\times10^{-3}$	Cu $\times10^{-3}$	Zn $\times10^{-3}$	Fe $\times10^{-3}$	Pb $\times10^{-3}$	Ni $\times10^{-4}$	Cd $\times10^{-3}$	Cr $\times10^{-3}$
1	201	n.d.	n.d.	n.d.	n.d.	28	40	n.d.
2	201	30	141	14	n.d.	14	n.d.	n.d.
3	201	n.d.	246	42	n.d.	n.d.	40	n.d.
4	234	n.d.	n.d.	14	11	n.d.	n.d.	n.d.
5	201	n.d.	n.d.	28	n.d.	28	n.d.	15
6	234	15	88	42	11	14	120	n.d.
7	208	15	35	14	11	n.d.	40	n.d.
8	214	n.d.	88	28	11	14	n.d.	15
9	227	n.d.	53	n.d.	n.d.	14	40	n.d.
10	208	n.d.	53	28	n.d.	28	40	15
11	201	n.d.	70	28	n.d.	n.d.	n.d.	n.d.
12	208	n.d.	n.d.	n.d.	n.d.	28	n.d.	15

n.d.= not detected.

Table 5. Phosphate, ammonium and nitrate concentration in the studied samples

Samples No.	Phosphate	Ammonium	Nitrate
	mg l^{-1}		
1	0.340	n.d.	n.d.
2	0.168	n.d.	n.d.
3	0.095	n.d.	n.d.
4	0.168	n.d.	n.d.
5	0.130	n.d.	n.d.
6	0.118	n.d.	n.d.
7	0.083	n.d.	n.d.
8	0.083	n.d.	n.d.
9	0.070	n.d.	n.d.
10	0.070	n.d.	n.d.
11	0.070	n.d.	n.d.
12	0.095	n.d.	n.d.

n.d: not detected

Table 6. Calcium, magnesium and total hardness and Langlier index in the studied samples

Sample No.	Ca- Hardness	Mg- Hardness	Total Hardness	Hardness class(1)	Langlier index
1	29.8	10.1	39.9	soft	-2.08
2	28.7	12.2	41.0	soft	-1.72
3	14.9	13.8	28.7	soft	-0.52
4	9.3	5.6	14.9	soft	-1.79
5	5.0	3.7	8.7	soft	-2.11
6	203.2	36.7	239.9	very hard	-1.70
7	32.4	16.2	48.7	soft	-1.96
8	34.6	16.8	51.3	soft	-1.53
9	24.5	12.0	36.4	Soft	-1.82
10	15.4	8.6	24.0	Soft	-1.96
11	19.7	14.6	34.3	soft	2.02-
12	4.8	6.4	11.2	soft	-2.16

(1): According to WHO, 2011, <60: soft, 60-120: moderately hard, 120-180: hard, >180: very hard.

Hardness

Obtained results indicate low calcium; magnesium and total hardness in all samples, which classified as soft, except sample No. 6 which had high calcium hardness and total hardness, and classified as very hard. Although there is no specific standard for hardness in drinking water, but aesthetic problems are well known when total hardness exceeds 160 mg l^{-1}. Also, corrosion could be associated with water have very low hardness. Accordingly, sample No. 6 is unsuitable for drinking, domestic and industrial uses, and samples No. 4, 5 and 12, may be dangerous for public health if they are used for drinking because of low hardness content and corrosivity. The rest samples are suitable from view of hardness.

Langelier index

Langelier index used to evaluate the aggressive potential of water. An index value < -2 would suggest a significant potential for corrosion and an index value > 2 should suggest the potential for scale formation in the piping. Results in Table 6 show that Langelier index values for all studied samples were negative. This result indicates that none of the studied samples have a tendency for scaling. Apart from samples 3 and 8, Langelier index for the rests were less than -2 or around it, which suggest that most samples have potential for corrosion. In addition to water pH, many other factors controlling corrosivity, i.e. chloride and sulphate concentrations, TDS, soluble oxygen and carbon dioxide. According to obtained results, we advice not to use metallic pipes to carry and distribute water from these wells.

Conclusion and Recommendations

The study revealed that deep groundwater in Al-Bewaness region vary markedly in EC, TDS and mineral ions content. Most of the studied samples were excessively mineralized. TDS content were between 422-4210 mg l^{-1}. Sodium was the dominant cation, and potassium was the second one. Potassium was present in high concentrations, but insufficient to maintain Na^+/K^+ optimal values (3/1). This was due to very high concentration of sodium. Calcium and magnesium were found in concentrations far below than the optimal values suggested by WHO. Sulphate was the dominant anions. According to WHO and Libyan guidelines, all samples were unsuitable and mustn't be used for drinking, except samples No.5 and 12 which can be used after correction of calcium and magnesium concentrations to raise total hardness and concentration of these elements to suitable level. Samples No. 4 and 10 which have sulphate and chloride concentrations respectively slightly above than the maximum permissible values, can be used in critical situations only. Periodical analysis for a sample from these two wells every 6 months are necessary to correct sulphate and chloride concentrations if it is possible, otherwise these wells must be left and find others. Also, calcium and magnesium concentration correction is necessary if these wells used for drinking, otherwise new wells must be found in these regions to cover community water demand for drinking and household. Also, water must not pumped directly to distribution pipes before filtration as happens now. Metallic pipes must not use for carrying and distribution these water as most of it have potential for corrosion.

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