Assessment of Groundwater Quality of Assabaa Region, Libya

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Abstract

The present work was carried out in order to investigate the physical and chemical quality of the Libyan Assabaa groundwater and the degree of its contamination. The achieved results were compared with international quality standards for drinking water. The samples were collected from five water wells of the Assabaa region. Several parameters were examined including Colour, Taste, smell, pH, total dissolved solids (TDS), Calcium and Magnesium Hardness, Total Hardness, Iron, Fluoride, Ammonia, Phosphate and Chloride. The results showed that the groundwater of Assabaa area were within the limitations of WHO Standards. However, some samples had a bit high of concentrations for TDS and Total Hardness. The most of the water wells shared the high concentration of Total Hardness which might be due to the earth geology of the studied area. This makes the water tasty unacceptable and therefore, the water might not be used as drinking water.

Keywords: Groundwater, Chemical quality, Total Hardness, Assabaa, Libya

1. Introduction

Water is one of the most important compounds that profoundly influence life. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Water pollution has become one of the main threats that face humanity today. Increasing everyday people activities lead to contamination of water sources including oceans, rivers, lakes and ground water. This contamination contributes to generating large amounts of polluted water that people cannot use in their daily life. Contaminated water is generated from many different sources involving petroleum refineries, dyes, drugs, paper, textile dye, detergents, surfactants, pesticides, herbicides, insecticides and pharmaceutical manufacturers [1]. These chemical contaminants can be organic pollutants such as alkanes, aliphatic, alcohols and aromatic compounds or inorganic like heavy metals, including lead, mercury, nickel, silver and cadmium. In addition, water can be contaminated by pathogens such as bacteria, viruses and fungi [2]. The water sources can be divided into two main categories including surface and underground water. The water surface such as reveries, lakes and seas exposure to many industrial activities leading to increase the contamination by biological and chemical pollutants. These massive amounts of contaminated water can negatively affect the aquatic environment such as algae, which is a very significant link in the food chain [3]. Many organic and inorganic toxic compounds which are harmful and dangerous on human, animal and plant life. Among these pollutants, phenolic compounds which are categorised by United States Environmental Protection Agency (USEPA) as priority contaminants due to their negative effects to human nervous system [4]. The effluents having contaminants such as synthetic chemicals, dyes, organic matters, refractory organic waste, heavy metals etc are discharged to the nearest water bodies with or without any preliminary treatments. This causes serious damage to the DO level and ecological balance of the ecosystem of the nearby receiving water bodies [5]. However, Groundwater is used for domestic and industrial water supply and also for irrigation purposes in all over the world. According to world health organisation (WHO), about 80% of all the diseases in human beings are caused by water [6]. Once the groundwater is contaminated, its quality cannot be restored back easily and to device ways and means to protect it. Groundwater quality helps us understand the hydro geologic system and groundwater contamination [7]. This important water source contains different elements, ions, and compounds according to the earth geology. The more common soluble constituents include calcium, sodium, bicarbonate and sulphate ions. Another common factor is chloride ion coming from sea water, and evapotranspiration concentrating salts, and sewage wastes. For example, nitrate can be a natural constituent but high concentrations often suggest a source of pollution. Water quality standards are needed to determine whether ground water of a certain quality is suitable for its intended use.

Table 1 Some water standards of WHO for drinking water

Characteristics	Value (mg/L)
TDS	1500
pH	6.5-8.5 (dimensionless)
Chloride	200
Total Hardness	500
Calcium	200
Magnesium	150
Ammonia	0.5
Iron	0.3
Fluoride	1.5
Nitrate	45
Phosphate	0.5

Table 1 shows some water standards of WHO for drinking water. The quality water should be in the range of these limitations to safe human life. Therefore, the aim of this research is to investigate the physical and chemical parameters of some water wells located in the Assabaa region in order to understand the characterisation of these water sources.

2. Materials and Methods

2.1 Data Collection

Five groundwater samples were collected from different wells located in Assabaa region. All fresh samples were obtained directly from the head of the wells while the water coming out. The average depths of the wells were between 100-200m. One litter of each collected water samples were stored at $4C^0$. The investigations were carried out in the laboratory immediately next day of work.

2.2 Materials and Equipment

All chemicals used in these experiments were checked for expire dates. Sodium hydroxide (NaOH 0.02N) and sulphuric acid (H_2SO_4 0.02N) were prepared and used. EDTA (0.8N). Potassium chromate, Phenol Naphthalene and Orange

Methyl Reagents. Regarding equipment Spectrophotometer (HACH DR900) and DS Meter were used.

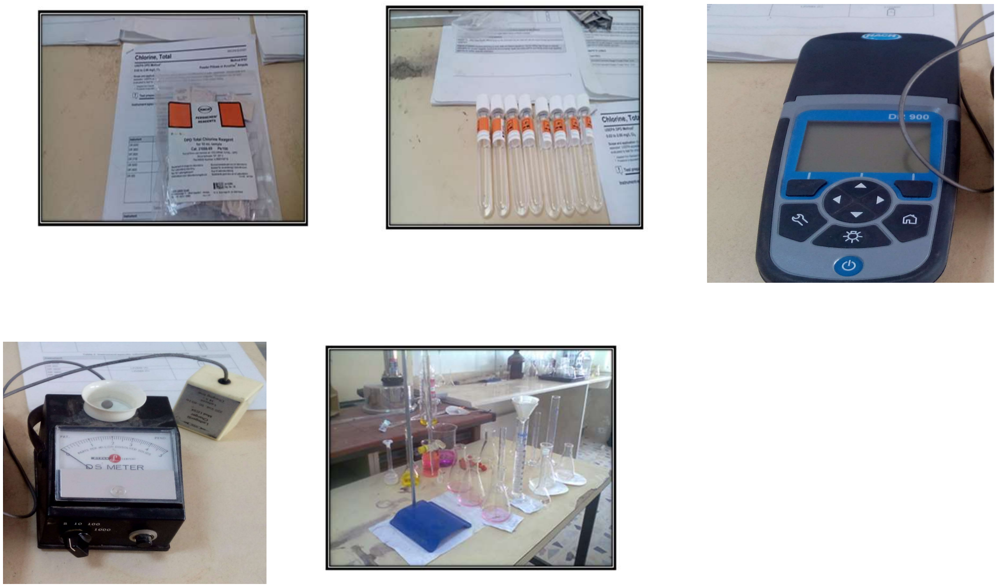

Figure 1 Chemicals and equipment used

2.3 Laboratory Procedures

The physical and chemical investigations of groundwater samples were performed according to different laboratory methods. Various quality parameters were effectively investigated including Colour, Smell, Taste, pH, Total Dissolved Solids (TDS), Calcium Hardness (CaH), Magnesium Hardness(MgH), Total Hardness(TH), Iron (Fe), Fluoride (F), Ammonia (NH_3), Phosphate (PO_4), and Chloride (Cl). Titration Method was carried out to determine Talk and TAci for each sample. Also DS Meter was used to measure TDS. Finally, Spectrophotometer was used to detect the other variables.

3. Results and Discussion

All results achieved were validated using World Health Organisation (WHO) standards. Tables (1-3) illustrate thirteen parameters determined for five groundwater wells. Table 1 shows the examined physical properties of the samples including colour, taste, smell and pH. There is no colour detected, therefor the turbidity should be very low due to the deep of the wells. The taste of samples water were a bit unacceptable, however small difference can be noticed comparing to treated water which might be to the dissolved salts and minerals in these samples.

Table 2 Physical properties of the samples

Parameter	N	Permissible level	Result
Colour	5	Colourless	Colourless
Taste	5	Tasteless	Unacceptable
Smell	5	No smell	No smell
pH	5	6.5-8.5	6.0-8.0

Table 2 includes the results some chemical parameters involving total dissolved solids TDS, calcium hardness CaH, magnesium hardness MgH, and total hardness TH. The range of TDS were between 500 and 590 mg/L which can be considered as good results according to the maximum permissible level which is 1500 mg/L. Calcium and magnesium were measured to determine the quality of groundwater which accounts for hardness in water, leading to bad taste and coloration of cooking utensils. The achieved results of CaH showed that the range was between 160 and 240 mg/L which is a bit high because the acceptable maximum level should be 200 mg/L. These high results detected in wells number 4 and 5. The MgH levels of the samples number 1, 3 and 4 were within the range, however wells number 2 and 5 were 400 mg/L and 466 mg/L respectively which they have high concentration of magnesium. The concentrations in the these samples showed that, magnesium levels were high exceeding WHO guidelines for drinking water quality. This phenomenon of high levels of magnesium hardness results in scales developing in water heaters, well pumps, boilers and cooking utensils, and it would require a lot more soap for washing clothes [8]. These high results might be due to the geology of earth. The same wells 2 and 5 had a high amount of TH which were 644 and 702 mg/L respectively. These results can support that the high concentration of total hardness TH comes from the magnesium compound. This phenomenon of high levels of hardness results in scales developing in water heaters, well pumps and boilers and it would require a lot more soap for washing clothes.

Table 3 Concentrations range of total dissolved solids (TDS),calcium hardness (CaH), magnesium hardness (MgH) and total hardness (TH)

Parameter	N	Permissible level (mg/L)	Min.(mg/L)	Max. (mg/L)
TDS	5	1500	500	590
CaH	5	200	160	240
MgH	5	150	88	466
TH	5	500	276	702

Figure 2 shows the above results as a function of TDS, CaH, MgH and TH and contains the maximum level of each parameter.

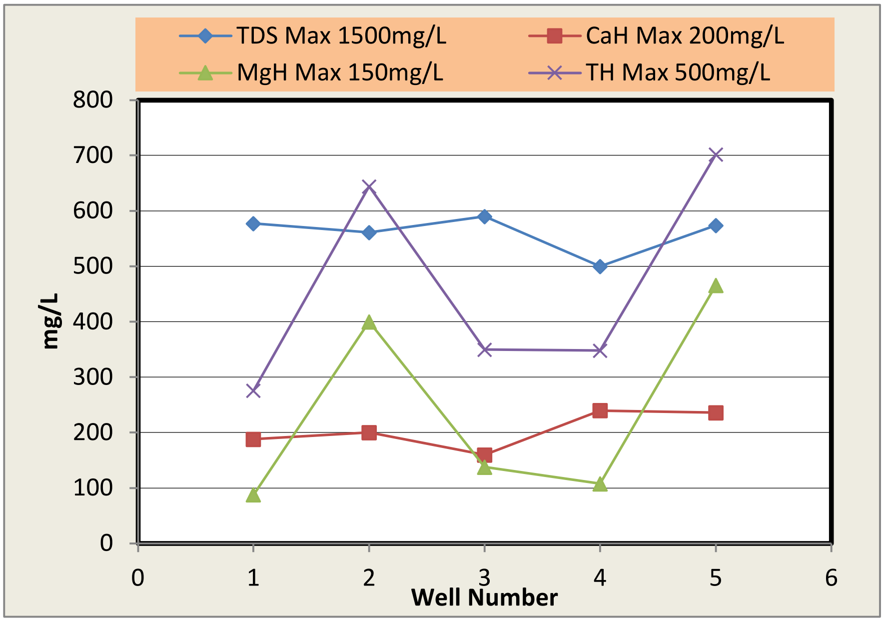

Figure 2 Variations of total hardness, calcium hardness, magnesium hardness and total hardness in the investigated samples

Table 3 illustrates the results of the rest of investigated parameters including iron (Fe), phosphate (PO_4), fluoride (F), ammonia (NH_3) and chloride (Cl). The results showed that all chemicals dissolved in the water were within the permissible level. As a result these water wells can be used as drinking water in terms of these chemicals. For instance, NH_3 was very low in all samples indicating that there is no any interaction between sewage water and these wells. This result is logical because the water wells are far from any sewage pipes. Furthermore, the concentration of F was in the level which is very important because the high concentration of F can be caused damage of teeth especially for children.

Table 4 Concentrations range of Iron (Fe), Phosphate (PO4), Flour (F), Ammonia (NH3), and Chloride (Cl)

Parameter	N	Permissible level (mg/L)	Min.(mg/L)	Max. (mg/L)
Fe	5	0.3	0.008	0.092
PO_4	5	0.5	0.0	0.16
F	5	1.5	0.77	1.2
NH_3	5	0.5	0.01	0.1
Cl	5	200	0.0	0.05

Figure 3 shows variations in Fe, PO_4, F, NH_3 and Cl and their maximum levels.

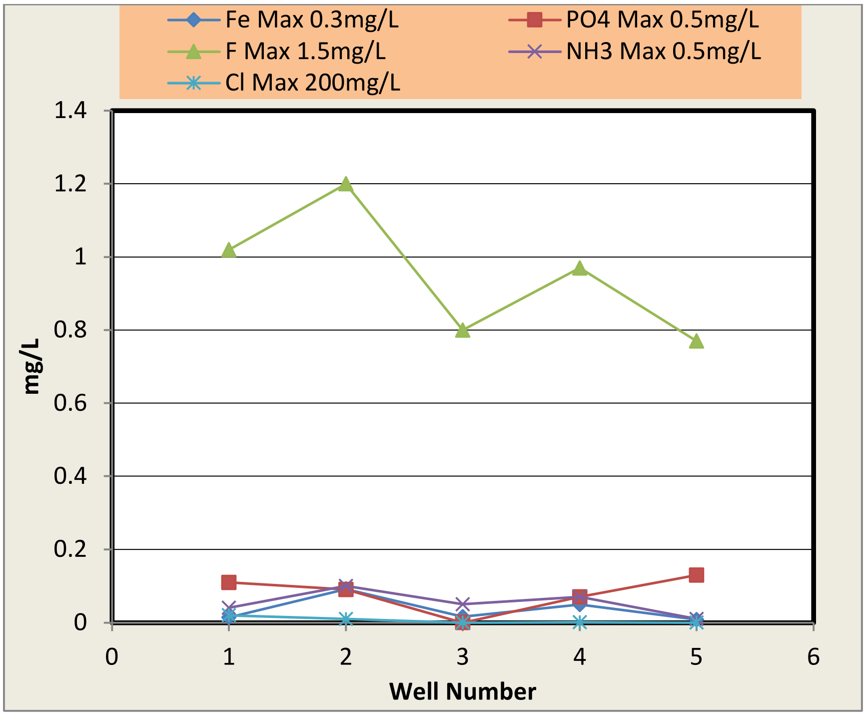

Figure 3 Concentrations of iron, phosphate, fluoride, ammonia and chloride in the selected water samples

4. Conclusion

To conclude, five water wells were investigated in terms of several physical and chemical parameters. The quality of most selected wells are complying with the WHO guidelines for drinking water quality. However, two of these wells have high concentrations of total hardness causing unacceptable taste. In addition, total hardness can increase scales developing in water heaters, well pumps and boilers , and it would require a lot more soap for washing clothes. Therefore, a suitable treatment requires to reduce the hardness founding in the investigated wells.

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