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Monitoring of chloride concentration in ground water of Sekket and Thomina areas, Misurata, Libya: correlation with some physical Parameters

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ABSTRACT

Chloride concentration in ground water samples was determined in ten sites of misurata zone (Sekket and Thomina areas). Sekket area considered one of the most important areas which provide Misurata city with drinking water, since Misurata zone is coastal zone and it relies on ground water as the main water source.Sixty random samples were collected from Sekket and Thomina and analysed for chloride content along with temperature,pH, electrical conductivity (E.C.) and total dissolved solids (T.D.S.)Chloride concentration detected in ground water of the studied sites varied between310.11-819.6 $mgl^{-1}$for Sekket andbetween1120.5- 2118.07 $mgl^{-1}$for Thomina area. Ground water samples contain high concentration of chloride compared to WHO permissible limit. For Sekket area, it's noticed that the chloride level is relatively constant in some spots compared to previous records from 1982 to 1987.Chlorideconcentration in relation with some other physical parameters was investigated.

Keywords: Chloride, ground water sample, Libya, monitoring ground water, physico-chemical parameters.

INTRODUCTION

Water is an essential resource that is threatened by pollution; therefore, monitoring of water quality has become an issue of vital importance. Some components are under strict regulation as they are dangerous to human health, while others are controlled by non-enforceable regulations as they only cause cosmetic or aesthetic effects. Chloride is an aesthetic contaminant as it imparts a salty taste to water. The concentration of chloride in water is variable and dependent on the chemical composition of water.

Normally, ground water has a lower concentration of chloride than surface water (Raquel *etal*., 2002). Chloride is widely distributed in nature in the form of salts of sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$). Chloride is leached from various rocks into soil and water by weathering. The chloride ion is highly mobile and is transported to closed basins or oceans.

Chloride in surface and ground water from both natural and anthropogenic sources, such as run-off containing road de-icing salts, the use of inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and sea water intrusion in coastal areas(WHO, 1984).

Contamination of ground water and surface water by Na^+ and Cl^- is a common occurrence in urban areas and has adversely affected municipal (Panno, 2006; Buttle and Labadia, 1999).

The purpose of this investigation was to monitor chloride concentration in ground water of Sekket area by comparing it with chloride concentration in other areas such as (Thomina area) since Thomina area is near from Sekket and the quality of its water is less than of Sekket and finally comparing the concentration level with available previous records from 1982 to 1987 and WHO.

Some parameters such as sodium ion (Na^+), temperature (T), electrical conductivity (E.C.), pH value, total Dissolved Solids (T.D.S.), Taste and odors were evaluated in correlation with chloride con-centration.

A number of suitable analytical techniques are available for determination of chloride in water, including Silver Nitrate Titration with Chromate indicator (Argentometric method), Mercury(II).
Nitrate Titration with Diphenyl-carbazone Indicator, potentiometric titration with Silver Nitrate, automated iron(III), Mercury(II),Thiocyanate colorimetry, chloride ion-selective electrode, Silver colorimetry, and ion chromatography(WHO,1996).

MATERIALS AND METHODS

The study area

Misurata city is a coastal old city. The population is over 380,000. It has a big industrial and agricultural activity and constitutes important commercial port. It follows Mediterranean sea's climate where it rains in winter.

Misurata city relies on underground water, rainwater as well as desalinated water since underground water is the most reliable source of water. Underground water are exploited from different wells which are divided in a number of fields such as Sekket and Thomina. Sekket lies at about 15 km south to Misurata city with altitude from 60°-70° above sea level. Thomina lies at about 15 km to south east Misurata on altitude from 20° to 35° meter above sea level as shown on the map (Fig.1).

Water sampling and analyses

Sixty random samples were collected from Sekket and Thomina areas (30 samples from each selected site, Sekket and Thomina) a long three months period (ten samples every month).

Analysis was carried out for pH, electrical conductivity (E.C), total dissolved solids (T.D.S), temperature, taste, odor, sodium and chloride. Samples collection and analysis were carried out according to the procedure of the standard methods (APHA, 2005). Sodium was determined by flame photometric method and chloride by silver nitrate titration with chromate indicator (Argentometric method).

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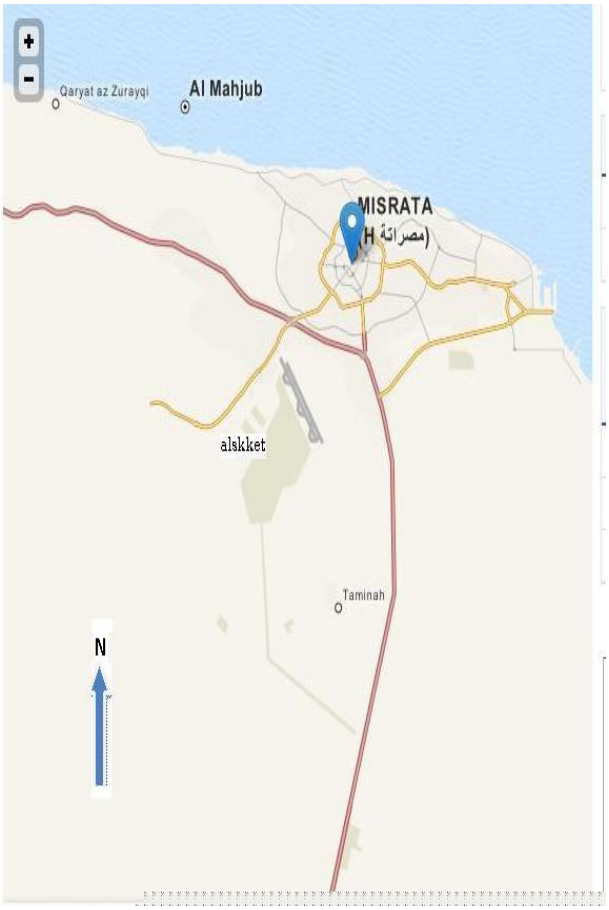

Figure(1):Satallite image of Misurata city, showing Sekket and Thomina areas.

RESULTS AND DISCUSSION

Data obtained from physiochemical parameters, recorded in Table 1 showed pH values were varied between 8.3 to 8.8 for Sekket areas. However, Thomina area recorded lower pH values ranged from 7.9 - 8.25 these ranges were fallen ranged of (WHO, 1984). Temperatures of samples were less than 37°C, except sample No. 6 (39°C) (Table 1).Temperature can affect every aspect of the treatment and delivery of potable water. Total dissolved solids of drinking water samples are given in table (1).

The data for T.D.S. show that most samples exceeded the limit of 1000 mgl^{-1}.The irregular variation of TDS values may attributed mixing of ground water with rich irrigation water, fertilizers and sewage discharge in addition to leaching of surrounding rocks (WHO, 1996).

Chloride concentration of all samples exceed the permissible limit for drinking water quality 250 mgl^{-1} (Table 1). The presence of chloride in natural waters can be attributed to many reasons such as contamination by sea water intrusion in coastal areas, dissolution of salt deposites, discharges of effluents from chemical industries and sewage discharge.

Each of these sources may results in local contamination of both surface water and ground water. (WHO, 1984).Chloride in the form of Cl^{-1} ion is one of the major inorganic anions in water and waste water. In potable water, the salty taste resulted from chloride concentrations is variable and dependent on the chemical composition of the water. Some waters containing 250mgl^{-1} chloride may have a detectable salty taste if the cation is sodium.

On the other hand, the typical salty taste may be absent in waters containing as much as 1000mgl^{-1} when the predominant cations are calcium and magnesium (APHA, 2005).

Concentrations of sodium (determined) in all samples were a ranged from 115 - 430 mgl^{-1}(table 1) for Sekket area, however it's ranged from 240 to 368 mgl^{-1} for thomania area. Sodium concentration in both Thomina area and samples 3 and 5 of Sekket area were higher than the permissible limit (200mgl^{-1}) of the WHO.

Table (1): Average concentration for the studied parameters of ground water in Misurata city.

Studied area	Sample number	Measured parameters							
		pH	T (°C)	T.D.S. (mg/l)	E.C.	Taste	Salt contents Na (mg/l) determined	Salt contents Na (mg/l) calculated	cL (mg/l)
Sekket	1	8.3	17	825	1650	Acceptable	115	201.5	310.11
	2	8.8	16	977.5	1955	Acceptable	140	271.1	417.1
	3	8.4	16	1212	2424	Acceptable	300	391.8	602.75
	4	8.6	15.5	1046	2092	Acceptable	175	293	450.7
	5	8.6	22.5	1562	3125	Acceptable	430	532.7	819.6
Thomina	6	7.9	39.7	1957	39154	Little salty	288	1376.7	2118.07
	7	8.25	24.5	1950	3900	Little salty	240	728.32	1120.5
	8	8.16	33.5	1957	3914	Little salty	279	916.4	1409.9
	9	7.91	34	1929	3858	Little salty	338	1226	1886.07
	10	8.05	32.5	1923	3846	Little salty	368	1239	1906.3

In most countries, the majority of water supplies contain less than 200mg of sodium per liter, but in some countries sodium levels exceed 250mgl^{-1}.

Particularly elevated levels of sodium are associated with ground water in areas where there is an abundance of sodium mineral deposits or where it has been contaminated by sea water intrusion (sea and estuarine sources) or other forms of pollution(WHO, 1984).

Electrical conductivity (E.C.) values of water samples in the studied areas showed high values as shown in

table (1). These high values may related to the increase of chloride since "chloride increases the electrical conductivity of water and thus increases its corrosivity" (WHO, 1996) which may resulted from intrusion of sea water with ground water. Also, using bio fertilizers for agricultural purposes may attribute in the high conductivity values. Weathering from surrounding rocks and sewage discharge may also play a role in increasing conductivity values in most of sampling sites.

The classification of drinking water based on electrical conductivity, most samples have high amount from total dissolved solids i.e. if sodium anion is the predominant anion, The samples will be very salty. Sample 6 from Thomina zone has the higher concentration of Cl^- (2118.07) and sample 5 has the higher concentration for sodium determined. Samples No. (1 and 2) from Sekket have the lowest concentration for sodium and chloride (115- 140mgl^{-1}) and (417.1 - 310.11mgl^{-1}) respectively.

The current chloride results for Sekket have been compared with chloride concentration from 1982 - 1987.* Its notice that the concentration of chloride is relatively constant in some spots compared to previous records, However the average of chloride concentration for samples under investigation is higher than the average chloride concentration of previously studied (Table 2). This increment may be attributed to sea water intrusion in coastal areas.

Samples from Sekket had an acceptable taste and odor but Thomina samples had a little salty taste. All samples haven't any color, except samples No 7 and 8 of Thomina area. At first, samples No 7 and 8 were not colored but after about ten minutes from sampling the color began to appear. The presence of iron in drinking water supplies is objectionable for a number of reasons unrelated to health. Under the pH conditions existing in drinking water supplies, ferrous salts are unstable and precipitate as insoluble ferric hydroxide, which settles out as rust colored silt. Such water often tastes unpalatable and stains laundry and plumbing fixtures. The iron that settles out in the distribution system gradually reduces the flow of water (WHO, 1984 and WHO, 1996). The brown precipitate in sample No. 7 was calculated by gravimetric method, it was about 260 mgl^{-1}.

Data analysis

T-test was applied to compare the current results obtained from Sekket and Thomina areas. It's noticed that, there were significant difference between chloride concentration in two areas, thus for pH, E.C, and T, by other hand there is no significant difference between sodium concentration (determined) in Sekket and Thomina areas.

Regression (R2) was used to know the correlation of studied parameters (pH, E.C., Na, T and TDS) to chloride concentration of samples studied. It is found that 92% from variation of chloride concentration caused by these parameters. T-test for every parameter shows that chloride concentration influenced only by temperature, i.e. 92% of variation chloride concentration was by temperature while the other parameters have no effect on chloride concentration i.e. 8% represented by other parameters. One way ANOVA test examines the present chloride concentration in comparison with chloride concentration of years from 1982 to 1987. The results show that p-value equal zero, i.e. there were significance difference between chloride concentration at different years above mentioned table (2). Results from low significant deviation (L.S.D.) test showed that chloride concentrations of current study 2012 and 1987 were different compared to other years with a p-value (p-value less than 0.05) (table 3).

Table 2shows that there is no difference between chloride concentrations of years (1982 - 1986) since the mean chloride concentration ranged from (333 to 338), but it was 370.9 and 520 mgl^{-1} at 1987 and 2012 respectively, i.e. there are reasons lead to the significant increase in the average chloride concentration.

Table (2): Average of chloride concentration of Sekket for current study and records 1982 – 1987.

Year	Lower concentrations mgl^{-1}	Higher concentrations mgl^{-1}	average concentration mgl^{-1}
Current study 2012	310.11	819.6	520.05
1982	252	322	333.54
1983	240	344	339.71
1984	252	360	339.91
1985	240	340	333.71
1986	213	346.5	338.30
1987	280	380	370.90

Comparsion current chloride concentration with previous records by ANOVA test

	Sum of squares	df	Mean squares	F	Sig.
Between Groups	178932.897	6	29822.149	11.409	.000
Within Groups	562005.160	215	2613.977		
Total	740938.057	221			

Table (3): LSD test to compare average of chloride concentration for current study and previous records of years 1982 to 1987.

(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig	95% Confidence Interval	
					Lower Bound	Upper Bound
2012	**1982**	186.51354*	24.96664	.000	137.3028	235.7243
	1983	180.33771*	24.00296	.000	133.0265	227.6490
	1984	180.13363*	24.00296	.000	132.8224	227.4449
	1985	186.33771*	25.44151	.000	136.1910	236.4844
	1986	181.75200*	23.98072	.000	134.4846	229.0194
	1987	149.14291*	25.33007	.000	99.2158	199.0700
1982	**1983**	-6.17582-	12.40500	.619	-30.6268-	18.2752
	1984	-6.37991-	12.40500	.608	-30.8309-	18.0711
	1985	-.17582-	15.00042	.991	-29.7425-	29.3909
	1986	-4.76154-	12.36192	.700	-29.1276-	19.6045
	1987	-37.37063-*	14.81063	.012	-66.5633-	-8.1780-
1983	**1984**	-.20408-	10.32923	.984	-20.5636-	20.1554
	1985	6.00000	13.33498	.653	-20.2840-	32.2840
	1986	1.41429	10.27745	.891	-18.8432-	21.6718
	1987	-31.19481-*	13.12111	.018	-57.0573-	-5.3323-
1984	**1985**	6.20408	13.33498	.642	-20.0799-	32.4881
	1986	1.61837	10.27745	.875	-18.6391-	21.8758
	1987	-30.99072-*	13.12111	.019	-56.8532-	-5.1282-
1985	**1986**	-4.58571-	13.29491	.730	-30.7908-	21.6193
	1987	-37.19481-*	15.59783	.018	-67.9390-	-6.4506-
1986	**1987**	-32.60909-*	13.08039	.013	-58.3913-	-6.8269-

CONCLUSION

- Concentration of chloride for Sekket sample less than that for Thomina, but chloride concentration for Sekket area is higher than international specifications and it is higher than the permissible limit ($250mgl^{-1}$) given by W.H.O. Since chloride concentration for current study is higher than previously records, it possibly, because of sea water intrusion at coastal areas.
- The concentration of chloride is higher than $250mgl^{-1}$ and there were no salty taste for Sekket samples and little salty taste for Thomina samples confirming that sodium is not the predominant cation.
- Statistical analysis revealed that chloride concentration has been affected only by temperature with respect to the studied parameters.
- It is noticed that, in current study there were significance difference between samples of Sekket and samples of Thomina with respect to chloride concentration, pH, E.C. and T while on other hand, there is no significant difference between samples of Sekket and samples of Thomina with respect to sodium concentration (determined).
- The comparison of chloride concentrations for current samples with chloride concentration of previously records of years 1982 to 1987, the statistical analysis shows that there is a significant increase in chloride level possibly due to sea water intrusion at coastal areas. Samples No.6 and 7 from Thomina area have brown color, this may attributed to the oxidation of dissolved ferrous and precipitate as insoluble ferric hydroxide, which settles out as rust colored silt.

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