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Quality Assessment of Drinking Water in Missan Province, Iraq

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Abstract The present study was undertaken to determine the physicochemical properties in drinking water samples collected from ten locations distributed in centre and districts of Moissan province during the months October, November and December; 2015. Laboratory tests were performed for the analysis of samples for pH, electrical conductivity, turbidity, calcium ion, magnesium ion, total hardness, chloride ion, sulphate ion, total dissolved solid, total suspended solid, nitrates and phosphates. These parameters were compared with the guideline value of World Health Organization (WHO) and Iraqi standards. Results indicated that some of these parameters did not exceed the permissible limit of the WHO and Iraqi standards for drinking water, such as pH, calcium ion magnesium ion, total suspended solid, nitrates and phosphates, whereas electrical conductivity, turbidity, total hardness, total dissolved solid, chloride ion and sulphate ion were above the permissible limits of WHO and Iraqi standards. Results of the present study suggested that the water sample is not suitable for drinking purpose.

Keywords Water; Physical; Chemical parameter; Moissan province

1 Introduction

Potable water is water free from disease causing organisms, and free from minerals and organic materials that may produce adverse physiological effects because good water is essential for the wellbeing of all people, humans may survive for many weeks without food, but barely few days without water because constant supply of water is needed to replenish the fluids lost through normal physiological activities (AWWA, 1990). The natural water analyses for physiochemical properties are very important for public health studies (Soylak *et al*., 2002). Some drinking water supplies have become contaminated with bacteria, viruses, heavy metals, nitrates and salt which enter into water supplies as a result of in adequate treatment and disposal of waste industrial discharges (Mohemmad Rafi *et al*., 2011). Exposure to these contaminants in water is thought to lead to human health effects ranging from minor effects such as fatigue to more serious effects such as cancer, in addition to these contaminants have impacted on economic status of the populations (Wilkes *et al.,* 1992). An adequate supply of safe and portable water assists in preventing the spread of gastrointestinal diseases (Ike and Ugodulunwa, 1999). This study aims at assessing of water quality in Moissan province for drinking purposes. It is hoped that results of this study will serve as baseline against which future anthropogenic effects can be measured.

2 Materials and Methods

Samples collection

The drinking water samples were collected in prewashed polyethylene bottles from ten locations namely Ali Al-grbi, Kumat, Al-Rafideen, Islamic unit, Qulat Salih, Al-Azer, Al-Musharah, Al-Kahlaa, Al-Maymona and Al-Mijer distributed in center and districts of Moissan province during the months of October, November and December; 2015.The samples after collection were immediately placed in an ice container.

Physical and chemical analysis

The collected samples were analysis for major physical and chemical water quality parameters like pH, turbidity, electrical conductivity, total suspended solid TSS, total dissolved solid TDS, chloride ion, calcium ion, magnesium ion, *sulphate ion*, total hardness TH, nitrate and phosphate. Prior to analysis all instruments were calibrated according to manufacturer's recommendations. Some physicochemical parameters including pH, turbidity and electrical conductivity were instantly determined on site by using pH meter, turbidity meter and electrical conductivity meter, while others parameters total suspended solid TSS, total dissolved solid TDS, chloride ion, calcium ion, magnesium ion, *sulphate ion*, total hardness TH, nitrate and phosphate were immediately analyzed upon laboratory arrival according to the procedures by APHA (1999).

3 Results and Discussion

Monthly variations of the main physical and chemical properties including pH ,TUR, EC, Ca^{+2}, Mg^{+2}, TH, TSS, TDS, Cl^{-1}, SO_4^{-2}, NO_3 and PO_4 of water samples from Missan province were given in tables from 1 to 12. Results of the present study revealed that the pH values ranged from 6.9 to 7.8 for drinking water samples, the lowest value recorded during October in station 7, whereas the highest during December in station 6. These values were within the permissible limits (6.5-8.5) of local and international standards (table, 13). Generally pH of water is influenced by buffering capacity of water (Muhamad *et al.,* 2011; Al-Sulaiman, 2015). The turbidity in water is mainly caused by solid matter present in the suspended state and it is a measure of light emitting properties of water (Gupta *et al.,* 2013). Results of this study showed that all the samples have turbidity values more than the local and international standards of the permissible limits (5NTU, table, 13). This may be attributed to the presence of sand silt finely organic matter and microorganisms, the greater turbidity values may be have human health risks such as gastrointestinal disease and turbidity can also have a negative impact on consumer acceptability of water as a result of visible cloudiness (Ezeribe *et al*., 2012). The electrical conductivity is the measure of capacity of solution to conduct electrical current through of the water and it is used in the water samples as an indicator of their salinity (Gupta *et al.,* 2013; Al-Sulaiman, 2015). The EC values ranged from 1978 to 2502 µS/cm, these values were above permissible limits of international and local standards at all stations except in station 7 during December and October (table, 13). The high EC values may be attributed to the presence of high amount of dissolved inorganic materials in ionized form (Kerketta *et al*., 2013). Concentrations of calcium ion and magnesium ion in the water samples were in the range of 47 to 93 $mg.l^{-1}$ and 125 to 185 $mg.l^{-1}$ respectively. All samples studied of drinking water have Ca^{+2} and Mg^{+2} levels falling within international and local standard limits (table, 13). Values total hardness ranged from 560 to 695 $mg.l^{-1}$ were more than the permissible limits of WHO and Iraqi standard for drinking water, therefore total hardness of all samples considered unsafe for drinking purposes. There is evidence that hard water plays a role in heart diseases, in addition to that higher concentration of magnesium ions makes the water unpalatable and act as laxative to human beings (Jazza, 2009; Ezeribe *et al*., 2012). The chloride results of drinking water samples in the present study showed high variation, which ranged from 269 to 424 $mg.l^{-1}$. These concentrations were above the permissible limits (250 $mg.l^{-1}$) of WHO and Iraqi standards (table, 13). Chloride in small levels are not harmful to humans in drinking water, and with some adaptation, the human body can tolerate water with as much as 200 $mg.l^{-1}$ chloride ion. However, concentration of chloride above 250 $mg.l^{-1}$, the water may taste salty (Hauser, 2001). The concentrations of SO_4 ranged between 260 and 390 $mg.l^{-1}$, the *sulphate* levels for all investigated samples were found to be greater than the values prescribed by international and local standards (table, 13). This ion is generally harmless, except its effect on taste. The major physiological effects resulting from high concentrations of SO_4^{-2} ions are gastrointestinal irritation, catharsis and dehydration (Gupta *et al*., 2009; Ghrefat, 2013). The estimate of TDS of water samples ranged between 1095 and 1351 $mg.l^{-1}$. It was observed that all stations showed above the permissible limits of WHO and Iraqi standards (table, 13). The presence of high concentrations of TDS in water may be objectionable of consumers (Roa *et al.,* 2012). Levels of TDS are a measure of all chemical substances dissolved in water and high of these values may be due to the presence of large concentrations of some ions such as Sulphate, Calcium, Magnesium, Chloride and Carbonate and Bicarbonate (Shareef *et al*., 2009). All samples studied of drinking water have TSS levels falling within international and local standard limits, which ranged between 15 and 60 $mg.l^{-1}$. Nitrates values ranged between 3.15 and 6.7 $mg.l^{-1}$ were lower that of WHO and Iraqi standard limits for drinking water (table, 13). Excess levels of nitrates can cause *Methemoglobinemia* as blue baby disease. Although nitrates levels that affect infants do not pose a direct threat to older children and adults (Ezeribe *et al*., 2012). Phosphorous is a vital nutrient for all living things. Cellular phosphates compounds trap energy generated from food consumed and transfer it to activities that demand it for growth, locomotion and reproduction. Without the phosphorus to build these energy compounds, cell life cannot exist (Nduka *et al.,* 2008). Phosphates level in our samples were ranged between 0.025 and 0.461 $mg.l^{-1}$. All the studied water samples have PO_4 levels falling within the WHO and Iraqi standard limits (5 $mg.l^{-1}$, table1~13).

Table 1 Monthly variation of pH values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	6.8	7.4	7.2
Kumat	2	7.1	7.35	7.3
Al-Rafideen	3	7.3	7.4	7.2
Islamic unit	4	7.1	7.4	7.8
Qulat Salih	5	7.4	7.8	7.6
Al-Azer	6	7	7.1	7.9
Al-Musharah	7	6.9	7.4	7.1
Al-Kahlaa	8	7.3	7.4	7.3
Al-Maymona	9	7.3	7.4	7.3
Al-Mijer	10	7	7.2	7.2

Table 2 Monthly variations of Turbidity (NTU) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	60	56	35
Kumat	2	58	33	38
Al-Rafideen	3	42	25	25
Islamic unit	4	35	28	41
Qulat Salih	5	57	23	55
Al-Azer	6	19	27	30
Al-Musharah	7	36	69	23
Al-Kahlaa	8	27	51	16
Al-Maymona	9	25	71	27
Al-Mijer	10	22	45	52

Table 3 Monthly variations of Electrical Conductivity EC (μS /cm) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	2344	2150	2187
Kumat	2	2270	2245	2098
Al-Rafideen	3	2255	2446	2018
Islamic unit	4	2411	2358	2010
Qulat Salih	5	2181	2502	2140
Al-Azer	6	2280	2434	2092
Al-Musharah	7	1979	2554	1978
Al-Kahlaa	8	2004	2430	2030
Al-Maymona	9	2080	2325	2121
Al-Mijer	10	2120	2363	2110

Table 4 Monthly variations of Ca^{+2} ion ($mg.l^{-1}$) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	140	143	160
Kumat	2	145	142	153
Al-Rafideen	3	143	153	151
Islamic unit	4	135	156	163
Qulat Salih	5	152	155	185
Al-Azer	6	138	170	148
Al-Musharah	7	150	141	162
Al-Kahlaa	8	150	151	154
Al-Maymona	9	130	142	161
Al-Mijer	10	125	151	135

Table 5 Monthly variations of Mg^{+2} ion (mg.l^{-1}) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	75	47	86
Kumat	2	80	50	81
Al-Rafideen	3	50	63	75
Islamic unit	4	60	55	88
Qulat Salih	5	63	66	93
Al-Azer	6	74	65	65
Al-Musharah	7	60	63	58
Al-Kahlaa	8	65	67	81
Al-Maymona	9	81	49	70
Al-Mijer	10	57	59	66

Table 6 Monthly variations of Total Hardness TH (mg.l^{-1}) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	635	695	675
Kumat	2	606	665	642
Al-Rafideen	3	580	624	600
Islamic unit	4	594	631	607
Qulat Salih	5	600	653	618
Al-Azer	6	625	659	625
Al-Musharah	7	560	652	687
Al-Kahlaa	8	605	688	622
Al-Maymona	9	630	620	645
Al-Mijer	10	642	636	662

Table 7 Monthly variations of Cl^{-1} ion (mg.l^{-1}) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	350	325	405
Kumat	2	340	313	365
Al-Rafideen	3	313	424	275
Islamic unit	4	335	358	300
Qulat Salih	5	335	405	310
Al-Azer	6	404	410	415
Al-Musharah	7	345	268	350
Al-Kahlaa	8	356	297	372
Al-Maymona	9	365	269	388
Al-Mijer	10	391	354	415

Table 8 Monthly variations of SO_4^{-2} ion (mg.l^{-1}) values of water samples from the selected sites

Station name	Station NO	Months		
		October	November	December
Ali Al-grbi	1	320	366	302
Kumat	2	260	365	338
Al-Rafideen	3	349	390	335
Islamic unit	4	275	389	325
Qulat Salih	5	270	390	290
Al-Azer	6	264	314	270
Al-Musharah	7	260	371	310
Al-Kahlaa	8	300	334	289
Al-Maymona	9	332	365	290
Al-Mijer	10	293	378	281

Table 9 Monthly variations of TDS ($mg.l^{-1}$) values of water samples from the selected sites

Station name	Station NO	Months October	November	December
Ali Al-grbi	1	1290	1174	1250
Kumat	2	1168	1158	1334
Al-Rafideen	3	1174	1351	1125
Islamic unit	4	1165	1271	1214
Qulat Salih	5	1145	1320	1155
Al-Azer	6	1171	1270	1182
Al-Musharah	7	1195	1320	1168
Al-Kahlaa	8	1280	1314	1190
Al-Maymona	9	1175	1268	1250
Al-Mijer	10	1107	1310	1240

Table 10 Monthly variations of TSS ($mg.l^{-1}$) values of water samples from the selected sites

Station name	Station NO	Months October	November	December
Ali Al-grbi	1	43	60	43
Kumat	2	51	56	57
Al-Rafideen	3	39	38	35
Islamic unit	4	48	29	53
Qulat Salih	5	53	30	56
Al-Azer	6	22	28	44
Al-Musharah	7	39	55	48
Al-Kahlaa	8	32	39	35
Al-Maymona	9	18	50	57
Al-Mijer	10	15	23	56

Table 11 Monthly variations of Nitrate ($mg.l^{-1}$) values of water samples from the selected sites

Station name	Station NO	Months October	November	December
Ali Al-grbi	1	4.9	6.2	3.6
Kumat	2	3.15	5.33	3.6
Al-Rafideen	3	5.5	5.04	3.8
Islamic unit	4	3.7	4.55	6.3
Qulat Salih	5	6.3	4.14	3.6
Al-Azer	6	6.6	4.75	4.8
Al-Musharah	7	6.7	4.5	4.5
Al-Kahlaa	8	5.8	5.8	5.4
Al-Maymona	9	5.16	6.06	6.4
Al-Mijer	10	5.7	4.9	4.8

Table 12 Monthly variations of phosphate ($mg.l^{-1}$) values of water samples from the selected sites

Station name	Station NO	Months October	November	December
Ali Al-grbi	1	0.065	0.078	0.258
Kumat	2	0.461	0.085	0.32
Al-Rafideen	3	0.322	0.064	0.121
Islamic unit	4	0.175	0.053	0.265
Qulat Salih	5	0.168	0.091	0.57
Al-Azer	6	0.052	0.085	0.353
Al-Musharah	7	0.151	0.457	0.252
Al-Kahlaa	8	0.079	0.152	0.217
Al-Maymona	9	0.441	0.025	0.208
Al-Mijer	10	0.187	0.149	0.418

Table 13 Values of physical chemical properties of WHO and Iraqi standards for drinking water

Parameter	WHO Standards 2008	Iraqi Standards
Ph	6.5-8.5	6.5-8.5
Turbidity NTU	5	5
Electrical Conductivity µ S/cm	2500	2000
TDS. $mg.l^{-1}$	1000	1000
TSS .$mg.l^{-1}$	60	60
Calcium. $mg.l^{-1}$	200	150
Magnesium. $mg.l^{-1}$	150	150
Total Hardness .$mg.l^{-1}$	500	500
Chloride .$mg.l^{-1}$	250	250
Sulphate .$mg.l^{-1}$	250	250
Nitrate .$mg.l^{-1}$	50	50
Phosphate $mg.l^{-1}$	0.5	0.5

4 Conclusion

This study assessed the physicochemical properties of drinking water from ten different locations in Missan province during the months of October, November and December, 2015. The analysis was carried out by taking certain important parameters like pH, TUR, EC,Ca^{+2}, Mg^{+2}, TH, Cl^{-1}, SO_4^{-2} TSS, TDS, NO_3 and PO_4. The results showed that some of the parameters determined did not exceed the permissible limit of the world Health Organization WHO and Iraqi standards for drinking water such as pH, calcium ion magnesium ion, total suspended solid, nitrates and phosphates, whereas electrical conductivity, turbidity, total hardness, total dissolved solid, chloride ion and *sulphate* ion were above the permissible limits of WHO and Iraqi standards. The physicochemical properties in the study suggested that the samples water is not suitable for drinking purpose.

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