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Environmental Study of Drinking Water to Some Areas of Baghdad–Side Al Karkh

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ABSTRACT

The study included four study stations located at Karkh sector in Baghdad Governorate (Al Qadisiyah, Al Yarmouk, Al Mansour and Hay Al Jamiea). The study lasted for 6 months to measure some of the physical, chemical and biological factors of the tap water and analyzed for the period from October 2015 until March 2016 to evaluated the efficiency of drinking water schemes. As turbidity values ranged between (1.7-5.3NTU). the result were non acceptable in the first station during the period of the study and in accordance with Iraqi standard specifications (417) and WHO. The total dissolved solid material values (TDS) ranged between (280-506 mg/l). As for the values of chloride, it ranged between (67.9-170 mg/l) while the values ranged between (253-370 mg/l), (88-128 mg/l) and (7-29 mg/l) for the each of the total hardness, Calcium and Magnesium hardness respectively. With regard to heavy metals, Ferrite (Fe) recorded values ranged between (0.001-0.11 mg/l), for Lead Pb (0.001-0.009 mg/l) and for Copper Cu (0.002-0.81 mg/l). a study was conducted to Coliform bacteria, as recorded values ranged between (0- 400 cell/ml). The recorded values for all the studied stations were high and therefore undrinkable during February, it was noticed that the highest values recorded in the first station for all of the parameters, but did not exceed the permitted value limits of the Iraqi standard (417) and WHO.

Keywords: Karkh-Baghdad, Drinking water, Turbidity, Hardness, Heavy metals, Coliform bacteria.

1. INTRODUCTION

Water is contaminated with everything that loses its properties, or changes its nature, which makes it unsuitable for humans, animals, plants and other organisms that live within it [1]. One of the most important water pollutants are from agriculture, industry and sewage. These pollutants are rich in a number of toxic heavy metals and bacteria [2]. Generality, the world and third world countries in particular are facing a problem of the most serious problems that threaten humanity which is the provision drinking water[3].Water means life and health as human needs to (2.5 l/day) fresh water to drink for the sustainability of vital processes in the body. This percentage increases to (20 l/day) when working in hot weather to ensure that do not drought [4]. And to obtain non polluted water and ready for human and industrial consumption, Raw water is exposed to three successive chemical, physical and bacteriological processes [5].

2. MATERIALS AND METHODS

Four regions were selected randomly within Baghdad - Karkh sector. Monthly water tap samples collected from (ST1 Al Qadisiyah, ST2 Al Yarmouk, ST3 Al Mansour and ST4 Hay Al Jamiea) with duplicate for each sample. Study period start from October 2015 until March 2016. The physical, chemical and biological factors of these samples were measured in laboratory. Total dissolved solids (TDS) measured by Millipore filter paper according to [6] and turbidity measured by turbidity meter. Chlorides Cl measured by [7]. According to standard methods for examination of water mentioned by American Public Health Association APHA, the total hardness and calcium Ca+, magnesium Mg+ hardness have been measured [8]. Some heavy metals Fe, Pb and Cu had been detected by using the method mentioned in [9]. Finally, the number of coliform bacteria have been detected and calculated by [7]. Due to the effect of the different factors measured in this study, the results were statistically analyzed by using analysis of variance (ANOVA), Duncan test and estimate of coefficients correlation between parameters.

3. RESULTS AND DISCUSSION

3.1 Turbidity and TDS

Turbidity is a measurement of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water. Turbidity measurements are often used as an indicator of water quality. Material that causes water to be turbid include large number of suspended particles like clay, silt, sand, organic and inorganic matter, algae, soluble colored organic compounds, plankton and other microscopic organisms [9,10]. The results showed that highest value of the turbidity was (5.3NTu) in first station and is compatible with both second and third station when recorded for the highest values during February 2016. While the fourth station recorded highest values in December 2015 which reached up (4.8 NTu). It was observed that higher values for turbidity recorded in winter season. The results agree with (12) where both recorded higher values. By contrast, a study conducted by (11) showed that highest values were recorded in summer months. The results as shown in table (1), a significant difference between stations were at $p < 0.05$. The 4th station exceeded the acceptable limits according to Iraqi standard specification [13] and WHO[14] of (5 NTU).

As for TDS, 1st station showed a higher value (506 mg/l) in December 2015 as well as agree with all stations recorded highest values in winter season. As shown in table (1), statistically there is no significant difference between stations during study period. The cause of TDS increase can be attributed to association with the colloidal assemblies of sedimentation basins[15]. TDS values was within the limits allowed according to standard specification and WHO[13,14] which is (1000 mg/l).

3.2 Total hardness, Ca+ and Mg+ hardness

The presence of various multivalent ions in form of calcium and magnesium ions or calcium and magnesium carbonate is one of the main causes of water hardness, as well as presence of other positive ions [16]. In table (1) the highest values of hardness was (370 mg/l) in station 1st in February 2016. As well as 2nd and 3rd station recorded higher values in the same month. The fluctuation of the total hardness values and their rise during winter months may be due to rainfall which is the main source of drinking water, soil washing and drifting to the river and the inefficiency of water treatment plant in removing the hardness well leading to an increase in the amount of salts and dissolved minerals in water [17]. The correlation was significant between turbidity (0.81) and total hardness and Ca+ hardness (0.56) at $P < 0.01$. The values were less than the standard limits for Iraqi water [13] and WHO[14] for total hardness (5000 mg/l). In January 2016 the 4th station appeared highest values of Ca+ hardness which reached to (128 mg/l) as well as 1st station recorded higher value in the same month. From the table (1) noticed there are no significant differences between all stations at $P < 0.05$. The difference values in Ca+ of the study stations may be due to the different mechanisms of operation in filter networks in terms of efficiency in filters used and the amount of soluble and calcined substances are additives [16]. The Ca+ values in all station didn't over the limits (200 mg/l) for Iraqi water [13] and WHO [14]. While the maximum value of Mg+ in the 1st station during February 2016 reached (29 mg/l). Which did not agree with other study stations at the time of recorded the highest values.

Also statistically, table (1) showed significant differences between the stations at $P < 0.05$. The increases in amount of Mg+ in tap water may be due to the inability of drinking water schemes to reduce its concentrations as found by [18,19]. In this study the Mg+ values could not exceeded the acceptable limits (150 mg/l) according to Iraq specification and WHO [13,14].

3.3 Chlorides Cl-

Chloride is added to water distribution network pipes as a final procedure of water treatment and sterilization [20]. The results of this study recorded higher values in all study station during December 2015. Table (1) showed that the higher value of Cl- was in 1st station (170 mg/l) while 3rd station recorded lowest values reach to (67.9 mg/l) in March. Chloride levels in water increased due to increase proportion of it is added by Baghdad mayoralty to eliminate pathogens (chlorination process) [21]. From the statistical analysis there is no significant difference between stations during the study due to the continuous increase in the amount of chloride in all stations and for all months at $P < 0.05$. However the values was acceptable to the standard limits in Iraqi water and WHO [13,14] for Cl- (600 mg/l).

3.4 Rare heavy metals Fe, Pb and Cu

These metals are called rare because they are found in small quantities in the earth's crust [22]. They are present in form of compounds or ions [23]. The results showed that the highest values of Fe and Pb were in the 1st station. The maximum value of Fe in this station reached to (0.11mg/l) as well as in other stations during winter season. Also in November 2015 Pb value reached to (0.009 mg/l) but did not agree with other stations that registered highest values during January 2016. From statistical analysis there is no significant differences between study month While the differences between stations was significant at $P < 0.05$. As for Cu, 4th station recorded maximum value (0.81 mg/l) in

November 2015. The increasing in rare heavy metals levels may be due to increased flow to the river water during winter season by the rain and an inefficient water treatment plant to remove these metals [24]. The values as shown in table (1) were acceptable for Iraqi standard limits [13] and WHO [14] which are (0.3 mg/l), (0.01 mg/l) and (1 mg/l) for Ferrite, Lead and Copper respectively.

3.5 Coliform bacteria

The presence of bacteria in drinking water indicates that water is not healthy for human use [25, 26]. Coliform bacteria in 1st station reached to the highest level (400 cell/l) in February 2016. As well as other stations recorded higher level in the same month (table1) a significant correlation between turbidity and coliform bacteria (r =0.93) at $P < 0.01$. Also the difference was significant between the stations and months of study period at $P<0.05$. The increase of bacterial levels may be due to the quantities of added doses of alum and chlorine were inaccurate as well as drinking water schemes are ancient [27]. The results during this study confirm that water was polluted with coliform bacteria and exceeded the acceptable level of water in Iraq and WHO which must be (0 cell/ml) [13,14].

Table 1: Range and the overall rate, the ± standard deviation and Duncan test for recipes studied in different stations.

Parameters	Station (Range , mean, SD)			
	ST1	**ST2**	**ST3**	**ST4**
Turb. (NTU)	2.1-5.3 3.7 ±1.02 B	2.1-3.2 2.7 ±0.75 B	1.7-4.0 2.9 ±0.81 B	1.8-4.8 6.6 ±1.14 A
TDS (mg/L)	314-506 410 ±94.5 A	280-470 375 ±102.5 A	288-460 374 ±96.3 A	281-501 391 ±139.7 A
T.H. (mg/L)	292-370 331 ±85.3 A	274-352 313 ±91.6 A	288-320 304 ±78.4 A	280-365 322.5 ±84.9 A
Ca+ (mg/L)	88-124 106 ±41.2 A	88-112 100 ±19.6 A	93-116 104 ±15.3 A	103-128 115 ±17.5 A
Mg+ (mg/L)	10-29 19.5 ±7.2 A	7-20 13.5 ±5.9 AB	7-13 10 ±4.6 B	8-15 11.5 ±4.3 B
Cl (mg/L)	79.9-170 124.9 ±35.2 A	76.9-140 108.5 ±29.4 A	67.9-130 100 ±33.6 A	79.9-140 110 ±34.6 A
Fe (mg/L)	0.001-0.11 0.06 ±0.03 A	0.002-0.09 0.05 ±0.03 A	0.003-0.08 0.04 ±0.02 A	0.002-0.07 0.04 ±0.02 A
Pb (mg/L)	0.001-0.009 0.005 ±0.002 A	0.002-0.008 0.005 ±0.002 A	0.001 ±0.007 0.004 ±0.002 A	0.001-0.006 0.004 ±0.001 A
Cu (mg/L)	0.003-0.19 0.10 ±0.04 A	0.003-0.32 0.16 ±0.05 A	0.002-0.73 0.36 ±0.12 A	0.004-0.81 0.40 ±0.15 A
Coliform bac. (cell/ml)	0-400 200 ±50 A	0-300 150 ±45 AB	0-300 150 ±45 AB	0-200 100 ±25 B

Table 2: The effect of station and date in Turb. (ppm)

Date	Station				LSD value
	ST1	**ST2**	**ST3**	**ST4**	
15/10/2015	2.2	2.1	2.1	2.0	1.13 NS
15/11/2015	2.1	2.3	1.7	1.8	0.96 NS
20/12/2015	3.0	2.2	2.5	4.8	1.25 *
20/1/2016	2.9	2.3	2.15	1.91	1.22 NS
20/2/2016	5.3	3.2	4.0	3.0	1.09 *
20/3/2016	3.1	2.6	3.2	2.7	1.24 NS
LSD value	2.05 *	1.77 NS	1.52 *	1.88 *	----

* (P<0.05), NS: Non-significant.

Table 3: The effect of station and date in TDS (ppm)

Date	Station				LSD value
	ST1	**ST2**	**ST3**	**ST4**	
15/10/2015	360	340	314	330	96.44 NS
15/11/2015	481	423	420	417	102.6 NS
20/12/2015	506	470	460	501	129.4 NS
20/1/2016	506	344	312	475	107.42 *
20/2/2016	314	280	288	281	98.22 NS
20/3/2016	360	298	301	320	809.17 NS
LSD value	114.6 *	97.2 *	109.7 *	126.3 *	----

* (P<0.05), NS: Non-significant.

Table 4: The effect of station and date in T.H. (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	308	311	308	299	76.43 NS
15/11/2015	292	304	288	308	69.12 NS
20/12/2015	308	274	288	280	86.43 NS
20/1/2016	355	304	253	365	81.29 *
20/2/2016	370	352	320	330	65.52 NS
20/3/2016	323	350	281	349	79.33 NS
LSD value	94.56 NS	113 4 NS	81.3 NS	114.5 NS	----

* (P<0.05), NS: Non-significant.

Table 5: The effect of station and date in Ca+ (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	100	101	95	105	13.48 NS
15/11/2015	88	94	93	104	17.04 NS
20/12/2015	101	88	95	103	14.55 NS
20/1/2016	124	89	88	128	14.91 *
20/2/2016	100	112	116	120	14.69 *
20/3/2016	112	121	96	120	15.09 *
LSD value	16.54 *	21.94 *	15.43 *	20.66 *	----

* (P<0.05), NS: Non-significant.

Table 6: The effect of station and date in Mg+ (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	19	14	11	12	6.02 *
15/11/2015	18	14	12	12	6.75 NS
20/12/2015	13	20	13	15	7.43 NS
20/1/2016	11	9	8	11	6.23 NS
20/2/2016	29	7	7	8	8.64 *
20/3/2016	10	12	10	12	5.77 NS
LSD value	6.79 *	6.22 *	7.59 NS	7.64 NS	----

* (P<0.05), NS: Non-significant.

Table 7: The effect of station and date in Cl (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	130	108	99.9	109	16.54 *
15/11/2015	150	120	120	130	19.86 *
20/12/2015	170	140	130	140	22.58 *
20/1/2016	109.9	79.9	99.9	109.9	19.32 *
20/2/2016	89.9	79.9	89.9	79.9	19.15 NS
20/3/2016	79.9	76.9	67.9	80.9	18.42 NS
LSD value	20.44 *	21.09 *	17.65 *	23.05 *	----

* (P<0.05), NS: Non-significant.

Table 8: The effect of station and date in Fe (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	0.003	0.003	0.004	0.004	0.002 NS
15/11/2015	0.02	0.03	0.01	0.04	0.0031 NS
20/12/2015	0.11	0.09	0.08	0.07	0.045 NS
20/1/2016	0.004	0.005	0.009	0.004	0.0052 NS
20/2/2016	0.001	0.002	0.003	0.002	0.0033 NS
20/3/2016	0.003	0.002	0.006	0.002	0.0041 NS
LSD value	0.024 *	0.008 *	0.054 *	0.0043 *	----

* (P<0.05), NS: Non-significant.

Table 9: The effect of station and date in Pb (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	0.003	0.003	0.002	0.003	0.0027 NS
15/11/2015	0.002	0.003	0.002	0.004	0.0031 NS
20/12/2015	0.009	0.005	0.003	0.002	0.0042 *
20/1/2016	0.002	0.008	0.007	0.006	0.0039 *
20/2/2016	0.002	0.003	0.003	0.001	0.0023 NS
20/3/2016	0.001	0.002	0.001	0.003	0.0021 NS
LSD value	0.004 *	0.0043 *	0.0039 *	0.0042 *	----

* (P<0.05), NS: Non-significant.

Table 10: The effect of station and date in Cu (ppm)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	0.003	0.003	0.002	0.004	0.025 NS
15/11/2015	0.18	0.28	0.73	0.81	0.149 *
20/12/2015	0.19	0.32	0.34	0.81	0.226 *
20/1/2016	0.004	0.004	0.004	0.005	0.0033 NS
20/2/2016	0.005	0.005	0.006	0.005	0.0029 NS
20/3/2016	0.004	0.003	0.004	0.004	0.0018 NS
LSD value	0.066 *	0.135 *	0.171 *	0.224 *	----

* (P<0.05), NS: Non-significant.

Table 11: Effect of station and date in Coliform bac. (cell/ml)

Date	Station				LSD value
	ST1	ST2	ST3	ST4	
15/10/2015	0	0	0	0	0.00 NS
15/11/2015	0	0	0	0	0.00 NS
20/12/2015	0	200	0	100	25.0 *
20/1/2016	50	0	0	0	12.50 *
20/2/2016	400	300	300	200	75.32 *
20/3/2016	0	0	0	0	0.00 NS
LSD value	60.22 *	75.30 *	50.10 *	55.95 *	----

* (P<0.05), NS: Non-significant.

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