ISSN: 0067-2904
GIF: 0.851

Investigation of the Drinking Water Quality of Some Residential Areas in Baghdad City - Karkh District

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Abstract

The study aims to identify the acceptability of drinking water for human consumption depend on Iraqi specification and WHO standards. Samples collected monthly for each station from March to December2014. The samples collected from six stations distributed in Baghdad City, the first two stations located in al-Kadmyai area , the 3rd and 4th located in AL- Doora while the last two stations located in Al-Amryai area. The study measured physical, chemical and bacteriological factors. The measured parameters were ranged each for pH 6.63-7, turbidity 0.4-1.3NTU,TDS394.2-960mg/l,total hardness 259.1-578while Ca and Mg were 43-134,20.1-72 mg /l respectively. Other chemical parameters like chloride ranged from 56.8-184 mg/l and heavy metals ranged from 0-0.01,0-0.053,0.038mg/l for Pb^{+2},Cu^{+} and Fe^{+} respectively. The bacteriological examination included a total count for aerobic bacteria which is ranging from 0-10000 cell/ml, Coliform, and fecal coliform were ranged 0-3000, 0-300 cell/ml respectively. The results compared with standard limits and found some parameters exceeded the acceptable limits.

Keywords: Drinking water, Water pollution, Chemical, Physical, Bacteriological, Heavy metals parameters.

التحري عن نوعية مياه الشرب لبعض الأحياء السكنية في مدينة بغداد – جانب الكرخ

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الخلاصة

اجريت هذه الدراسة لغرض معرفة مدى صلاحية مياه الشرب في بعض مناطق بغداد للاستهلاك البشري ، حيث تم اخذ العينات ابتداءً من شهر اذار 2014 ولغاية شهر كانون الاول 2014 وبمعدل شهري لكل محطة حيث تقع المحطة الاولى والثانية ضمن منطقة الكاظمية ،اما المحطتين الثالثة والرابعة تقعان ضمن منطقة الدورة، اما المحطتين الخامسة والسادسة فتقعان ضمن منطقة العامرية . شملت الدراسة قياس بعض العوامل الفيزيائية والكيميائية والمعادن الثقيلة والبكتريولوجية ، اذ تراوحت قيم الاس الهيدروجيني pH 6.63– 7.9 ، اما قيم العكورة فقد تراوحت بين 0.4 –1.3 وحدة كدرة نفثالية ، اما قيم المواد الصلبة الذائبة الكلية فقد كانت394.2– 960 ملغم / لتر ، وتراوحت قيم العسرة الكلية وعسرة الكالسيوم والمغنيسيوم بين 259.1– 578، 43– 134، 20.1– 72 ملغم / لتر. أما فيما يخص الكلوريد فقد سجلت قيم تراوحت بين 56.8– 184 ملغم / لتر، وتراوحت قيم المعادن الثقيلة للرصاص والنحاس والحديد ما بين 0 –0.01، 0– 0.053، 0– 0.38 ملغم / لتر، أما بالنسبة للعوامل البكتريولوجية فقد تم دراسة العدد الكلي للبكتريا الهوائية وتراوحت اعدادها بين 0– 10000 خلية / مل، أما اعداد بكتريا القولون فقد تراوحت بين 0 – 3000 خلية / مل، أما بكتريا القولون البرازية فقد تراوحت اعدادها بين 0 – 300 خلية / مل. وعند مقارنة مياه

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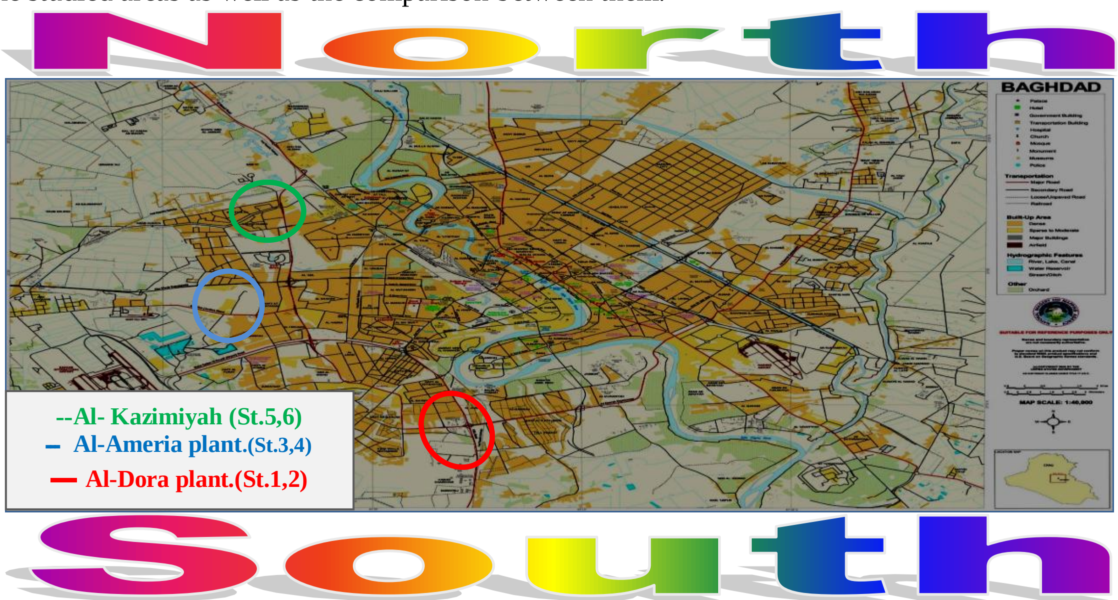
الشرب مع الحدود المسموح بها للمواصفة العراقية والعالمية WHO وجدهنالك بعض العوامل تجاوزت الحدود المسموح بها.

Introduction:

Water has uncountable benefits, but on the other hand is more environmental components susceptible to contaminants because of its characteristics that make it to be more environmental components received for the pollutants in the environment and then get the pollution, which is defined as a disturbance in natural balance for environment which lead to affect the lives of organisms [1].
These negative effects of water pollution are not only on human, but extend to forests around the world also quality and purity of water and air. The problem of water pollution concomitant with increasing proportion of the population around world that the daily consumption of water by the population that deposit a large amounts of human pollutants of water by untreated sewage as well as animal and agricultural pollutants that reach to rivers, making them as the source of many pathogenic bacteria in addition to fecal coliform group used as an indicator of fecal contamination in water, due to coupling of many diseases to microbial pollution of water and the attention of the World Health Organization (WHO) and the US Environmental Protection Agency (USEPA) and the United Nations Environment Program (UNEP) water borne diseases and control it. This lead to give a great attentionto microbial pollution in water, especially studies related to public health directly, as the World Health Organization reports that 80% of the diseases that afflict humanity related to water contamination with microbial pathogens [2]; [3].Industries consider as main source for water pollution which is negatively impact on living organisms especially humans, where take industrial parks water that they need in the manufacturing from rivers and lakes and then dispose industrial water to rivers after be loaded with contaminated materials (organic inorganic) and toxic materials such as lead, copper, and iron, with accumulation in the rivers leading to diminishing fish stocks and other organisms in food chain and causing intestinal diseases for human[4].The aim of the research to assess the quality of drinking water in the studied areas as well as the comparison between them.



Picture 1- The map of Baghdad City showing the study stations.

Materials and methods:

Description of study district:

The study included three residential areas within the Karkh district in the city of Baghdad, the first in Kazimiyah district , which provides drinking water from the drinking water treatment plant of Al-Karama treatment plant , where select two locations for sampling throughout the duration of the study, the first site in the locality of 427 (St. 1,2), the second in Al- Dora district , which provides drinking water from the drinking water treatment plant in the same area(Al-Dora treatment plant), where select two locations for sampling throughout the duration of the study, the first site in the locality of 826(St.3), which lies up to 2 km from the station while the second site was in the locality of 834(St.4), which lies up to 5 km from the station), the third site in Amiriya district , which provides drinking water from the drinking water treatment plant of Al-Karkh treatment plant , where select two locations for sampling throughout the duration of the study, the first site in the locality of 638 (St.5), while the second site was in the locality of 636 (St.6).

Samples collection

In our study samples collected in fact nine times from March to December 2014. For chemical analysis samples collected in plastic bottles (2-3.5) litter closed tightly and transfer to laboratory with ice cooler bag. pH measured by pocket pH meter GLP pH / ORP meter WTW 720 (Germany). Turbidity by turbidity meter Jenwaw Company (Model-6035).and total dissolved solids (TDS) measured by Millipore filter paper according to[5]. Chlorides , Total hardness (TH) and (Ca^+ , Mg^+) hardness measured according to standard methods[6,7] .Fe ion measured by phenathroline method [6] also some heavy metals had been detected like Cu^{+2} and Pb^{+2} [8]. Bacteriological examination had been done directly after collection water samples in sterilized glass bottles .Total count for bacteria by Plate count method and Most Probable Number (MPN) were examined according to [7,9] also coliform bacteria and fecal coliform have been detected according to [10,9].Statistical tests for results have been done like analysis of variance (ANOVA) , Duncan test ,LSD and correlation coefficient .

Results and Discussion:

1. pH:

Mean values for pH was unstable through the study period which is a range between 6.63-7.9 as shown in Figure-1.Highest value recorded in April at the 1st station while the lowest pH value recorded in autumn season (November) at the 2nd station Table-1 because of formation of acids when chlorine added as disinfectant to water[11] . Most of recorded results referred that pH values tend to be high as shown in other studies like [12, 13,14].statistical analysis showed significant differences for pH values between stations through study period . Generally pH values were acceptable according to Iraqi specification (417)[15,9].

2. Turbidity and TDS

As shown in Figure-2 higher reading recorded for turbidity in spring (April) compare to summer and autumn. Statistical analysis shows significant differences $P \leq 0.05$ between the stations during the months of study and the highest reading recorded at the 6th station (1.3) NTU.While the lowest reading (0.4) NTU in 1st and 6th stations.

The recorded values for turbidity were acceptable according to limits of Iraqi specification (417) [15,9].High readings for turbidity in April may be due to rain falls, drift of mud and suspended materials to surface water [16] or breakage in water pipes network [17,18]. Statistical analysis shows a significant correlation($r= 0.48$, $P \leq 0.01$) between turbidity and TDS.

In Figure-3 Total dissolved solids rise in the spring season at the 1st. station (960mg/l) may be due to rain fall that cause soil drift to surface water [19],which cause increases in salt concentration in water[20].So the significant correlation value was($r=0.09$ at $p \leq 0.05$) between TDS and magnesium and with total hardness ,chloride ($r=0.22$,$r=0.28$ at $p \leq 0.01$) respectively .Results agreed with [21]. All TDS readings were accepted according to Iraqi specification (417) [15,9].

3. Ca^+, Mg^+ and total hardness:

Ca^+ recorded lowest reading (43mg/l) at 3rd station in September and highest reading(134mg/l) at 2nd station in June ,as show in Figure-4.Readings for Ca^+ agree with [22, 23].

Explain[24] the effect of temperature changes on CO_2 level which in turne increases calcium dissolving in water . From Table-1 all Ca^+ readings within acceptable limit which is 200mg/l as mentioned in Iraqi specification (417) [15,9]. Figure-5 shows the lowest (20.5 mg/l) and highest (72mg/l) value for Mg^+ at the 4th station in December and 2nd station in June respectively. Mean values for Mg^+ were acceptable for Iraqi specification (417) [15,9]. Mg^+ show significant differences at $p<0.05$ through the study period.

High readings for Mg^+ in summer may be caused by dust storms[25],because the metal structure(Ca^+ and Mg^+) of dust particles leads to increase the metals concentration in water[26]. Generally results of Ca^+ and Mg^+ agreed with [27]. Figure-6 shows the total hardness(TH) readings for the six stations .Total hardness readings range between (259.2mg/l)in march at the station(6) and (578mg/l)in June at station (2).This value was unacceptable because the maximum limit is(500mg/l) according to Iraqi specification (417) [15,9] .Also 3rd station exceeded the acceptable limit. Total hardness increases in water because inefficiency water treatment plant , pollution of surface water with industrial and domestic wastes and nature of salts content of the soil [28]. Total hardness readings show significant differences $p<0.05$ through study period at and the results agreed with [29].

4. Chloride:

Chloride values were unstable through the study period .In summer season recorded lowest value (56.8mg/l) in May at stations 5,6, while the highest value (184mg/l) recorded in June at 2nd station. All readings for chloride were within the acceptable range as mentioned in Iraqi specification(417) [15,9]. In spite of the variation in the readings were significant at $p<0.05$ between stations as well as between months of study. As shown in Figure-7 chloride readings tend to be high in autumn season for all stations may be the treatment plant increased chloride addition to drinking water as precaution especially in summer season to destroy all pathogens [30] or indication a possible problems like breakage in water distribution system[31] .

5. Heavy metals (pb^{+2},Cu^{+2},Fe^{+2}):

Concentration of Cu^{+2} and Pb^{+2} in water range from nondetectable to detectable (0.01-0.053mg/l) in spring season respectively. So the differences between stations for Pb^{+2} and Cu^{+2} were not significant as show in Figure-8,9 and that's agreed with [32].He explain that the metals concentration in river water which is considered the main source of raw water for purification projects in Iraq will not affected by seasonal changes .as well as old residue in water from battery factory[33].The new methods for water treatment added some heavy metals in water [34] . The concentration of Pb^{+2} and Cu^{+2} were accepted according to Iraqi specification (417) [15]and WHO [9].

Iron ion concentration in water ranged from nondetected and detectable value (0.38mg/l) in spring season which has exceeded the maximum acceptable limit (0.3mg/l) (Iraqi specification (417) [15,9] .Both of 1st and 2nd station recorded significant differences at $p<0.05$ through the study period as show in Figure-10.Stastical analysis show a significant correlation between Fe^{+2} with Pb^{+2} (r=0.59)and Cu^{+2}(r=0.45) at $p\leq0.01$ .The increases of Fe^{+2} ion concentration in water may be due to sterilization of water with chloride instead of ozone which is able to convert Fe^{+2} ion to the insoluble form(Fe^{+3}) and removed by filtration [35].

6. Bacteriological examination:

Total count of aerobic bacteria , bacteriological examination showed increases in total count of aerobic bacteria in April(10000cell/ml) but in march the total count for aerobic bacteria decline to(0,000cell/ml) as showing in Figure-11.That may be due to an appropriate temperature for bacterial reproduction ,old piped city project and inability to meet growing population need [36].As well as un efficiency of purification process lead to increase in water turbidity and this confirmed by the significant correlation(r=0.60) at $p \leq0.01$ between bacterial total count and means of turbidity, however turbidity inhibits the sterilization process through providing a protection for bacteria from chlorine [17]. The bacterial count as seen from Figure-11 exceeded the acceptable limits (100cell/ml) (Iraqi specification(417)[15,9].For coliform and fecal coliform bacteria highest number recorded in April (3000cell/ml) and (300cell/ml) respectively and the lowest numbers recorded in march (Zero cell/ml) show in Figure-12 and 13. From Table-1 statistical analysis shows significant differences at $p\leq0.01$ between the 1st and 2nd station for coliform and fecal coliform bacteria at whole study period. So 1st and 2nd station consider unacceptable for drinking use because the bacterial count should be (Zero cell/ml), Iraqi specification (417)[15,9] . The significant correlation between coliform and fecal colifrm is r=0.37at $p\leq0.01$. Increasing number of bacteria due to old piped city project or un efficient percipation and filtration process[37].also not been enough time for water to sterilize with chlorination[38] .

Table 1- Range and the mean, ± Standard Deviation and Duncan test for recipes studied in different stations

parameters	St.1	St.2	St.3	St.4	St.5	St,6
pH	6.98-7.9 7.44 0.63±a	6.63-7.9 7.26 0.58±a	6.73 – 7.8 7.26 0.62±a	6.68 – 7.8 7.24 0.74±a	6.84 – 7.8 7.32 0.48±a	6.9 – 7.7 7.3 0.67±a
Turbidity NTU	0.4 -1.4 0.9 0.03±a	0.47-1.2 0.8 0.05±a	0.42-1.3 0.8 0.06±a	0.42-1.1 0.75 0.03±a	0.4-1.2 0.8 0.04±a	0.43-1.3 0.8 0.02± a
TDS Mg\L	509.4-960 734.7 91.6 ±a	506.4-959 732.7 97.4±a	394.2-845 619.6 102.6 ±ab	506-848 135.7± 677 ab	502.3-650 92.7± 576.1 b	501.3-680 590.6 113.8±b
Ca Mg\L	57-97.7 77.3 8.2±ab	48-134 91 7.5±a	43-72 57.5 8.4±b	51-89 70 6.4±ab	57-67.9 62.4 6.9±b	43-67.3 55.1 5.9±b
Mg+ Mg\L	20.93-62 41.4 5.7±a	28.2-72 50.1 8.2±a	30.29-63 46.6 5.8±a	20.1-63 41.5 3.9±a	20.5-52 36.2 7.4±a	21.6-48 34.8 7.1±a
Total hardness Mg\L	301.1-478 389.5 63.7± ab	323-578 85.3± 450.5 a	320.2-575 447.6 95.2± ab	347-475 411 68.4± ab	275.7-373 86.3± 324.3 b	259.1-396 57.2± 327.5 b
Chloride Mg\L	71-142 106.5 12.7±b	71.9-184 127.9 8.4±a	71-170 120.5 11.7±b	71-142 106.5 9.5±b	56.8-99.4 78.1 9.6±b	56.8-113 84.9 7.4±b
Pb Mg\L	ND-0.004 0.002 0±a	ND-0.01 0.005 0±a	ND-0.003 0.0015 0± a	ND-0.01 0.005 0±a	ND-0.003 0.0015 0±a	ND-0.001 0.0005 0±a
Cu Mg\L	ND-0.01 0.005 0±a	ND-0.053 0.026 0±a	ND-0.01 0.005 0±a	ND-0.05 0.025 0±a	ND-0.006 0.003 0±a	ND-0.002 0.001 0±a
Fe Mg\L	ND-0.36 0.18 0.002±a	ND-0.38 0.19 0.02±a	ND-0.3 0.15 0.01±a	ND-0.3 0.15 0.01±a	ND-0.3 0.15 0.01±a	ND-0.3 0.01± 0.15 a
Aerobic bacterial Cell\ml	ND-10000 5000 146±a	ND-10000 5000 209±a	ND-8800 4400 176±b	ND-3400 1700 246±c	ND-3900 172± 1950c	ND-7300 3650 269±b
Coliform bacterial Cell\ml	ND-3000 1500 120±a	ND-2000 1000 80±b	Zero 0 0±c	Zero 0 0±c	Zero 0 0±c	Zero 0 0±c
Fecal Coliform bacterial Cell\ml	ND-300 150 35±a	ND-200 100 20±a	Zero 0 0±b	Zero 0 0±b	Zero 0 0±b	Zero 0 0±b

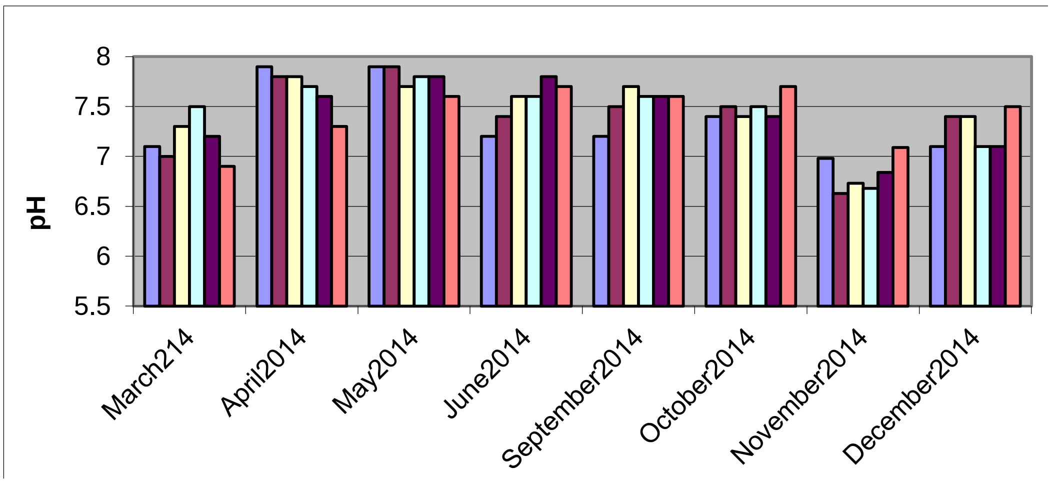


Figure 1- The pH value according to months and stations

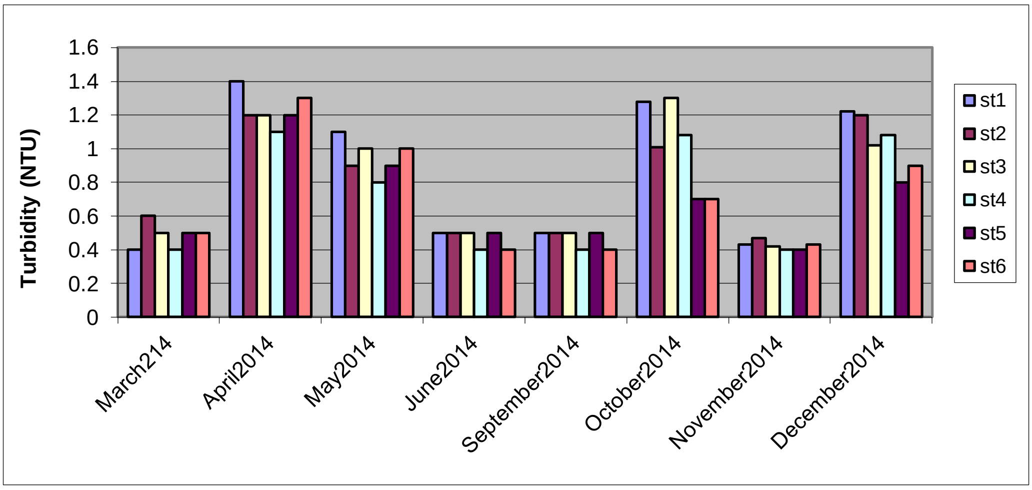


Figure 2- The turbidity value according to months and stations

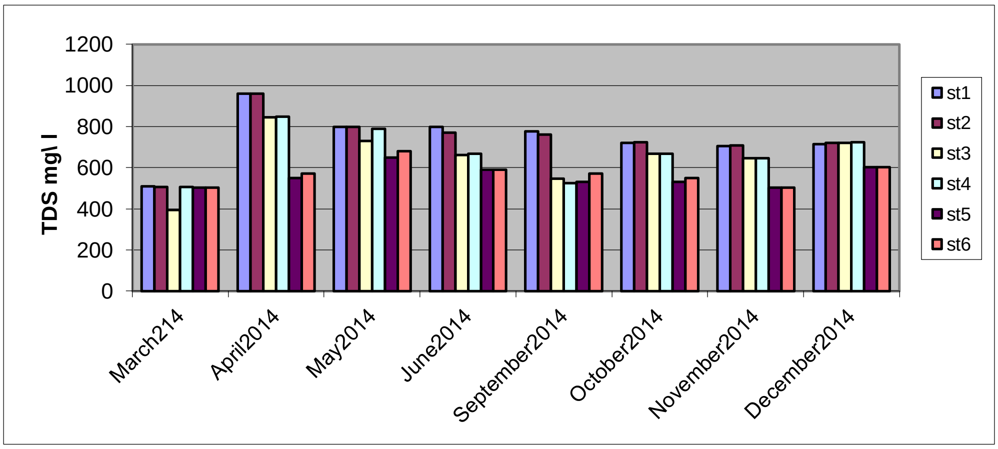


Figure 3- The TDS value according to months and stations

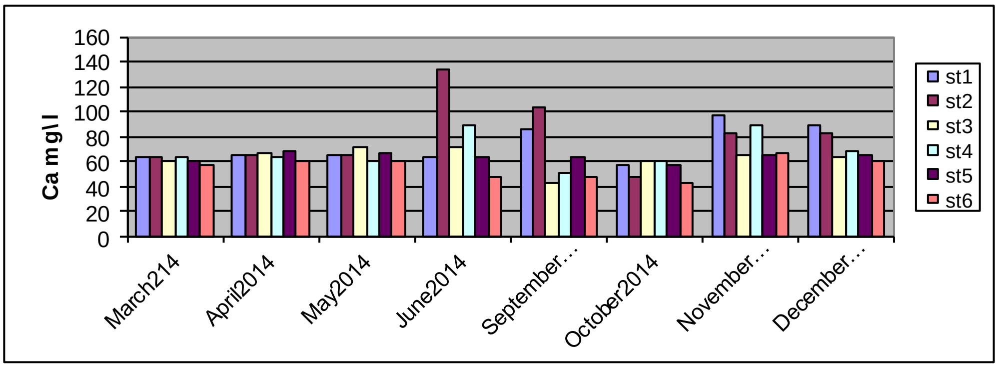


Figure 4- The Calcium value according to months and stations

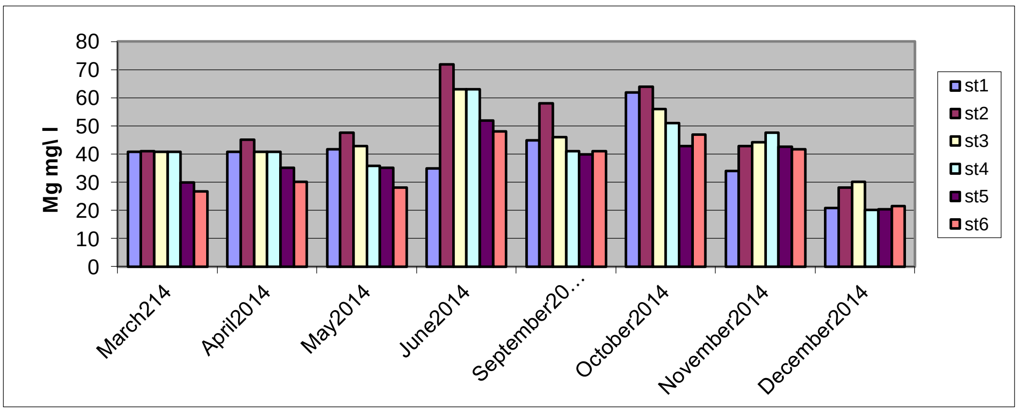


Figure 5- The Magnesium value according to months and stations

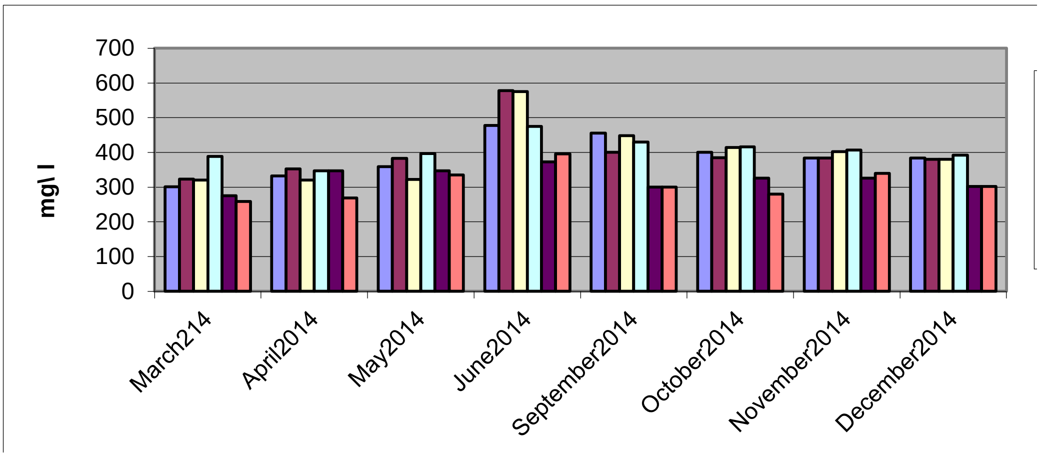


Figure 6- The total hardness value according to months and stations

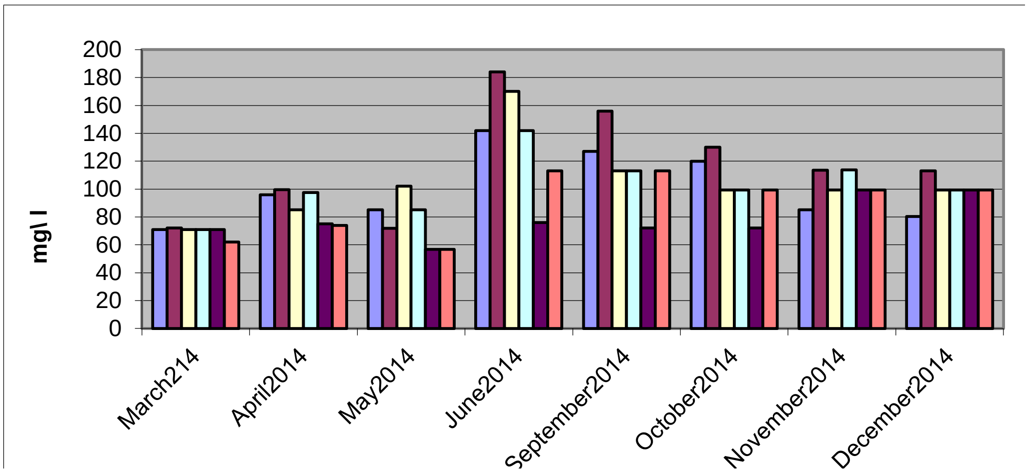


Figure 7- The Chloride value according to months and stations

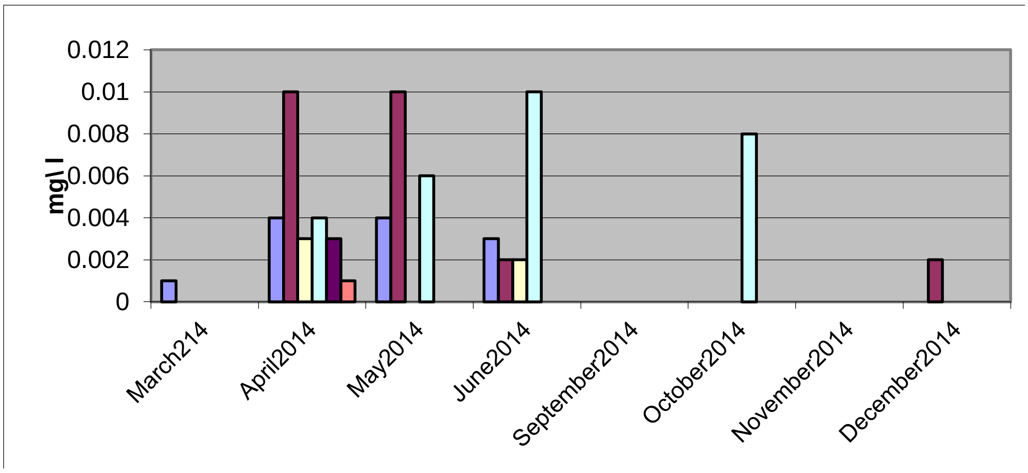


Figure 8- The lead (Pb) concentration value according to months and stations

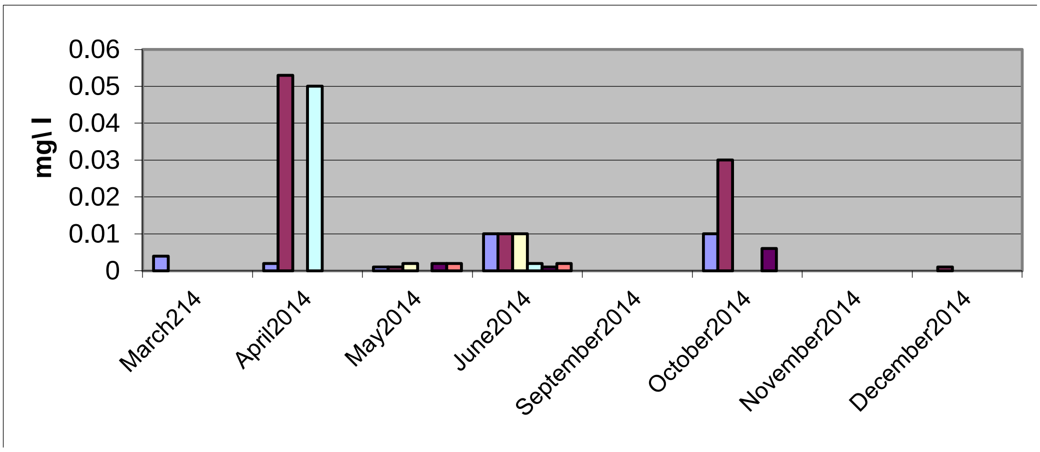


Figure 9- The Copper (Cu) concentration value according to months and stations

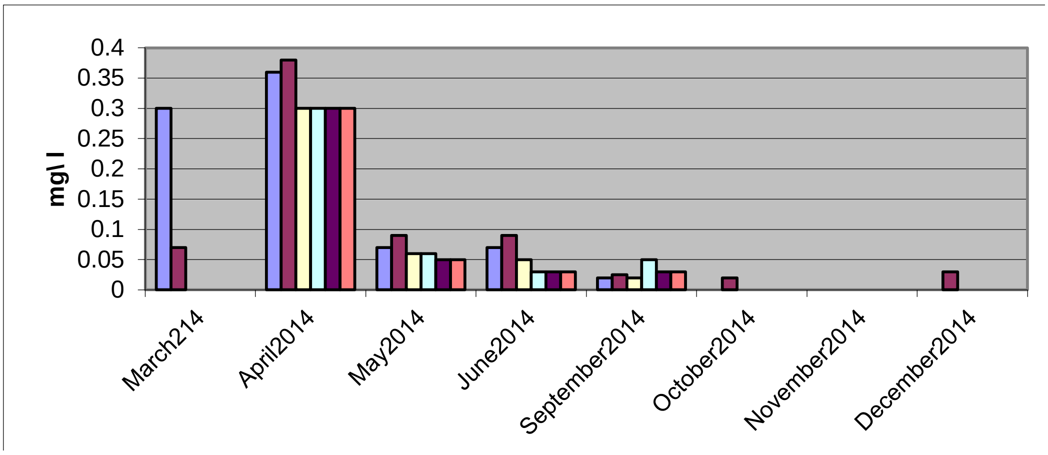


Figure 10- The Iron (Fe) concentration value according to months and stations

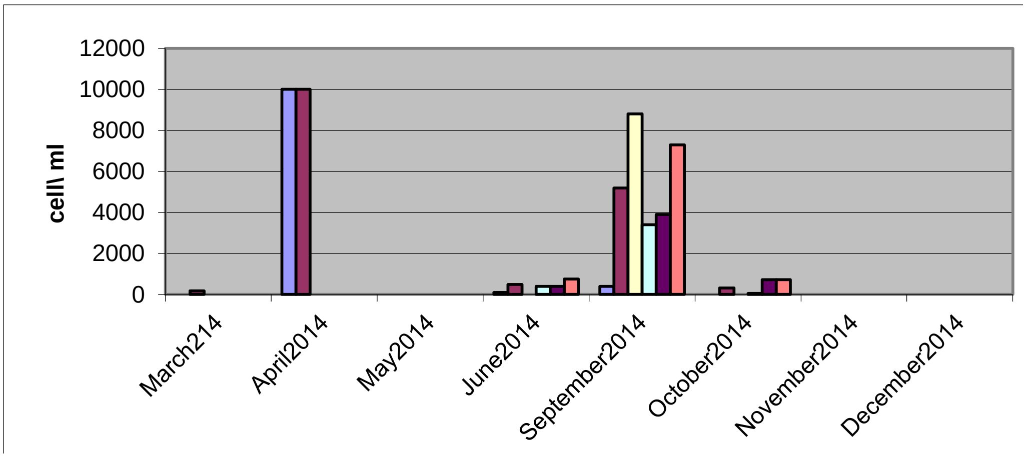


Figure 11- The total aerobic bacterial count according to months and stations

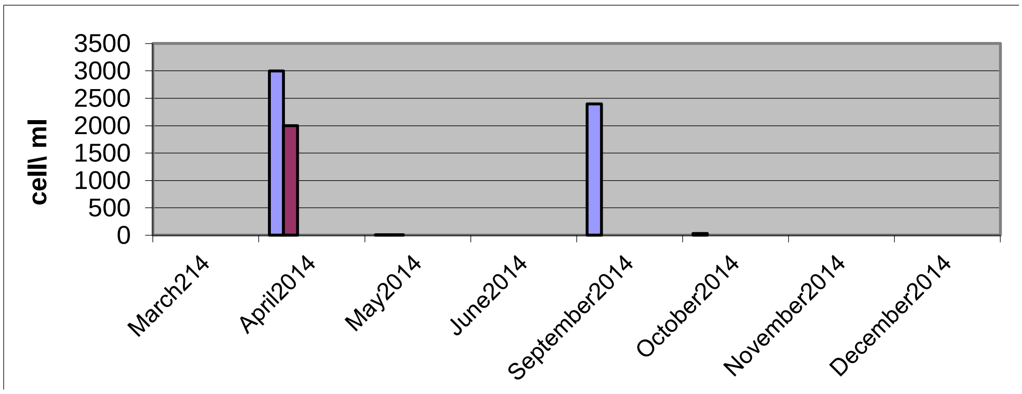


Figure 12- The Coliform bacterial count according to months and stations

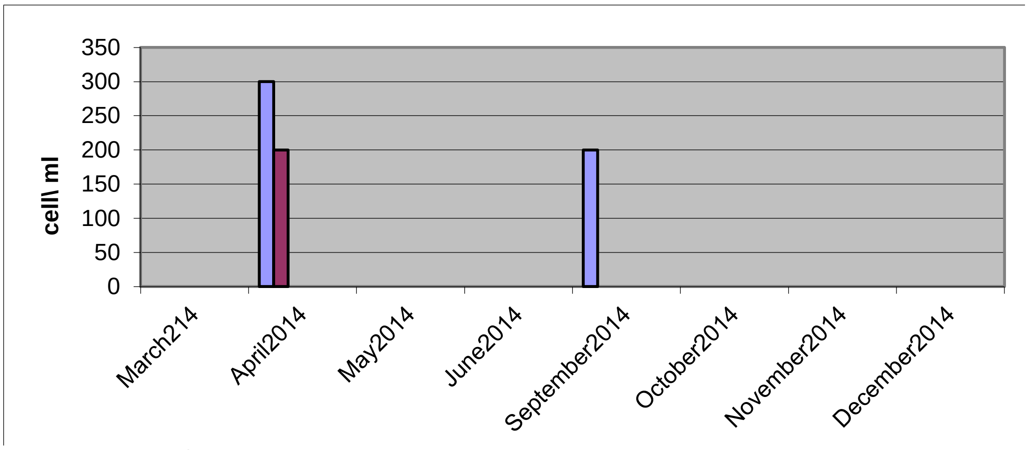


Figure 13- The Fecal coliform bacterial count according to months and stations

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