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EVALUATION OF HEAVY METALS WITH SOME PHYSIOCHEMICAL AND BIOLOGICAL PARAMETERS FOR GROUND WATER IN SOUTH OF NAJAF CITY, IRAQ

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ABSTRACT

A study has been carried out on the quality of Groundwater (GW) in south of Najaf city were evaluated by determining Heavy metals (HMs),physiochemical and biological parameters of twenty different public GW on February 2015.This paper present an assessment of the levels of Heavy metals ; Co, Cr, Zn, Cd, Pb, Mn, Fe and Cu by using Atomic Absorption Spectrophotometry (AAS) , some physiochemical properties; hydrogen ion concentration (pH), Electrical conductivity (EC), Total dissolved solids (TDS), chemical oxygen demand (COD), Turbidity (Tur.), Salinity (Sal.), Cations (Na^+, K^+), and biological parameters for ten different public GW of them; total choliform (T.C), total plate counts (T.P.C) and pseudomonas. This study shows great variations among the analyzed samples with respect to their physical, chemical and biological parameters. However, some values were higher the maximum permissible levels recommended by world health organization (WHO) drinking water standards. The harvests of metallic contents except Mn, Fe, Cu , Cr and Zn were higher then maximum permissible levels recommended by WHO drinking water standards. The investigations shows that the GW in the study area cannot using as drink water according to the result of HMs , physiochemical and biological properties and the water in the studied wells can be used for irrigational only.

KEYWORDS: Heavy metals (HMs), Physiochemical and biological parameters , WHO, Groundwater ,Total plate count ,Total coliform, South of Najaf city.

INTRODUCTION

Water is one of the most powerful components in living organisms .Water is mainly collected from various resources like rivers, lakes ground water etc.[1]

In the recent years Ground water contamination has attracted a lot of attention and has become an important environmental issue[2] and between the wide diversity of contaminants affecting water resources, heavy metals receive particular concern considering their strong toxicity even at low concentrations.[3] Heavy metals can be absorbed by plants, wildlife and people through the food they eat.[4]

They can also be absorbed through water and breathing. Some heavy metals can become more concentrated when animals (predators) use other animals for food (prey) as part of the food chain. This is called biomagnifications. Some metals, such as iron, chromium and copper, are needed in small quantities to keep people and animals healthy. Problems can occur with these metals if the body receives too much of them. Heavy metals such as lead and mercury are never desirable in any amount. Once inside our bodies different metals can build up in different body parts, including the kidney, liver and spleen. Heavy metals composition of foods is of interest because of their essential or toxic nature. For example, iron, zinc, copper, chromium, cobalt, and manganese are essential, while lead, cadmium, nickel, and mercury are toxic at certain levels.[5] Arsenic is a highly toxic element and its presence in food composites is a matter of concern to the human's wellbeing.[6] Zinc deficiency, resulting from poor diet, alcoholism, and malabsorption, causes dwarfism, hypogonadism, and dermatitis, while the toxicity of zinc due to excessive intake may lead to electrolyte imbalance, nausea, anaemia and lethargy.[7] Groundwater quality comprises the physical, chemical, and biological qualities. The physicochemical parameters of groundwater include transparency, temperature, pH, Electrical Conductivity (EC), Turbidity, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Free Carbon Dioxide, Total Hardness, Chlorides, Phosphates and Nitrates.[8] Groundwater generally moves slowly. The movement of a contaminant within an aquifer depends on its physical, chemical, and biological properties. Therefore, contamination often remains undetected for long periods of time making cleanup difficult, if not impossible. This often results in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems.[9] It is possible to predict, to some degree, the transport within an aquifer of those substances that move along with groundwater.[10]

MATERALS AND METHODS

Study area

The studied areas are located in the south of Najaf city on the edge of the western plateau of the lower Mesopotamian at 70 km south of the ancient city of Babylon and 180 km southwest of Baghdad the capital of Iraq. South by Najaf lands is flat and leveled linked to the Euphrates river water, it is higher in the southern portions of the desert areas, extending to the Kingdom of Saudi Arabia. Twenty well water samples were collected in February 2015. As it is indicated in Figure (1).

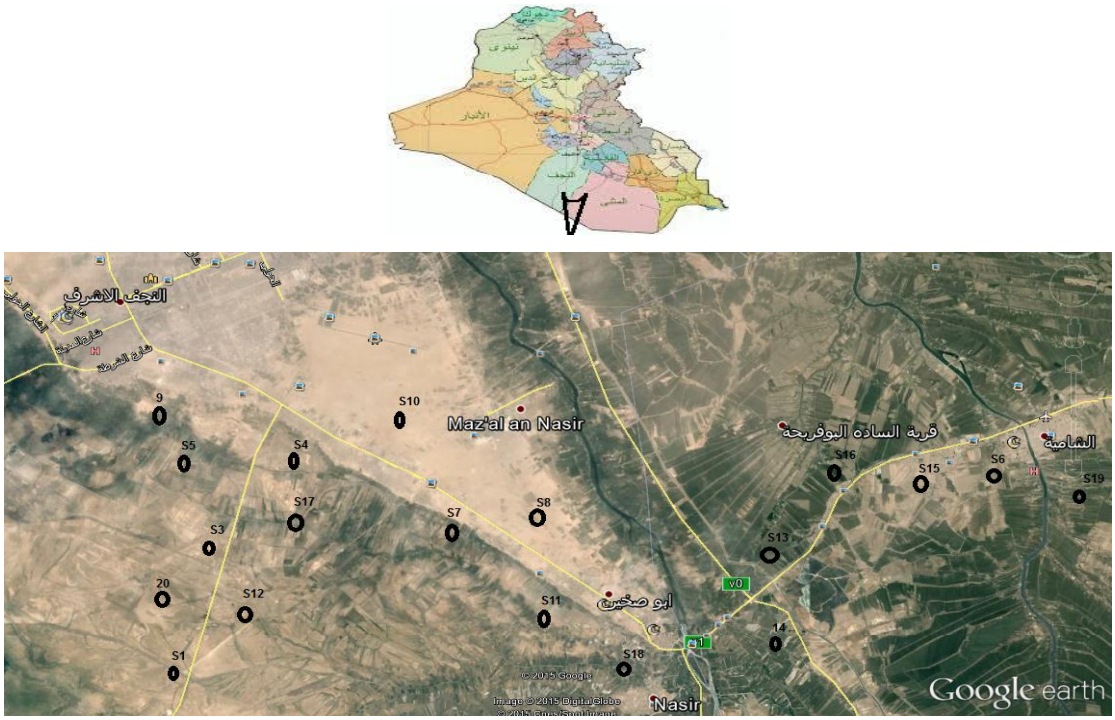

Figure (1): Location of wells in South of Najaf city.

Sampling strategy

Three water samples (A, B and C) were collected from each well (S1-S20) for the heavy metals , physiochemical and biological analysis. For determining heavy metal concentrations, 50mL water were acidified with approximately 0.5ml of concentrated HNO_3 (BDH) and passed through acid washed folded filters, the filtrate was stored in acid washed polypropylene tubes until it was measured. Co, Cr, Zn, Cd, Pb , Mn , Fe and Cu in samples were detected by AA 6300 Flame Atomic Absorption Spectrophotometer, Shimadzu, Japan. Sampling and analytical techniques followed the suggestions by.[11-13] The Hydrogen Ion Concentration (pH), Electrical Conductivity (EC), Total Dissolved Solids (TDS), chemical oxygen demand (COD), Turbidity (Tur), and Salinity (Sal) of water samples were measured.

pH, EC, COD and TDS of water samples for chemical analysis were filtered, then refrigerated at 4 °C before chemical analysis by multi meter type Crison MM40, Spain. Sampling and analytical techniques followed the recommendations by.[14][15] Turbidity (Tur) measured by turbicheck, Loribond, Germany. Salinity (Sal) was determined according to the procedure[14] measured by WTW, Germany. Sodium ion (Na^+) and Potassium ion (K^+) were determined[16] by flam photometer type 378 Elico, England. The determination of biological parameters is done directly after the collect samples where (TPC), Pseudomonas was determined by using serial dilutions of the water samples in sterile buffered water, followed by preparation of pour plates, using standard plate count agar in replicates of three.[17] (T.C) was determined by the membrane filtration technique. A 50-ml portion of the water sample was passed through a 0.45-rim membrane filter. The filter was then removed and aseptically placed onto a plastic petri dish (60 by 15 mm) containing m-Endo agar LES (Difco Laboratories). Endo agar plates were examined, and the number of coliform colonies was determined after 24 h of incubation at 35°C. Results were expressed as total Coliforms per 100 ml of water.[18]

RESULT AND DISCUSSION

Heavy Metals

For the protection of human health, guidelines for the presence of heavy metals in water have been set by different International Organizations such as USEPA, WHO, EPA, European Union Commission[19], thus, heavy metals have a maximum permissible level in water as specified by these organizations. The results of various heavy metals (HMs) analysis in groundwater samples (GWS) are listed in figure (2). During present investigation, Cobalt (Co) usually occurs in association with other metals such as copper, nickel, manganese and arsenic. Small amounts are found in most rocks, soil, and surface and under GW, plants and animals. Cobalt (Co) ranged from 0.007 to 0.0159ppm in GWS with average 0.0089 ppm. Most of GWS collected from the study area contained Co above permissible limit < 0.001-0.002ppm recommended by WHO for drinking water. The concentration of Cr varied from the range of ND to 0.0063ppm with average 0.0029ppm. GWS contained chromium within permissible limits, 0.05ppm prescribed by WHO. The concentration of zinc (Zn) ranged between 0.00015 to 1.1114ppm with average0.0715ppm, and found within permissible limit 3ppm recommended by WHO for drinking water. Cadmium (Cd) metal was found in the range of 0.0007 to 0.1766ppm with average 0.0286ppm. The high concentration of Cadmium in some water samples of the study area may be attributed to the runoff from the agricultural

fields where pesticides as well as cadmium containing phosphates fertilizer have been used. GWS collected from the study area contained lead (Pb) ranged from 0.0016 to 0.1038ppm with average 0.0257ppm above permissible limit 0.01ppm recommended by WHO for drinking water.

The possible source of Pb are combustion of gasoline, uses of lead arsenate as a pesticide as well as its uses in lead pipe, paints, pigments and lead storage batteries.[20] Manganese (Mn) metal was found in the range of 0.0092 to 0.5609 ppm with average 0.1314ppm, and found within permissible limit 0.5 ppm. Recommended by WHO for drinking water. the range of Iron (Fe) between 0.0018 to 0.4912 ppm with average 0.0987ppm, and found within permissible limit 0.3 ppm recommended by WHO for drinking water. Eventually,the range of Copper (Cu) between ND to0.0255 ppm with average 0.0117ppm, and found with permissible limit 2ppm recommended by WHO for drinking water.[21]

Table (1): Status of heavy metals in ground water samples.

HMs	Mean	Max	Min	WHO
Co (ppm)	0.0089	0.0159	0.0007	<0.001-0.002
Cr (ppm)	0.0029	0.0063	ND	0.05
Zn (ppm)	0.0715	1.1114	0.00015	3
Cd (ppm)	0.0286	0.1766	0.0007	0.003-0.005
Pb (ppm)	0.0257	0.1038	0.0016	0.01
Mn (ppm)	0.1314	0.5609	0.0092	0.5
Fe (ppm)	0.0987	0.4912	0.0018	0.3
Cu (ppm)	0.0117	0.0255	ND	2

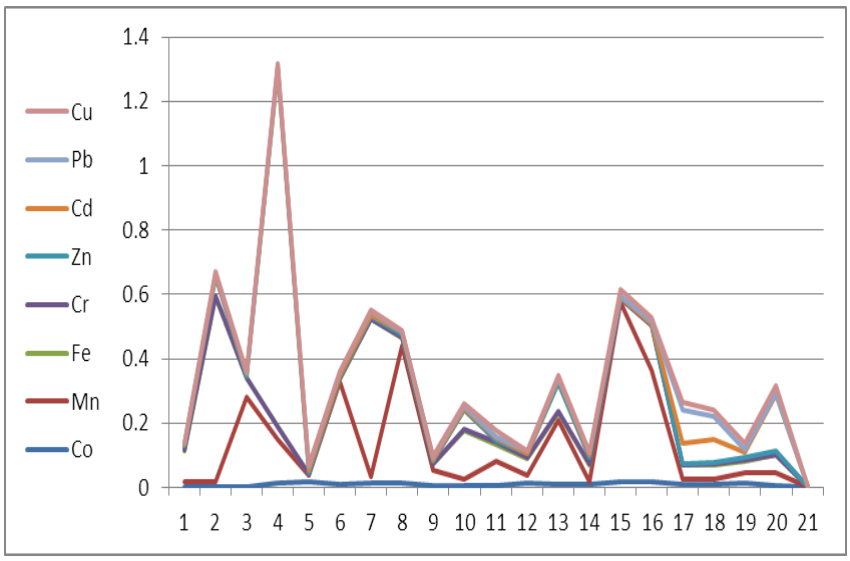

Figure (2) : Concentrations of Heavy Metals in ground water samples.

Physicochemical parameters

The results of physicochemical parameters of water samples are presented in Table (2) . The pH of a water system is very important in determination of its quality because it affects other parameters such as solubility of metals.[22] The pH values recorded were in the range of 2.9 – 8.3 and the mean value was 6.7. This indicates that the water is slightly acidic and this may aid solubility and leaching out of trace metals.[23] Electrical conductivity (EC) and total dissolved solids (TDS) are a measurement of water's capacity for carrying electrical current and it is related to the concentrations of ionized substance in the water. not citations The levels affected by EC of water are a direct function of TDS, from the results it was evident that the highest value of 15046 µs/cm is obtained at S6 where as the lowest value of 1890 µs/cm is obtained at S17. Samples analyzed for TDS are showing values range 1134 to 9780 ppm, as compared with the standard value which is 800ppm. The sampling location number is having higher TDS values in collected ground water samples. The fluctuations in EC correlated positively with the TDS which are indicators of polluted water. Chemical oxygen demand (COD) is measured the amount of organic compounds in water (i.e the amount of organic pollutants found in surface water) , from the results it was evident that the highest value of 139 (ppm) is obtained at S3 where as the lowest value of ND (ppm) is obtained at S2, S4,S6,S7,S9-20. Suspended matter of turbidity often includes mud, clay and slit. Turbidity values ranged from 0.04 NTU to 71.8NTU. The maximum permissible levels for turbidity from 0-10 NTU.[24] The excessive turbidity in water causes problems with water purification process such as flocculation and filtration, elevated turbid water is often associated with the possible of microbiological contamination as high turbidity makes it difficult to disinfect water properly.[25] Salinity is a major water quality limitation on the environmental values (including potential beneficial uses) of groundwater. It is influenced by human action such as irrigation, disposal of waste waters, seawater intrusion in response to excessive extraction from coastal aquifers, and the likes. Excessive salinity in all groundwater may limit their use and therefore the productivity of lands reliant on bore water irrigation. Lower salinity levels were registered from 0.3ppt to 9.7ppt. These values were low compared with WHO guidelines values of 3-10ppt. . Mean concentrations of sodium and potassium from the GW samples were 288.5 and 42.9ppm, respectively. Sodium is more mobile in soil than potassium and so it is used often as an indicator of human impacts to shallow GW. Sodium is also a common chemical in minerals. Like potassium, sodium is gradually released from rocks.

Table (2): Status of physiochemical parameters in ground water samples.

Parameters	Mean	Max.	Min.	WHO*
PH	6.76	8.3	2.9	6.5-8.5
EC (µs/cm)	8111	15046	1890	800
TDS (ppm)	4351	9780	1134	500
COD (ppm)	15.7	139	ND	<10
Salinity (ppt)	3.1	9.7	0.3	3-10
Turbidity (NTU)	5.33	71.8	0.04	5
Na^+ (ppm)	288.8	679.7	87	20
K^+ (ppm)	42.9	356.3	6.6	10

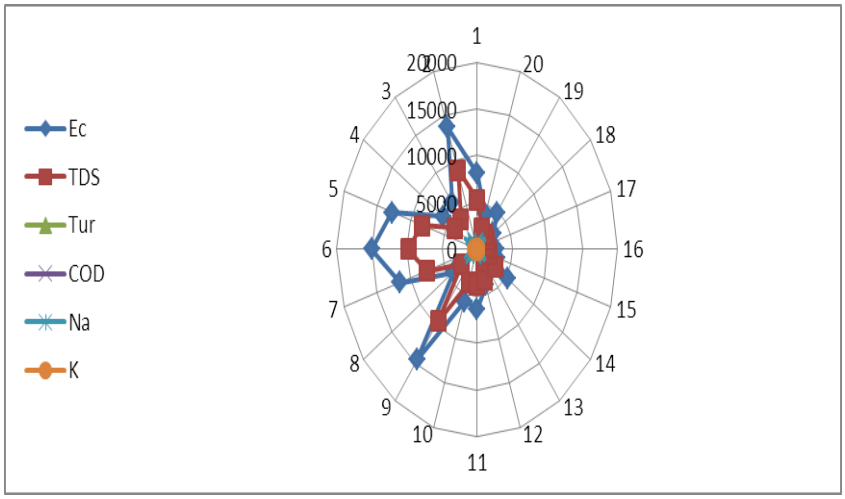

Figure (3): Correlation of heavy metals and some physiochemical parameters.

Biological parameters

Total Plate Count, also termed as Total Viable Count (TVC), gives information about the number of aerobic bacteria present in a sample. All the samples were found to have TPC. Commonly, the Total Coliforms (TC) gives the information about the Coliform bacteria which consider the most common indicator organism used for monitoring water quality , in the present study, TPC ranged from 1500 Cfu/ml to 10000 Cfu/ml and TC ranged from 7.8 Cfu/ml to 540 Cfu/ml . In all the samples shows higher values compare with the permissible limit <100 Cfu/ml and <1 Cfu/ml, respectively recommended by WHO for drinking water **[26]**. Pseudomonas bacteria can be found naturally in the ground and within drinking water sources such as aquifers. The presence of Pseudomonas may cause several health problems including skin rash and other skin infections, ear infection, urinary tract infection, and in rare instances, pneumonia. During present investigation, Pseudomonas ranged from ND to 23 in ground water samples (GWS).[27]

Table (3): Status of biological parameters in ground water samples.

Parameters	Mean	Max.	Min.	WHO*
T.P.C Cfu /ml	5750	10000	1500	<100Cfu/ml
T.C Cfu /100ml	112.78	540	7.8	<1Cfu/100ml
Pseudomonas	5.04	23	ND	<1Cfu/ml

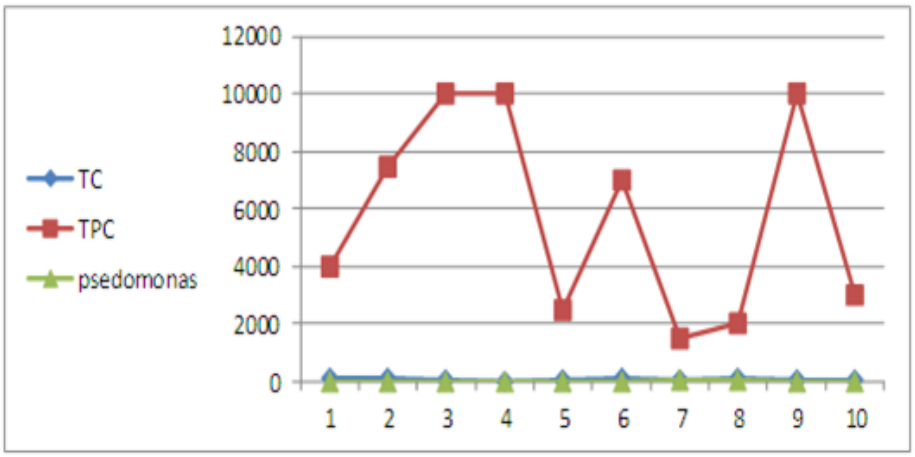

Figure (4): Correlation of some Biological parameters.

CONCLUSIONS

These results show high concentrations of some toxic heavy metals including cobalt ,cadmium and lead according to the maximum permissible levels recommended by world health organization WHO drinking water standards.Physiochemical and biological properties more than WHO guideline values, these refer to inefficiency for drinking water.

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