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Water quality indices for Euphrates River.

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ABSTRACT

Saod WM, Rashid FA, Turki AM, Mansoor Al-Taee MJ., Water quality indices for Euphrates River, Onl J Vet Res., 23 (5):407-413, 2019. Authors describe bacteria, physical and chemical properties, conductance, suspended and dissolved solids, pH, hardness, trace and heavy metals for water quality index (WQI) from 5 samples of different locations of the Euphrates River, Ramadi, Iraq, Spring 2018. We found aerobic bacteria reached $114*10^{-8}$ cell/ml with *Enterobacter amnigenu, Klebsiella aerogenes, Pseudomonas spp, Escherichia coli, Proteus sp, Shigella spp* and *Streptococcus faecalis* predominating. Water pH varied 7.6-7.8 with 742±2mg/L dissolved solids and hardness of 1333.2±38 mg\L exceeding limits of 500 and 1000 mg\L. Sodium levels were 145.1 ± 0.94 and potassium 11.08 ± 1.06mg/L (within limit). Calcium (105±7 mg/L), magnesium (56.4±6.4 mg\L) and sulphate (265.6±1.47 mg/L) exceeded permitted levels whereas and nitrate ions were below limit (2.2± 0.8mg/L). Conductance was 1245.2±91 µs\cm exceeding limit of 750 µs\cm and total suspended solids 215±37.5 mg\L, well above limit of 50 mg\L. There were no significant correlations between water quality and conductivity, hardness, calcium but there was with coliform count (P 0.001) and magnesium levels ($P < 0.05$). We find that water samples from The Euphrates River, Ramadi, Iraq, were of poor quality, and should not be ingested by animals or humans

Key Words: Euphrates River, Water pollution, Chemical, Microbial, WQI

INTRODUCTION

Water pollution is defined as presence of unwanted materials, changes in quality (1) or not potable (2)(3). Quality of potable water has been standardized by WHO (4) and prevalence of deaths due to ingestion of polluted water has been estimated at ~3.1% (5). Water can be contaminated with toxins such as arsenic, copper, manganese, silver, aluminum, cadmium or lead (6). When concentrations of some trace elements increase beyond limits, they may become toxic (6). A main source of infection is ingestion of water contaminated with pathogenic bacteria from human and animal feces which may also pollute fresh potable water by containing pathogenic bacteria (7-10). Diarrhea associated with ingestion of polluted water is a major public health issue especially in children under 5 years and poor or unsanitary conditions (11). The water quality Index (WQI) is used to gauge potability of water (12). Authors report WQI based on chemical pollutants, contamination, conductance and particles in water samples taken from different locations of the Euphrates River, Ramadi, Iraq

MATERIALS AND METHODS

Five 250ml water samples were siphoned from The River Euphrates, Ramadi city, Iraq under sterile conditions into bottles as illustrated in Figure 1 below. The samples were analyzed at The Department of Chemistry, University of Anbar, Iraq. Microbiological analysis was performed immediately to avoid alterations in bacterial populations.

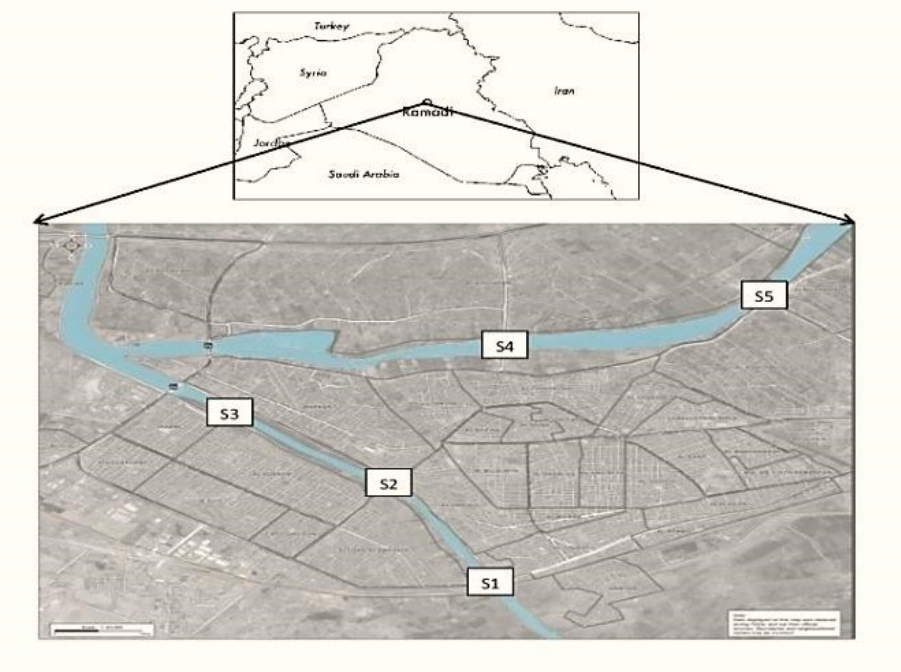

Figure 1. Ramadi City sampling location on Euphrates River. S1 Omer Bin Abdulazize, S2 Alhooz, S3 Alqasim, S4 Elboatha and S5 Elbofaraj

Various physio-chemical factors namely total suspended solid (TSS), pH, TDS (total dissolved solids), conductivity were determined by standard titrimetric methods, Sodium, potassium and calcium were determined by Atomic Emission Spectrophotometry (AES) as described (12).

Magnesium, copper, zinc, nickel, Chromium and manganese were estimated by Atomic Absorption Spectrometry (AAS) (12). Standard solutions of 1000 mg/L were prepared for titrations. Lead and Cadmium were assessed by using (Graphite Furnace Atomic Absorption Spectrometry) GFAAS (12). Sulfate, nitrite and nitrate were assessed by using UV-VIS spectrophotometric analysis. Nitrites, nitrate and Sulfate were measured at 275, 543, 420 nm respectively. The WQI of Euphrates River was calculated using CCMEWQI method as described (13). For more details about CCMEWQI were documented in CCME (13). The following relations are used to calculate the index scores of CCME WQI technique:

$$F_1 = (\frac{number\ \ of\ \ failed\ \ variables}{total\ \ number\ \ of\ \ variables})x\,100 \qquad (1)$$

Where F1 (scope) represents the percentage of variables that do not meet their objective at least once during the time period under consideration (" failed variables), relative to the total number of variables measured.

$$F_2 = (\frac{number\ \ of\ \ failed\ \ tests}{total\ \ number\ \ of\ \ tests})x\,100 \qquad (2)$$

Where F2 (frequency) represents the percentage of individual tests that do not meet objectives (" failed tests)

F3 (Amplitude) represents the amount by which failed test values do not meet their objectives. F3 is calculated in three steps:

1. The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an " excursion " and is expressed as follows .When the test value must not exceed the objective:

$$excursion_i = (\frac{failed\ \ test\ \ value_i}{objective_j}) - 1 \qquad (3a)$$

For the cases in which the test value must not fall below the objective:

$$excursion_i = (\frac{objective_j}{failed\ \ test\ \ value_i}) - 1 \qquad (3b)$$

If the objective equals zero:

$$excursion_i = failed\ \ test \tag{3c}$$

2. The collective amount by which individual tests are out of compliance is calculated by summing the excursions of individual tests from their objectives and dividing by the total number of test (both those meeting objectives and those not meeting objectives). This variable, referred to as the normalized sum of excursions, or nse , is calculated as :

$$nes = \frac{\sum_{i=1}^{n} excursion_i}{No\ \ of\ \ tests} \tag{4}$$

3. F3 is them calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a range between 0 and 100.

$$F_3 = \frac{nse}{0.01nse\ \ + 0.01} \tag{5}$$

The CCME Water Quality Index (CCMEWQI):

$$WQI = 100 - \frac{\sqrt{F_1^{\,2} + F_2^{\,2} + F_3^{\,2}}}{1.732} \tag{6}$$

Bacterial counts were determined in 100µL water serially diluted and aseptically cultured onto brain heart infusion agar, each sample was cultured onto 2 plates incubated 24h at 37 ◦C with counts as CFU/ml. Bacterial were identified on MacConkey, blood agar, EMB (Eosine Methylene Blue) Salmonella Shigella Agar (S.S Agar) Shigellac ,cholera and brilliant green agars. cultured for 24h. at 37˚C. Cultures were subcultured for Gram stain and identified by VITEK 2.

RESULTS

Results are shown in Tables 1 and significant correlations on Figures 2 and 3 below.

Table 1. Physicochemical Analysis of Water Samples from The Euphrates River, Ramadi, Iraq,

Parameters	Omer Bin Abdulazize (1)	Alhooz (2)	Alqasim (3)	Elboatha (4)	Elbofaraj (5)	WHO Standard *(14)*
PH	7.7	7.6	7.8	7.7	7.8	7-8.5
Total solids (TSS) (mg\l)	140	300	192	270	176	50
Conductivity (µs/cm)	1247	1354	1312	1000	1375	750
Total dissolved solids TDS (mg\l)	746	804	776	602	782	500
Hardness (TH) (mg\l)	1150.16	1242.28	1474.06	1588	1211.5	1000
Na(mg\l)	147	144	150.6	143.4	140.5	200
K(mg\l)	13.2	10.8	9.8	11	10.6	75
Ca(mg\l)	91	98	116	125	95	250
Mg(mg\l)	43.6	50.6	63.5	68	56.3	50
SO4(mg\l)	268.5	271.6	280.06	245.827	261.84	250
NO3(mg\l)	0.5	2.432	2.796	3.820	1.479	50
NO2(mg\l)	0.8	0.067	0.08	0.046	0.094	50

Table 2: Water Quality Indices for water samples from The Euphrates River, Ramadi, Iraq.

Sample water Code	Water quality Index
Omer Bin Abdulazize (1)	35
Alhooz (2)	34.5
Alqasim (3)	44.8
Elboatha (4)	42.4
Elbofaraj (5)	38.4

Table 3: Trace elements and heavy metals *(mg/L)* in water samples from The Euphrates River.

Parameters	1	2	3	4	5
Cu	0.015	0.021	0.013	0.019	0.025
Zn	0.023	0.014	0.027	0.018	0.013
Ni	0.022	0.015	0.021	0.011	0.014
Mn	0.01>	0.01>	0.01>	0.01>	0.01>
Cr	0.01>	0.01>	0.01>	0.01>	0.01>
Pb	0.01>	0.01>	0.01>	0.01>	0.01>
Cd	0.01>	0.01>	0.01>	0.01>	0.01>

Table 4: Bacteriological analysis of Euphrates River in Ramadi City

Sample water Code	Log TPC	Log CFU	Salmonella Shigella	Vibrio cholera
Omer Bin Abdulazize (1)	9.57	5.813	N.S	N.S
Alhooz (2)	9.6	5.5	N.S	N.S
Alqasim (3)	10.0	5.6	N.S	N.S
Elboatha (4)	9.845	5.64	N.S	N.S
Elbofaraj (5)	9.72	5.7	N.S	N.S

Table 5: Bacteria found in The Euphrates River, Ramadi, Iraq.

Parameters	1	2	3	4	5
E.Coli	+	+	+	+	+
aerogenesKlebsiella	+	+	+	+	+
Citerobacter braki	+	+	+	+	+
Enterobacter.amnigenu	+	+	+	+	+
Pseudomonas spp	+	+	+	+	+
Escherichia coli	+	+	+	+	+
Proteus sp	+	+	+	+	+
Shigella sp	+	+	+	+	+
Sterptococcus faecalis	+	+	+	+	+
Aerogenes	+	+	+	+	+
Salmonella typhosa	-	-	-	-	-
Vibrio cholera	-	-	-	-	-

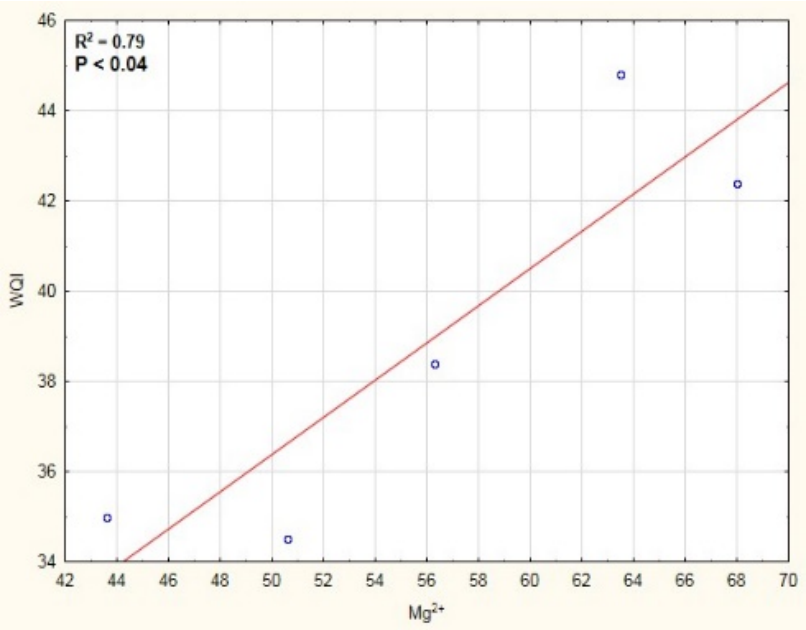

Figure 2. Correlation (R^2=0.79) between magnesium with water quality (Pearson's test).

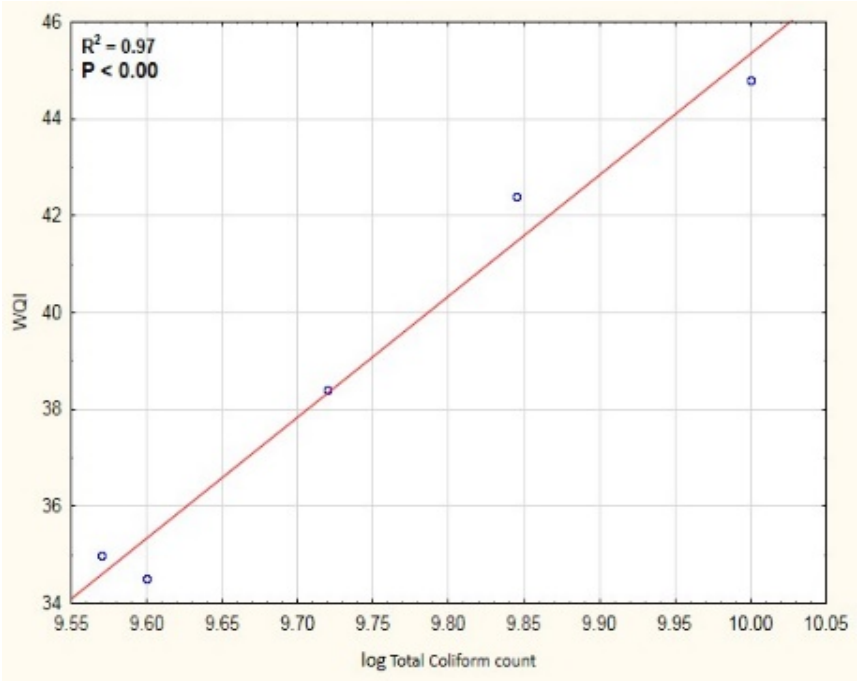

Figure 3. Pearson' correlation of coliform counts versus water quality index (P < 0.001)

DISCUSSION

CCME WQI water standards are 95 – 100 excellent, 80 – 94 Good, 65 – 79 Fair, 45 – 64 Marginal and 0 – 44 poor (15), therefore our WQI of 35-45 (Table 2) suggests that water quality of the Euphrates River in Ramadi, Iraq is poor (13). pH varied 7.6 to 7.8 an acceptable value below the limit of 8.5 (14). Ph reflects alkaline and acid constituents in river water possibly due to carbonates, bicarbonate and carbon dioxide (16). Conductivity, a measure of water capacity to transport electricity, was quite high at 1150 to 1588 above the recommended 750µS/cm (14). which may have been due to high salt content as described (17).

Total solids as shown in Table 2 were in excess of WHO limits (500mg/L) ranging 602 to 804 mg/l. Calcium (Ca^{+3}) ranged 19 to 125 mg/l well below recommended levels of 150mg/L (14), and magnesium (Mg^{+2}) 43.6 to 68 mg/l are found in high concentrations in groundwater in the form of bicarbonate, sulphate or chloride in a lesser extent. Water hardness ranged 1000 to 1375mg/l. Surface water above 1000 mg/l is regarded as very hard. Sodium 140.5 - 150.6 mg/l, potassium 11.08 mg/l and calcium were below who limits but sulphates 348.8 to 280.06 mg/l above. The sulphate concentration is possible to react with different human organs when level is exceeding above the acceptable limit of 400 mg/l. The NO_3 level in the river water is detected from 0.5 to 3.82 mg/l with 2.2mg/l average. While NO_2 value in the water of river is detected to be 0.046 to 0.8 mg/l) as in table (1).

We found no significant correlations between water quality (WQI) and conductivity, hardness, calcium but did with coliform count ($P < 0.001$) and magnesium levels ($P < 0.05$). We detected high count of aerobic bacteria of ~$59.8*10^{-8}$cell/ml for all samples of 46.6 × 10-4 cfu/ml (Table 4). In fact we found very high levels of coliform in all samples probably from refuse sewage and dump sites. The bacteria found are typically isolated from feces in sewage, dump or dredging sites (18) including *S. aureus*, *Pseudomonas* spp, *E. coli* and *Shigellas* spp which we isolated. The isolates *per se* are not pathogens, but in water can suggest other pathogens (19, 20). Rahman.I.A.K et al (2009) report similar findings to ours. Except for sulphates, nitrtes and trace metals did not exceed WQI limits (Table 1)

REFERENCES

1.Alrumman, S.A; El-kott, A.F.; Kehsk, M.A. (2016). Water pollution: Source and treatment. *American* Am *J Environ Engineer*. 6(3),88-98.

2. Briggs, D.)2003(. Environmental pollution and the global burden of disease. British medical bulletin. 68,1-24.

3. Bibi, S.; Khan, R.U.; Nazir, R.; Khan, P.; Rehman, H. U. (2016). Heavy metals in drinking water of Lakki Marwat District, KPK, Pakistan. *World Appl Sci J*.;34(1):15-19.

4. Khan, N.; Hussain S.T.; Saboor, A.; Kim, K.S. (2013). Physiochemical investigation of the drinking water sources from Mardan, Khyber Pakhtunkhwa, Pakistan. nt. J. Phys. Sci.;8(33):1661-71.

5. Pawari, M.J:Gawande, S. (2015). Ground water pollution & its consequence. *IJERGS.*3(4),773-76

6-Sanai, G.h. (2006). Industrial Toxicology1(7) Revision, University of Tehran Press. Iran.

7. Fenwick A. (2006). Waterborne Diseases—Could they be Consigned to History? *Science*. 313(5795):1887.

8. George, I.; Crop, P.; Servais, P.; (2001). Use of β-D-Galactosidase and β-D-Glucuronidase Activities for Quantitative Detection of Total and Faecal Coliforms in Wastewater. *Can. J. Microbiol*. 47:670–675.

9. Grabow, W.O. (1996). Waterborne Diseases: Update on Water Quality Assessment and Control. *Water SA*.; 22:193–202.

10. Halder, J.N.; Islam, M.N. (2015). Water pollution and its impact on the human health. *J Hum Environ*.2(1):36-46.

11. Seas, C.;Alarcon, M.; Aragon, J.C.; Beneit,S.;Quiñonez, M.; Guerra, H.;Gotuzzo, E. (2000).Surveillance of Bacterial Pathogens Associated with Acute Diarrhea in Lima. *Peru. Int. J. Infect. Dis*.4:96–99.

12. Parparov, A.; Lambright, K. D.; Hakanson, L.; and Ostapenia,A. (2006) .Water Quality Quantification: Basics and Implementation *Hydrobiologia*. 560:227-237.

13.Canadian Council of Minister of the Environment (CCME) (2001). "Canadian Water Quality Guidelines for the Protection of Aquatic Life: CCME Water Quality Index 1.0, Technical Report," Canadian Council of Ministers of the Environment Winnipeg MB, Canada. Available at: http: // www. ccme ca/source to tap/ wqi. html.

14.W.H.O. (1996). Guidelines for Drinking Water Quality.2nd ed. Vol.2-Health Criteria and other Supporting Information، Geneva.

15.Canadian Council of Ministers of the Environment (CCME) (2006) A sensitivity Analysis of the Canadian Water Quality Index. Available at: htt://www. ccme ca/ ourwork /water. html.

16. Hem, J. D. (1985). Study and interpretation of the chemical characteristics of natural water. Water Supply Paper 2254, U.S. Geological Survey, U. S.

17. Zaidan.A.A.; Rahman.I.A.K.; Saod.W.M.;(2009). An environmental study of the chemical and physical pollutants in the water of the Euphrates river in Ramadi and Fallujah. Journal of University of Anbar for pure Science. Vol (3). I SSN: 1991-8941.In Arabic
18. Ikpesu, T. O;.and Ariyo, A.B. (2017). Evaluation of Hydrochemical and Microbiological Contaminants isolated from Brass River in Niger Delta Ecological Zone. JST. 9 (1):20-30.
19. Figueras, M. J, and Borrego, J. J. (2010). New perspectives in monitoring drinking water microbial quality. Int. J. Environ. Res. Public Health 7:4179–4202.
20.EPA, (2003). US Environmental Protection Agency Safe Drinking Water Act. EPA 816 – F – 03 –016.
21.Rahman.I.A.K.; Zaidan.A.A.; Saod.W.M.;(2009). Study of some bacterial contaminants in the Euphrates River *and the lakes of Therthar and Habbaniah*. Journal of University of Anbar for pure Science. Vol (3). I SSN: 1991-8941. In Arabic
22.EPA, (2002). US Environment Protection Agency, Safe Drinking Water Act Ammendment http:// www. epa. gov/safe water /mcl. Html
23.Schlegel, H.G. (2002). General Microbiology. 7. Cambridge. University Press. 480.
24. Krishna K. S.;Chandrasekar, N.; Seralathan, P.; Godson, P.S.;Magesh, N.S.; (2011) Hydrogeochemical study of shallow carbonate aquifers, Rameswaram Island, India. *Environ Monit Assess*. 184(7):4127–4139.
25. Mehjbeen, J.; and Nazura, U. (2013). Assessment of heavy metal (Cu, Ni, Fe, Co, Mn, Cr, Zn) pollution in effluent dominated rivulet water and their effect on glycogen metabolism and histology of Mastacembelus armatus. Javed and Usmani SpringerPlus. 2(390):
26. Prabu, P. C. (2009) Impact of Heavy Metal Contamination of Akaki River of Ethiopia on Soil and Metal Toxicity on Cultivated Vegetable Crops. Electronic. *EJEAFChe*.8(9): 818- 827.