Journal of Advances and Scholarly Researches in Allied Education
Vol. 18, Issue No. 4, July-2021, ISSN 2230-7540

Drinking Water Microbiological Studies in Relation to Human Health

Praveen Manker[1]*, Dr. Mohd. Ahamad[2]

[1] Research scholar, Shri Krishna University, Chhatarpur M.P.

[2] Assistant professor, Shri Krishna University, Chhatarpur M.P.

Abstract - Most of India is considered "highly water-stressed" due to the high ratio of annual water consumption to availability. Commonly found in India, calcium bicarbonate (Ca-HCO3) ground water has an EC of 750 microsiemens (S/cm) at 250 degrees Celsius. They are of mixed cation and mixed anion type when the electrical conductance (EC) is between 750 to 3000 S/cm, and they are of sodium chloride (Na-Cl) type when the EC is over 3000 S/cm. Over 70 samples of drinking water were analyzed microbiologically in this study.

Keywords - Water samples, Water quality, Drinking water, Ground water.

----------X----------

INTRODUCTION

We depend on water to survive. The beauty of our watery planet as seen from space beyond words. Water is exceptional in the Universe due to its one-of-a-kind chemical composition. The presence of liquid water on Earth is what allowed for the development of life on our planet and nowhere else in the solar system. Since the beginning of time, water's chemistry has provided a favorable environment for the growth of life on Earth. There wouldn't be any life on Earth without it. Water is the only naturally occurring material that can exist in all three main states of matter (solid, liquid, and gas). Since it can dissolve almost everything, water plays an essential part in almost every human endeavor. Ag, ind, en, and life all rely on water to thrive. Our survival depends on water, making it the most important chemical element. [1-2]

To put it simply, life on Earth depends on water. Water's presence molds, refreshes, and sustains our globe. Water's transformational enchantment lies in the fact that it may take on many forms and move from one location to another. To put it simply, water is the oxygen that sustains life on Earth. Constantly supplying it with nutrients, oxygen, and other necessities of life. There is never any stillness in water. It constantly changes locations throughout the globe. The planet seems blue to us. To say that water has had a defining role in human history is an oversimplification.[3-4]

Given its centrality, it's only fitting that we mark its appearance on certain occasions with appropriate observances:

MARCH 22ND - WORLD WATER DAY JUNE 8TH – WORLD OCEAN DAY

1980s – INTERNATIONAL DECADE OF WATER

Seventy-five percent of Earth is covered by water, and every living thing depends on it. Nearly all of Earth's water is locked up in the planet's salty oceans, making it unfit for human consumption or agricultural use; the remaining 1.7% is distributed among groundwater, glaciers, and the ice caps of Antarctica and Greenland; the remaining 0.001% is found in vapor clouds; and the remaining 0.01% is found in other large water bodies. All life on Earth depends on the 2.5% of the planet's water that is freshwater, and of that, 98.8% is locked up in ice and underground aquifers. [5]

The amount of freshwater found in rivers, lakes, and the air is less than 3% of the total. The quantity of freshwater included in living things and man-made objects is much lower, at only 0.003% of the total. There is more than 30 percent of the world's fresh water just where we stand. Water makes up 366 quadrillion gallons of Earth's total mass. Unfortunately, just 0.0007% of it is drinkable. Seven billion people now have to split this finite supply. Daily water intake should be between two and five liters. Blood is mostly water (around 55%). The average human body is between 55% and 78% water. In 2005, researchers led by Jeffrey Utz found. Potable water, often known as drinking water, is water that is safe for human consumption.[6.8]

Water is put through a battery of tests to see whether it meets the standards necessary for

human consumption and household use. Key indicators of safe drinking water include:

Microbiological: Coliform bacteria, Escherichia coli, Vibrio cholerae, and other viruses & protozoan parasites are all examples. Contamination from sewage is indicated by the presence of fecal coliforms (such as E. coli). Protozoan oocysts including Cryptosporidium, Giardia lamblia, Legionella, and viruses are all potential pollutants.[9-11]

MATERIAL AND METHODS

It was ensured that samples for bacteriological analysis were not contaminated in any way while being collected.

Sample containers: All of the samples were collected in either sterile glass vials or plastic tubes with screw tops. The amount of residual chlorine in the water was measured just where samples were obtained.

Sampling procedures: Before it came time to fill the sample bottle, it was kept sealed. The bottle's cork and neck were covered during sampling to prevent cross-contamination.

Preservation and storage of samples: Once water samples were collected, they were immediately sent for bacteriological testing. Within an hour of collection, the technical processes for bacteriological investigation had begun.

A membrane filtration technique was employed for the isolation of fecal coliforms. Based on colonial, morphological, and biochemical properties, enteric bacteria isolated on respective selective and differential media were identified using Bergy's Manual of Determinative Bacteriology, 1994.

Total Coliforms:

Total coliforms were isolated using Endo Agar Medium (10 g Peptone, 10 g lactose, 3 g sodium chloride, 3 g dipotassium phosphate, 2.5 g sodium sulphite, 0.4 g basic fuchsin (pararosaline), 15 g agar, 1 liter of distilled water, pH 7.5). The composition's medium was made, put into an autoclave at 15 pounds of pressure for 15 minutes, and then poured onto petri dishes. The samples of test water were diluted serially in distilled water to ensure sterility. Sterile petri plates containing solidified medium were poured with 0.1 ml of test samples from 103 and 104 dilutions.

Sterile glass was used to disperse the sample throughout the media for even coverage. To incubate the plates, we set the temperature to 37 degrees Celsius and left them there for 36 hours. The study was run three times for accuracy. The colonies were counted using the Quebec Colony Counter.

Faecal Streptococci:

To isolate fecal streptococci, a medium was prepared with 6.0g beef extract, 10.0g peptone, 10g lactose, 0.4g sodium azide, 15.0g agar, distilled water 1.0 liter, pH 7.0. The composition's medium was made, put into an autoclave at 15 pounds of pressure for 15 minutes, and then poured onto petri dishes. The samples of test water were diluted serially in distilled water to ensure sterility. Sterile petri plates containing solidified medium were poured with 0.1 ml of test samples from 103 and 104 dilutions. Sterile glass was used to disperse the sample throughout the media for even coverage. We incubated the plates for 36 hours at 37 degrees Celsius. The study was run three times for accuracy. The colonies were counted using the Quebec Colony Counter.

Faecal Coliforms:

Isolation of faecal coliforms was accomplished using a medium consisting of 5.0g of proteose peptone, 3.0g of yeast extract, 1.0g of sodium lauryl sulphate, 0.3g of bromothymol blue, 15.0g of Agar, 11.0 liters of distilled water, and a pH of 7.3. The composition's medium was made, put into an autoclave at 15 pounds of pressure for 15 minutes, and then poured onto petri dishes. The samples of test water were diluted serially in distilled water to ensure sterility. Sterile petri plates containing solidified medium were poured with 0.1 ml of test samples from 103 and 104 dilutions. Sterile glass was used to disperse the sample throughout the media for even coverage. We incubated the plates for 36 hours at 37 degrees Celsius. The study was run three times for accuracy. The colonies were counted using the Quebec Colony Counter.

RESULTS

In the current study, 70 samples of water were taken from different locations around Jabalpur and analyzed for bacterial contamination. Evaluations of HPC, total coliforms, fecal coliforms, fecal streptococci, and staphylococci were performed on water samples taken from 20 bore wells, 22 residential tap water supply, 15 public areas, 3 open wells, 5 packaged drinking water samples, and 5 household filter waters. The data was tallied as follows:

The probes spanned a full calendar year, from March of 2019 to February of 2021. The primary aim of this research was to compare seasonal changes in pathogen levels in drinking water samples and to evaluate the quality of water from different sources.

Total Coliforms:

Total coliforms are a kind of bacteria that may be found in a wide variety of habitats, including dirt,

plants, mammalian intestines (including our own), and water. However, the presence of total coliform bacteria suggests that the water supply has been tainted by other, more dangerous microbes. Indicating recent fecal contamination, the presence of E. coli in water may serve as an early warning of the presence of other disease-causing organisms such bacteria, viruses, and parasites. Some E coli strains, such as 0157:H7, may cause illness even in healthy people. Both sewage and natural waterways contain total coliform bacteria. The feces of humans and animals may include some of these bacteria, but many coliforms are heterotrophic and may thrive in water, particularly in the presence of biofilms. Contamination or regrowth of biofilms in water storage tanks or distribution networks might be detected by measuring total coliforms there. Bacteria colonize water distribution networks in a very particular way. Pathogens in the water may interact with the biofilm, making them more resilient.

Total coliform counts in the bore well water samples peaked in the BW15 sample at 0.68 103 CFU/100 ml in early 2019. In 2019, the BW10 sample had a minimum count of 0.09X103CFU/100ml. The average number of CFUs per 100 ml was calculated to be 0.34X103. In 2020, the highest total coliform concentration was found in a BW15 sample during the monsoon at 1.46 103 CFU/100 ml. In 2020, the lowest CFU count was found in BW13, at 0.15 x 103 per 100 ml. 0.73 103 CFU/100 ml was determined to be the average. After the monsoon, the highest concentration of total coliforms was found in BW11 sample in 2019–20 and BW16 sample in 2020–21, both with a count of 0.66 103 CFU/100 ml. In 2019–20, the lowest total coliform count was found in a BW9 sample, and in 2020–21, it was found in a BW4 sample, with a minimum of 0.25X103 CFU/100ml. The average number of CFUs per 100 ml was calculated to be 0.42X103.

Table 1: Total Coliforms in Open Wells

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
OW1	Hukumpet	2.96	3.02	2.90	2.62	3.39	2.84
OW2	Dowlaiswaram	2.85	2.91	3.07	2.96	3.31	3.06
OW3	Govindpuram	3.18	3.05	3.18	3.25	3.29	2.19
Maximum		3.18	3.05	3.18	3.25	3.39	3.06
Minimum		2.85	2.91	3.07	2.96	3.29	2.19

Table 2: Total coliforms in Packaged Drinking Water

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
PDW1	Aquafina	0.00	0.00	0.00	0.00	0.00	0.00
PDW 2	Kinley	0.00	0.00	0.00	0.00	0.00	0.00
PDW 3	Dolphin	0.01	0.00	0.00	0.00	0.05	0.00
PDW 4	Sapphire	0.00	0.00	0.00	0.00	0.00	0.00
PDW 5	Dr. water	0.00	0.03	0.02	0.00	0.03	0.00
Maximum		0.01	0.03	0.02	0	0.05	0
Minimum		0	0	0	0	0	0

Table 3: Total coliforms in Filtered Water

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
FW1	Alcot gardens	0.15	0.69	0.26	0.28	0.69	0.04
FW2	Danavaipet	0.27	0.23	0.10	0.39	0.63	0.13
FW3	Dowlaiswaram	0.33	0.40	0.11	0.27	0.41	0.15
FW4	Aryapuram	0.38	0.24	0.12	0.36	0.58	0.25
FW5	C.T.R.I.	0.25	0.38	0.33	0.50	0.82	0.51
Maximum		0.38	0.69	0.33	0.5	0.82	0.51
Minimum		0.25	0.23	0.1	0.27	0.41	0.13

Faecal Coliforms:

Faecal coliforms are a subset of the total coliforms found only in the digestive tracts and feces of mammals. Fecal coliforms are taken more seriously as an indicator of animal or human waste than total coliforms because their origins are more particular than those of the more generic coliform group of bacteria. Untreated surface waters and soils contaminated by feces often contain high numbers of fecal coliforms. They are measured to gauge how well the water is being purified. E. coli is the most common kind of faecal coliform and a reliable predictor of faecal contamination and the presence of potentially harmful microorganisms. Some coliform species are only found in the feces of warm-blooded animals, suggesting that the presence of coliforms in water may be linked to faecal pollution. For example, up to 95% of the Enterobacteriaceae identified in feces are E. coli, making it the sole genuine faecal coliform (Waite, 1985). Raw sewage, storm water, effluent from waste water

treatment facilities, and industrial sources are all potential origins of feces.

Table 4: Faecal Coliforms in Open Wells

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
OW1	Hukumpet	1.23	1.43	1.31	1.08	1.53	1.31
OW2	Dowlaiswaram	1.18	1.38	1.38	1.23	1.50	1.41
OW3	Govindpuram	1.32	1.45	1.43	1.35	1.49	1.01
Maximum		1.32	1.45	1.43	1.35	1.53	1.41
Minimum		1.18	1.38	1.38	1.23	1.49	1.01

Table 5: Faecal Coliforms in Packaged Drinking Water

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
PDW1	Aquafina	0.00	0.00	0.00	0.00	0.00	0.00
PDW 2	Kinley	0.00	0.00	0.00	0.00	0.00	0.00
PDW 3	Dolphin	0.01	0.00	0.00	0.00	0.02	0.00
PDW 4	Sapphire	0.00	0.00	0.00	0.00	0.00	0.00
PDW 5	Dr. water	0.00	0.01	0.01	0.00	0.01	0.00
Maximum		0.01	0.01	0.01	0	0.02	0
Minimum		0	0	0	0	0	0

Table 6: Faecal Coliforms in Filtered Water in Jabalpur

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
FW1	Alcot gardens	0.06	0.33	0.12	0.12	0.31	0.02
FW2	Danavaipet	0.11	0.11	0.04	0.16	0.29	0.06
FW3	Dowlaiswaram	0.14	0.19	0.05	0.11	0.18	0.07
FW4	Aryapuram	0.16	0.12	0.06	0.15	0.26	0.11
FW5	C.T.R.I.	0.10	0.18	0.15	0.21	0.37	0.23
Maximum		0.16	0.33	0.15	0.21	0.37	0.23
Minimum		0.1	0.11	0.04	0.11	0.18	0.06

Faecal Streptococci:

The term "Fecal Streptoccci" is often used to refer to a group of taxonomically diverse cocci found in the digestive tracts of humans and animals (Facklam and Collins,1989). The presence of faecal streptococci is a common sign of feces contamination. This kind of bacterium is a gram-positive, catalase-negative, non-spore-forming cocci that prefers a temperature of 35 degrees Celsius and a medium with bile salts and sodium azide. Enterococci from feces grow best in 6.5% NaCl at 45°C, making them a kind of fecal streptococci. When compared to coli forms, fecal streptococci are more resilient to environmental stress and chlorine, and they may survive in the environment for longer.

In 2019, the highest concentration of faecal streptococci was found in the bore well water sample BW15 before the monsoon. In 2019, the lowest CFU count was found in the BW3 sample, at 0.02 103 per 100 ml. The average number of CFUs per 100 ml was determined to be 0.08X103. The highest level of faecal streptococci in the BW15 sample was 0.31 103 CFU/100 ml during the monsoon in 2020. In 2020, the lowest CFU/100 ml count was found in a BW13 sample, at 0.03X103. The average number of CFUs per 100 ml of solution was calculated to be 0.17 x 103. In BW16, the highest level of faecal streptococci was 0.16 103 CFU/100 ml after the monsoon in 2020-21. BW sample had a minimum of 0.05X103 CFU/100ml. The average number of CFUs per 100 ml was calculated to be 0.09X103.

Table 7: Faecal Streptococci in Open Wells

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
OW1	Hukumpet	0.72	0.87	0.58	0.57	0.73	0.73
OW2	Dowlaiswaram	0.70	0.84	0.61	0.65	0.71	0.78
OW3	Govindpuram	0.78	0.88	0.64	0.71	0.71	0.56
Maximum		0.78	0.88	0.64	0.71	0.73	0.78
Minimum		0.7	0.84	0.61	0.65	0.71	0.56

Table 8: Faecal Streptococci in Packaged Drinking Water

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
PDW1	Aquafina	0.00	0.00	0.00	0.00	0.00	0.00
PDW 2	Kinley	0.00	0.00	0.00	0.00	0.00	0.00
PDW 3	Dolphin	0.00	0.00	0.00	0.00	0.01	0.00
PDW 4	Sapphire	0.00	0.00	0.00	0.00	0.00	0.00
PDW 5	Dr. water	0.00	0.01	0.00	0.00	0.01	0.00
Maximum		0	0.01	0	0	0.01	0
Minimum		0	0	0	0	0	0

Table 9: Faecal streptococci in Filtered Water

		2019-20			2020-21		
Sample Code		Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml	Pre-Monsoon (Summer) In 10^3 CFU/ 100 ml	Monsoon (Rainy) In 10^3 CFU/ 100 ml	Post-Monsoon (Winter) In 10^3 CFU/ 100 ml
FW1	Alcot gardens	0.04	0.20	0.05	0.06	0.15	0.01
FW2	Danavaipet	0.07	0.07	0.02	0.08	0.14	0.03
FW3	Dowlaiswaram	0.08	0.12	0.02	0.06	0.09	0.04
FW4	Aryapuram	0.09	0.07	0.02	0.08	0.12	0.06
FW5	C.T.R.I.	0.06	0.11	0.07	0.11	0.18	0.13
Maximum		0.09	0.2	0.07	0.11	0.18	0.13
Minimum		0.06	0.07	0.02	0.06	0.09	0.03

CONCLUSION

Total coliforms, fecal coliforms, and fecal streptococci counts were found to be highest during the monsoon owing to rainfall, and lowest during the post-monsoon and the pre-monsoon periods, respectively. Maximum microbial growth was recorded during the 2020 monsoon, when there were continuous heavy rainfalls until the end of the November month, according to the research. This season was shown to have a high frequency of microbial diversity.

REFERENCES

1. Pedley, S., Howard, G.The public health implications of microbiological contamination of groundwater. Q J Eng Geol Hydroge. 2018; 30(2): 179–88.
2. Foster, S.R., Hirata, D., Gomes, M., D' Elia, M.P. Protección de la Calidad del Agua Subterránea, Guía para Empresas de Agua, Autoridades Municipales y Agencias Ambientales. Washington DC Banco Mundial. 2015.
3. Edmunds, W.M., Shand, P. Natural Groundwater Quality. European Union Countries: Blackwell; 2018.
4. Al-Khatib, I.A., Arafat, H.A.Chemical and microbiological quality of desalinated water, groundwater and rain-fed cisterns in the Gaza strip, Palestine. Desalination. 2019; 249(3): 1165–70.
5. Aydin, A.The microbial and physico-chemical quality of groundwater in west Thrace, Turkey. Pol J Environ Stud. 2017; 16(3): 377–83.
6. Bitton, G., Gerba, C. Groundwater pollution microbiology: the emerging issue. In: Bitton, G., Gerba, Ch., editors. Groundwater Pollution Microbiology. New York: John Wiley and Sons; 2020: 1–7.
7. Close, M., Dann, R., Ball, A., Pirie, R., Savill, M., Smith, Z.Microbial groundwater quality and its health implications for a border-strip irrigated dairy farm catchment, South Island, New Zealand. J Water Health. 2018; 6(1): 83–98.
8. Emmanuel, E., Pierre, M.G., Perrodin, Y.Groundwater contamination by microbiological and chemical substances released from hospital wastewater: health risk assessment for drinking water consumers. Environ Int. 2019; 35: 718–26.
9. Erah, P.O., Akujieze, ChN, Oteze, G.E.The quality of groundwater in Benin City: a baseline study on inorganic chemicals and microbial contaminants of health importance in boreholes and open wells. Trop J Pharm Res. 2016; 1(2): 75–82.
10. Keswick, B.H. Sources of groundwater pollution. In: Bitton, G., Gerba, Ch., editors. Groundwater Pollution Microbiology. New York: John Wiley and Sons; 2017: 39–64.
11. Özler, H.M., Aydin, A.Hydrochemical and microbiological quality of groundwater in west Thrace Region of Turkey. Environ Geol. 2018; 54: 355–63.

Corresponding Author

Praveen Manker*

Research scholar, Shri Krishna University, Chhatarpur M.P