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Chapter- 12

Drinking Water Pollution: The Microbiological Approach

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Keywords: Drinking water sample, MPN count, Coliforms

Abstract:

Water is one of the most essential constituents of the environments. It is the vital source of a kind of life on earth. The quality of drinking water has always been a major health concern, especially in developing countries. The inaccessibility of potable water to large segment of a population in the rural communities is the major health concern in most part of developing countries. This study was designed to evaluate the physico-chemical and bacteriological qualities of drinking water of different sources mainly from ground water and running tap water in Midnapore sadar block of Paschim Medinipur and their comparison. It was found that Total hardness of ground water was always higher than tap water. Biological oxygen demand also higher in ground water than tap water. Bacteria from collected water samples were quantified by dilution plate technique. MPN Test were applied to detect the presence of coliforms, which may be pathogenic in nature and are responsible for the cause of diseases like cholera, dysentery, tuberculosis, etc. in man and domestic animals. Few of these water sources are not suitable for domestic and drinking purposes. Out of four sites, tap water of Midnapore college campus is more suitable for drinking purpose as it shows negligible number of coliform bacteria. Both the water sample (ground water and tap water) from Rajabazar area are more polluted which correlate with physico-chemical as well as microbiological parameters. Therefore, proper treatment is necessary for domestic use of this water.

Introduction:

Water is one of the essential natural resources on the planet. More than 70% of the Earth's surface is covered in water and one of the most important and abundant compounds of the ecosystem. Humans can consume only about 0.3% of it. Anthropogenic development of any civilization depends on their fresh water resources. These Water resources include surface water and ground water. As we all know that groundwater is the main source of irrigation and domestic water in the most part of the world. Here surface water is most responsible for maintaining ground water level and fresh water resources in the planet.

Water quality is a critical factor affecting human health and welfare. Studies showed that approximately 3.1% of deaths (1.7 million) and 3.7% of disability-adjusted-life-years (54.2 million) worldwide are attributable to unsafe water, poor sanitation and hygiene. The problem is the backward socio-economic development resulting in one of the lowest standard of living, poor

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environmental conditions and low level of social services. Water meant for drinking must therefore meet quality standards. Water quality is essentially determined by its physical and chemical characteristics. Naturally, ground water contains mineral ions. These ions slowly dissolves from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and aquifer (Timothy O. et.al. 2023)

As water pollution is getting serious, houses especially in the urban area started to equip with a water filter system. People are concern with the presence of pollutants such as heavy metals and toxic chemical in their daily drinking water (Patil et.al.2012; Mondal et al., 2022). Filtered water is the main source of safe and reliable drinking water. However there is still a debate on the efficiency of filtration system to comply with the regulations as water that physically looks colourless, odourless and even tasteless is not sufficient to determine that the water is safe for consumption. In fact, the drinking water should be examined on microbiological and physicochemical quality. The WHO in its 2002 report, recommended that increased emphasis be placed on home water treatment and storage, and that more research should be conducted to assess the health benefits of such interventions. Contaminants can be in the form of microorganism that barely visible in unaided eyes. A number of authors have reported a statistically significant deterioration in the microbiological quality of water between the source and point of use in the home.

The natural and manmade factors responsible for water pollution. Sewage sludge solid wastes etc. produces significant amount of chemical besides heavy metals which could adversely affect the human health, vegetation aquatic life forms and ecosystem. The physicochemical parameters are disturbed due to introduction of several inorganic ions. A part of these ions introduced several other inorganic and organic wastes disturb the quality of water. Such as hardness, Ca and Mg hardness, pH Increase in the concentration of these parameters beyond permissible limit adversely affect the aquatic flora and fauna which in turn affect the ecosystem of water body sometimes causing adverse damages.

The only source of water for drinking and agricultural purpose throughout the Medinipur city, west Bengal, India is the underground water. In nature, the hydrochemistry of the water sources were affected by a rich of metal ions and other physical factors that leads the water more polluted. In this work, the physico-chemical analysis of drinking water quality was studied at Medinipur city, Paschim medinipur. The main aim of this study was to carried out different physcochemical parameters of water samples collected from different sites of Medinipur City and to recommend the whether it is potable or not. The major water quality parameters considered for the examination in this study are like pH, temperature, total dissolved solids (TDS), dissolved oxygen (DO), total hardness and alkalinity.

Material and Method:

Area of Study :

The study was conducted in Midnapore town and its surroundings in West Midnapore district of West Bengal. The area is located at longitude 87°10'E to 87°20'E and latitude 22°22'N to

22°30'N and is 23 meter above sea level. The climate follows a hot tropical monsoon weather pattern. Vegetation includes eucalyptus and sal forest on the North West side of town. Arabari, the forest range which was the site of India's first Joint Forest Management scheme, is only 30 km away. 4Water is a scarce resource in Midnapore. Most of the water comes from the Kasai River, which shrinking in size every year due to over-exploitation. The municipal water supply is free but not ample; tap water is available for about two hour twice a day and is stored by those who can, in plastic, metal, or concrete reservoirs or in buckets. The water is of questionable purity prompting the proliferation of individual water purification units. In this study drinking water sample are tap water as well as domestic well water collected from (1) Pramodnagar (2) Town colony (3) Medinipur college campus and (4) Razabazar area

Sampling, Preservation and Methods of analysis:

Total 4 water samples from each Sources were collected. The samples were collected during the month of April and May in 2023. All samples were collected in high-density plastic bottles. During sampling sample bottles were cleaned with ambient water before taking the samples. During whole study AR grade chemicals were used. The analysis is based on APHA (2005, 2019, 20th eds.) for examination of water and wastewater. Parameters like pH, turbidity, and temperature were checked at 15 to 17 random points at each site and considered the average for each site while the rest of the parameters were checked in the laboratory, and methods for analyzing these parameters are shown in the table below. Some standard preservative media was used to preserve the samples till it use for analysis in laboratory.

Table 1: Methods for water analysis parameters (physicochemical).

Sr. No.	Parameters of water	Analytic methods
1	Colour	Visually
2	PH	Potentiometric
3	Temperature	Thermometric
4	Electrical Conductivity(EC)	Conductometric
5	Total Dissolved Solids(TDS)	Gravimetric
6	Total suspended solids(TSS)	Gravimetric
7	Total hardness(TH)	titrimetric
8	Dissolved oxygen (DO)	Winkler method
9	Biological oxygen demand (BOD)	Std. five days incubation
10	Total bacterial counts	Plate count technique
11	Total coliform bacteria counts	MPN method through MTF
12	No of phytoplankton	Microscopic

Total bacteria:

For bacterial analysis of water and sediments, a water sample was collected in autoclaved glass bottles, and the sediment sample was collected in a Petri plate with the help of a sieve. Water samples and sediment samples were serially diluted up to 10-4 dilution and 0.1ml of each dilution were inoculated in nutrient agar media by spread plate method. After inoculation all plates were incubated at 37oC in the incubator for 48 hours. Then different types of bacterial colonies were seen on the petri plates. The bacterial colonies were counted for Colony Forming Unit.

Total coliform Bacteria:

Conventional MTF technique was used to determine the most probable number (MPN) of coliform bacteria present in those Well water. This technique normally involves three steps.

Presumptive Test:

Differential medium for the isolation of coliforms was MacConkey broth - Purple. Three broth tube series – the first series containing 3 double-strength broth tubes and the remaining two series comprising 6 single-strength broth tubes – were inoculated with 10ml, 1ml, and 0.1ml of water (ratio 3:3:3), respectively. Tubes were incubated at 37oC and observed at 24 and 48 hours. A presumptive test is positive for coliforms if acid and gas are produced in Durhams tubes.

Confirmed Test:

To eliminate false-positives from non-coliform organisms, eosin methylene blue (EMB) agar plates were inoculated with a loop-full from each positive presumptive broth tube by streaking across the agar surface. Plates were incubated for 24 h at 37oC.

Completed Test:

Finally, nutrient agar slants and Mac Conkey broth tubes were inoculated with distinct colonies picked from cultured isolates on EMB agar plates. After incubation for 24 h at 37oC, broth cultures were observed for acid and gas production and cultured isolates on agar slants were gram stained using technique described by Aneja (2003).

Quantification of plankton:

For biological analyses Collection, preservation and qualitative assessment of phytoplankton were done by following Khondker and Kabir (1995) and Johansen (1940) using microscope. The average number of phytoplankton was expressed per liter of original water by using the following equation:

Phytoplankton (No. / ml) =C ×100/A×D×F

Where, C= Total no of phytoplankton counted;

A= Area of field counted;

D= Depth of the field on mm

F = No. of fields counted.

Result and discussion:

Physicochemical parameters: The colours of the investigated ground water and tap water were observed visually. The observed colour was in majority of wells bluish clean but light dim in Towncolony Sarkar Well and bluish-green in Towncolony Mazumder Well (2). Light green colour represented lower planktons, where the greenish blue and brown colour represented higher planktons (Islam et al., 2015). Baruah et al. (1997) reported that, a well and phytoplankton enriched water body appears to be dark greenish blue. Higher plankton concentrations sometime are responsible for blooming, which results less oxygen in water. All the tap water are colour less.

Surface water temperature could be influenced by factors such as geographical position, seasonality, diurnal period, circulation of air, quantity of cloud cover, depth of water and its flow rate (Mobin et al., 2014). Water temperature range of all collected samples was 28.5-29.0C during the month of April. According to EQS (1997) standard temperature for surface water is 20 to 30oC for sustaining aquatic life. Generally aquatic organisms are affected by pH, because most of their metabolic activities are dependent on it. It is an important indicator of water quality and sustaining life in aquatic ecosystem (Kumar et al., 2011). High pH levels are undesirable since they may impart a bitter taste to the water. The pH of all collected water samples were 7.29-7.72 with an average 7.20±0.29.(Table 1), result showed that, pH values are within the permissible limit. Similar analysis has done by Islam and Azam (2015). Fluctuations in pH values within different sampling points attributes the factors like removal of CO2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction of temperature, and decomposition of organic matter (Rajasegar, 2003).

Dissolved oxygen (DO) is one of the most vital parameters in water quality assessment and reflects the physical and biological processes prevailing in the water (Trivedi and Goel, 1984). Adequate DO is necessary for good water quality, survival of aquatic organism and decomposition of waste by microorganism. Where the rates of respiration and organic decomposition are high, the DO values usually remain lower, than where the rate of photosynthesis is high. The DO of all collected ground water samples were 4.56-5.58mg-1 with an average value of 4.88±0.40 mg-1(Table 1). The trend of DO level in investigated tap water found to be little higher, but some fluctuation observed in case of Razabazar area and Midnapore college campus. Well of Towncolony Mazumder Well (2) where values are 5.57 mg-1 and 5.58 mg1 respectively. According to Patil et al. (2012) the optimum range of DO in natural water is 4.0-6.0 mg-1. Based on the study, the measured values of DO level of all water samples were in good condition. Biochemical oxygen demand (BOD) is a measure of the oxygen in the water that is required by the aerobic organisms. High BOD levels indicates lower in DO, because the oxygen that is available in the water is being consumed by the bacteria leading to the inability of fish and other aquatic organisms to survive. The BOD of all collected water sample were within range of 0.65-1.01 mg-1 with an average value 1.02±0.32mg-1 (Table 1).The permissible limit for BOD for drinking water is 0.2 mg-1, for recreation 3mg-1 and 10 mg-1 for irrigation 10 mg-1 (ECR, 1997). In our observation BOD of Town colony Dutta Well is more or less higher (1.01

mg-1) than other wells which indicates that the water is not for domestic use. Water of other Wells also not suitable for drinking purposes.

In water, Total Dissolved Solids (TDS) are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. The range of TDS values were 0.11 - 0.78 mg-1.but slightly higher in Town colony Dutta Well. Similar works have done by Tavares et al. (2010) and Meghla et al. (2013).

Electric conductivity (EC) itself is not a human or aquatic health concern, but it can serve as an indicator of other water quality problems. High values of EC show that a large amount of ionic substances are present in water (Patil et al., 2012). The conductivity of Towncolony Sarkar Well is higher than others Wells indicates that this pond contains large amount of ionic substances.

Physico-chemical Profile (Table): 1

Ground water:

Sr. no.	Name of the source of water	PH	Temp. (°c)	EC	TDS (mg\l)	TSS (ppm)	TH (ppm)	DO (mg/l)	BOD (mg/ l)
1	Promodnagar	7.55	28	0.54	738	285	355	4.56	6.8
2	Towncolony	8.12	28.5	0.46	580	320	406	5.57	3.2
3	Midnapore college campus	7.32	28.60	0.32	854	225	230	4.54	3.5
4	Razabazar	7.11	28.5	0.46	1450	750	212	5.58	6.6

Tap water:

Sr. no.	Name of the source of water	PH	Temp. (°c)	EC	TDS (mg\l)	TSS (ppm)	TH (ppm)	DO (mg/ l)	BOD (mg/ l)
1	Promodnagar	6.66	28.5	0.42	540	335	176	6.56	3.8
2	Towncolony	7.78	29.5	0.60	430	456	212	4.12	2.5
3	Midnapore college campus	7.86	29.5	0.55	425	345	118	3.32	1.5
4	Razabazar	6.44	29.5	0.62	1092	721	115	7.5	5.8

Table 2: Bacterial count and population of phytoplankton on different areas:

Ground water:

Sr. no	Name of the wells	Total bacterial count (x 10^4 cfu/ml)	No of phytoplankton (orga./ml)
1.	Promodnagar	6.8	24
2.	Towncolony	5.8	23
3.	Midnapore college campus	6.5	25
4.	Razabazar	8.2	40

Tap water:

Sr. no	Name of the wells	Total bacterial count (x 10^4 cfu/ml)	No of phytoplankton (orga./ml)
1.	Promodnagar	3.2	00
2.	Towncolony	2.4	00
3.	Midnapore college campus	1.5	00
4.	Razabazar	4.4	00

Table 3: Most Probable Number of Coliform Bacteria in water sample of Different areas:

Ground water:

Well Sources	Water Quantity(ml)	Total Number of tubes	Number of positive Tubes	MPN Per 100 ml.
Promodnagar	10 1.0 0.1	3 3 3	3 2 1	1100
Towncolony	10 1.0 0.1	3 3 3	2 3 2	460
Midnapore college campus	10 1.0 0.1	3 3 3	3 2 2	140
Razabazar	10 1.0 0.1	3 3 3	3 3 2	2460

Tap water:

Well Sources	Water Quantity(ml)	Total Number of tubes	Number of positive Tubes	MPN Per 100 ml.
Promodnagar	10 1.0 0.1	3 3 3	3 3 0	249
Towncolony	10 1.0 0.1	3 3 3	3 1 1	150
Midnapore college campus	10 1.0 0.1	3 3 3	3 1 0	43
Razabazar	10 1.0 0.1	3 3 3	3 2 1	1100

Microbiological parameters

A detailed comparative study was made using microbiological examination on selected community Wells water and tap water in Midnapore Sadar block for the detection of various bacteria and their population .Total heterotrophic bacterial load of those ground water sample sources ranges from

5.8×104 CFU/ml (Towncolony) to 8.2×104CFU/ml (Razabazar) (Table 2). This is consistent with the study of Jun et al. (2000) who reported microbial load of aerobic heterotrophic bacteria in the Wells water which fluctuated between 0.01 and 8.7×105CFU /ml. Though microbes can serve as food source to fishes, some nutrients can also be obtained through the sediment sources; hence, high microbial load can be harmful to health. Sun and He (1997) and Jun et al. (2000) show that the different types of community swage are the sources of bacterial contamination. The population of total bacteria in tap water is less than the ground water, but the tap water of the Rajabazar area shows 4.4 x 104 cfu/ml of water, which is higher than other tap water.

Coliform counts per unit sample sources also show some levels of contamination. Over the years, the detection and isolation of pathogens from water have proved difficult and indicator organisms are used as surrogates. Coliform bacteria were initially used for formulating (Stevens's et al.2003) water quality standards due to their ease of enumeration via the Multiple-Tube Fermentation (MTF) technique until recent discovery about total coliforms originating from dissimilar sources (WHO 1997). While coliform genera like *Escherichia* and *Klebsiella* are mostly native inhabitants of the intestinal tract, others like *Enterobacte*r and *Citrobacte*r can originate from faecal, plant and soil materials (Stevens et al. 2003). In our observation, we found MPN of coliform in high ground water of Razabazar and Promod Nagar, whereas tap water shows little contamination. High levels of contamination with the presence of these indicator organisms could be alarming and could be linked to neglecting sanitation practices in municipal areas. It could also be a result of an increase in the rate of microbial infiltration, possibly due to fecal contamination (Nakade, 2013), either of animal or human origin.

Attempts have been taken to evaluate the number of phytoplankton present in the above ponds at a particular time. Generally, phytoplankton or algae are indicators of water quality and indicate the suitability of aquatic life. The ascending order of phytoplankton population: Towncolony Mazumder Well 1 (10) < Towncolony Sarkar Well (25) < Towncolony Mazumder Well 2 (27) < Towncolony Dutta Well (75). The higher concentration of plankton in community ponds indicates healthy water in terms of aquatic life (Airsang and Lakshman, 2013).

Conclusion:

The results obtained during the present study were compared with standards and it was found that some of the parameters in all these four wells were near to the limits or above desirable limits. So, it can be concluded that water of all those wells (ground water) are not potable and the tap water of few places are potable. Both the Ground water and tap water of Razabazar area are not suitable for drinking purposes.

Reference

Airsang, R.V. and Lakshman, H.C. (2013), Impact of seasonal fluctuation of phytoplankton diversity in fresh water Lake of Arekurahatti in Navalgund of Dharwad. Asian Journal of Environmental Science. 8(2):81-85.

Aneja, K.R. (2003), Experiments in Microbiology, Plant pathology and Biotechnology. New Age International, India.

APHA (American Public Health Association), (2005), Standard method for examination of water and wastewater .21st Eds. Washington DC. Pp: 15-36.

Baruah, B.K., Chaudhary, M. And Das, M. (1997), Plankton as index of water quality with reference to paper mill pollution. Poll. Research.16 (4):249-263.

EQS (Environmental Quality Standard) (1997), Bangladesh Gazette, Registered.

Department of Environment, Ministry of Environment and Forest, Govt. Of Bangladesh.

Islam, S.M.D. and Azam, D. (2015), Seasonal variation of physicochemical and toxic properties in three major rivers; Shitalakhya, Buriganga and Turag around Dhaka city, Bangladesh. Journal of Biodiversity and Environmental Science, 7(3):120-131.

Jun, X., Xiuzheng,F. And Tongbing, Y. (2000). Physico-chemical factors and bacteria in fish ponds. Naga the ICLARM quarterly.23 (4):16-20.

Johansen, D.A. (1940) Plant Microtechnique. McGraw-Hill, New York, 523.

Khondker, M and MA Kabir (1995). Phytoplankton primary production in a mesotrophic pond in sub-tropical Bangladesh. Hydrobiologia 304:39-47.

Mobin, M.N., Islam, M.S., Mia, M.Y. and Bakali, B. (2014), Analysis of Physiochemical properties of the Turag river water,Tongi.Gazipur in Bangladesh. Journal of Environmental Science and Natural Resources. 7(1):27-33.

Mondal, P., Adhikary, P., Sadhu, S., Choudhary, D., Thakur, D., Shadab, M., Mukherjee, D., Parvez, S., Pradhan, S., Kuntia, M., Manna, U., & Das, A. (2022). Assessment of the impact of the different point sources of pollutants on the river water quality and the evaluation of bioaccumulation of heavy metals into the fish ecosystem thereof. *Int. J. Exp. Res. Rev.*, 27, 32-38. https://doi.org/10.52756/ijerr.2022.v27.003

Meghla, N.T., Islam, M.S., Ali, M.A., Suravi and Sultana, N. (2013), Assesment of physiochemical properties of water from the Turag river of Dhaka city, Bangladesh. International Journal of Current Microbiology Applied science. 2(5):110-122.

Nakade D.B. (2013) Assessment of bacteriological quality of water in Kolhapur city of Maharashtra, India.Int. Res.j.Enviromental Sci. ISSSN 2319-1414 vol.2 (2), 63-65,

Patil, P.N., Sawant, D.V. and Deshmukh, R. (2012), physicochemical parameters for testing of water a review. International Journal of Environmental Science, 3(3):1194-1207.

Rajasegar,M. (2003), Physico-chemical characteristics of the Vellar estuary in relation to shrimp ferming. Journal of Environmental Biology, 24:95-101

Steven, M., Ashbolt, N. And Cunliffe, D. (2003), Recomendation to change the use of Coliforms as microbial indicators of Drinking water quality. Australia: National Health and Medical Research Council.

Sun, Y. And He, Z.Y. (1997). Shrimp pond settlement- The quantity of nutrient dispersion and seasonal changes between water and mud contacting surfaces. Mar. Fish.Res.18 (1):60-66.

Timothy O Ogunbode, Victor O Oyebamiji, Olukemi Aromolaran, Oluwatobi O Faboro and Ibukun R Ogunbode. (2023). Impact of Human Management of Hand-Dug Well Facility and Its Accessories on Groundwater Quality .Environmental Health Insights. Volume 17: 1–7.

Trivedi, R.K. and Goel, P.K. (1984), Chemical and Biological methods for water pollution studies. Environmental publication, Karad. Maharastra. India.

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