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Original Article

Comparative Assessment of Physico-Chemical Characteristics to Underground and Surface Water Khagaria, Bihar (India)

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Abstract *- The present study deals with the comparative assessment of the Physicochemical characteristics of underground and surface water (Pond) of the Khagaria District, Bihar. Different physicochemical parameters (TDS, pH, Iron, Total hardness, Alkalinity, Chloride, Calcium, Arsenic, and Magnesium) were determined during the month of March to analyze and compare the underground water and Surface water (Pond) quality. Collected samples were analyzed according to APHA (2005) for different physicochemical parameters, and the results were compared with standard values prescribed by ISI-IS: 2296 and BIS (1991). The study revealed that the Iron level was much lower in pond water compared to the underground water, which is much above the Desirable or permissible limits. The TDS of pond water is much lower than Handpump water. The total hardness of pond water was much lower than underground water. The alkalinity of pond water was found to be between 100-160 mg/l. Whereas the alkalinity of underground water ranged from 240-360 mg/l.*

Keywords *- Arsenic, Assessment, Calcium, Iron, Underground water.*

1. Introduction

Our earth contains about 1.36 x 10 cubic kilometers of water; of this, about 97% is contained in oceans and seas, about 2% is locked in glaciers and polar ice, and the rest (about 1%) is in lakes, streams, rivers, and underground recourse The sea (ocean water & salty and is not useful for human consumption. Less than 1% of water is effectively available as freshwater, Suitable for human consumption and several activities like agriculture, fishing, recreation, etc.

Ponds have been used since time immemorial as a traditional source of water supply in India (Mahobe 2013). A pond is also important for ecology as it has much significance in the environment- as it supports aquatic biodiversity, has large carbon sequestration capacity, regulates temperature and humidity (microclimate, regulation); rainwater harvesting & surface groundwater recharge other beneficial effects such as aquaculture (Kumar and Pratap 2015). Ponds are fragile ecosystems and are venerable to pollution (Bassi et al., 2014). There are various sources of contamination in these ponds (Swarnakar and Choubey 2016). However, the pond is polluted mainly due to the discharge of wastewater from nearby areas (Bhulyan and Gupta 2007). Pollution primarily affects physicochemical characteristics leading to the destruction of the community, disrupting delicate food webs, and deteriorating the lake's environment (Golder and Chattopadhyay 2016). The physicochemical properties of water contribute to decision-making for pollution control in the environment protection process (Kamal et al., 2007, Verme et al., 2012; Patel and Parikh, 2013, Uddin et al., 2016.)

Khagaria district is in Bihar and is located on the global map between 25°15’ and 25°44' North latitude and 86°17' and 86°52’ East longitude. The district occupied an area of 1486 sq Kilometers. In total, the district has around 4640 hectares of ponds at different places. Six rivers flow through it, and they are Ganga, Burhi Gandak, Kamla Balan, Baghmati, and Koshi. These rivers fed perennial ponds, while some ponds were seasonal and dry during the summer season; when the underground water level fell to pollution, eutrophication and urbanization, many ponds lost their status, and now only scares no. of ponds can be seen here.

A number of workers have done their work on physico-chemical parameters of pond water (Paul and Mukerjee 2006, Chaurasia and Pandey 2007, Kiran 2010, Mondal et al., 2011, Prasath et al., 2013, Mohobe 2013 Bharvimani and Puttaiah 2014, Mishra et al., 2014, Swarnakar and Choubey 2016, Kumari and singh 2016). A literature review suggested that a systematic study on the comparative study of water quality of underground and pond water of Khagaria has not been done. In this regard present study aimed to investigate a comparative account

of the Physico-chemical properties of water in terms of certain selected parameters. The principal objective was to investigate the fluctuation of Physicochemical parameters of pond water and underground amber of Khagaria. In this way, the present study will generate an important baseless database for the pond water over underground water, which would be helpful to evaluate the difference in water quality of both ponds and underground water.

2. Materials and Methods

2.1. Study Area

The study was carried out in the 3 ponds and handpump in three random Khagaria places.

2.1.1. Pond Water

1. Chautham Block - Purvi Borna Panchayat – Borna Village, Lat. 25.53093°E, Long. 86.718373°N
2. Chautham Block - Hardia Panchayat- Badla Ghat Railway Station, Lat. 25.550426°E, Long. 86.58928°N
3. Khagaria Block - Bachauta Panchayat – Bhiryahi Village Lat. 25.53376°E, Long. 86.455743°N

2.2.2. Handpump Water

1. Chautham Block – Dhutauli Panchayat – Malpa Village, From Sarjan Kr's home Lat. 25.533122°E, Long: 86.6151830°N
2. Khagaria Block – Bachautta Panchayat – Bhiryahi Village, From Chandan Sada's home, Lat. 25.533616°E, Long. 86.457361°N
3. Alauli Block– Amba Panchayat – Icharua Village, From Mohan Kr's Home, Lat. 25.604108°E, Long. 86.431226°N

2.2.3. Collection Procedure

A total number of 18 samples were collected for analysis from three random ponds and hand pumps located in Khagaria. Water samples were collected and stored in 1-litre and 0.5-litre capacity clean with high-density polythene bottles with poly seal caps. Before collecting samples, bottles were properly washed and rinsed with the water to be sampled. The hand pumps were pumped for a sufficient duration before collecting the underground water sample so that the stagnant water, if any, was completely removed. The pond water sample was taken from the bank of the pond.

1-litre bottle 6 samples were used for physico-chemical assessment of TDS, pH, Total hardness, Alkalinity, Chloride, Calcium, and Magnesium.

A 0.5-litre bottle of 6 samples was used for the physico-chemical assessment of only Iron and Arsenic, and sampling was thoroughly washed and rinsed with 8N HNO_3, followed- by distilled water—the 5 ml conc. HNO_3 per half a litre of the sample was added at the time of collection to minimize the adsorption of metals on the container walls and to check bacterial growth.

A small vial of 25 ml was used to ascertain the bacteriological quality of water.

Bacteriological field test kit, which works on the H_2S strip method. This method is a rapid and reliable method which is used to assess microbial water quality. For assessment, opened the kit cap and filled the water sample of both 3 ponds and 3 handpumps up to the fill line (20 ml). Replaced the cap and shook gently. Placed the bottle on a flat surface at room temperature for 24-48 hours and observed the results. If the water sample changes colour, turning black, it is contaminated.

3. Methodology

There were 6 sampling spots selected through random sampling in the Khagaria district, including pond water from Hardia, Borna and Bhiryahi. Handpump water from Dhutauli (Sarjan Kr's home), Bachauta (Chandan Sada's home) and Amba Icharua (Mohan Kr's home). The water sample was collected in the month of March, which can be called the pre-monsoon period when groundwater contained heavy metals in higher concentration compared to the post-monsoon period.

The collected samples were submitted to PHED (Public Health Engineering Department) Khagaria, Government of Bihar, for estimation of the physico-chemical test of groundwater.

4. Results and Discussion

4.1. Total Alkalinity

Alkalinity expresses the water's buffering capacity, which appreciably maintains the pH by absorbing access H+ ions and protecting the water body from pH fluctuation. The main factors for alkalinity are carbonates, bicarbonates, hydroxide ions, ammonia, organic acid, etc. Alkalinity acts as a buffer against rapid pH change (Lodh et al., 2014; Paul et al., 2010, 2014). Alkalinity is recorded within the prescribed range given by WHO, i.e. 200-600 mg/l, whereas the mean value of pond water is 160 mg/l, whereas the mean value of handpump water was 313.33 mg/l. Mondal et al., 2011 also observed a similar result for pond water. Alkalinity showed a significant, positive correlation with hardness.

4.2. Chloride

Chloride occurs naturally in all types of water. In natural freshwater, however, its concentration of chloride increases the corrosive property of water. The chloride content of studied water samples was within the permissible limit prescribed by BIS as the maximum value of chloride in Hand Pump water was 60 mg/l, and that of pond water was 40 mg/l. Similar results were also observed by Verma et al., 2010. Qureshimativa et al., 2015; Paul DK and Sumona Sanyal et al., 2017. The observed value of chloride is within the desirable value, i.e. 250 mg/l as per BIS standards (IS 10500:1991)

4.3. Total Dissolved Solids (TDS)

Solids refer to the suspended and dissolved matter in water (Qureshimatva et al., 2018). It is a very useful parameter describing the chemical constituents of the water and can be considered as edaphically relation that

contributes to productivity within the body (Goher 2002). The mean TDS of handpump is 340 mg/l. Whereas the Mean TDS of pond water is 169.66 mg/l. Both pond water and underground water were under desirable limit Type and quality of TDS define the color and electrical conductivity of the water body (Tank and Chippa 2013).

4.4. Total Hardness (TH)

Total hardness is caused due to the presence of cations etc. This like Ca++, Mg++, Fe++ etc. This is the property of water to precipitate soap by forming the complex with calcium and magnesium present in water. TH of the studied pond and the handpump was found within the prescribed limit, and the Mean value recorded was 313.33 mg/l of handpump, whereas the Mean TH of pond water was found to be 160 mg/l. Patil and Tijara 2001, have observed similar results in pond water.

4.5. pH

One important factor that serves as an index for pollution is pH (Moundiotiya et al.' 2004). PH is the indicator of the acidic or alkaline condition of water status. The standard for any purpose in terms of pH is 6.5-8.5. A 95% confidence limit for pH was found to be 7.78 to 8.26. It shows the alkaline nature of water. Waxi and Subla (1990) reported that the pH value was above 8 in natural water. The pH of the studied pond water and hand pump water was found to be within the prescribed limit of 7.10 - 7.84.

4.6. Calcium (Ca)

Calcium is important for the proper development of bones and teeth of human beings. The hand pump water contains calcium in different ranges from 64 -168 mg/l, whereas pond water contains calcium in the range of water 30-40 mg/l. The calcium level in both the water was sample found within the permissible limit.

4.7. Magnesium (Mg)

High Mg level in drinking water reduces the risk of death from Ischemic Heart disease, especially in men (Ragna Rylander, MD et al., 1991). Magnesium is important for many processes in the body, including regulating muscle and nerve function, blood sugar levels, blood pressure, making protein, bone and DNA. The magnesium level of both pond and handpumps water was found within the permissible limit of 30 to 100 mg/l. The pond water was found within the range of 16 to 17.28 mg/l, while the hand pump water was found within the range of 21-60 mg/l.

4.8. Arsenic (As)

Arsenic is the most toxic heavy metal found in water. Arsenic at high concentrations coagulates protein, possibly attacking the Sulphur bonds and maintaining the secondary and tertiary structures of proteins.

The three major biochemical actions of Arsenic are coagulation of proteins, complexation with Coenzymes, and uncoupling of phosphorylation. Acute Arsenic poisoning arises from ingesting as little as 0.01 mg/l of As. Chronic effects can appear from its accumulation in the body at low intake levels for prolonged periods. Arsenic occurs in water as a result of industrial mineral dissolution, discharges, or the application of insecticides. The arsenic level of both pond and hand pump water was found within a desirable limit of 0.01 mg/l. Pond water contained Arsenic levels from the range of 0.002 to 0.004 mg/l. At the same time, hand pump water contained Arsenic levels in the range of 0.001 to 0.003 mg/l.

Table 1. Physico-Chemical Test Report

Sl. No.	Block Name	Village	Location Details	Parameter in mg/l								
				TDS	pH	Iron	Total Hardness	Alkal inity	Chloride	Ca	Mg	Ar
Desirable Limit				500	6.5	1.00	200	200	250	75	30	0.01
Permissible limit in the absence of alternate source				2000	8.5	NR	600	600	1000	200	100	NR
1	Alauli	Amba Icharua	Handpump Water	380	7.72	1.40	340	300	60	160	57.6	0.001
2	Chautham	Malpa	Handpump Water	340	7.54	1.80	320	300	60	168	60	0.003
3	Khagaria	Bhiryahi	Handpump Water	300	7.32	1.42	280	260	40	64	21	0.001
4	Khagaria	Bhiryahi	Pond water	143	7.20	0.82	120	100	40	48	16.8	0.004
5	Chautham	Hardia	Pond water	148	7.10	0.57	180	140	40	48	17.28	0.002
6	Chautham	Borna	Pond water	218	6.82	0.75	180	160	30	48	16	0.002

4.9. Iron (Fe)

Iron is a mineral that the body needs for growth and development. Our body uses iron to make Hemoglobin, a protein in red blood cells that carries oxygen from the lungs to all body parts (National Institutes of Health Office of Dietary Supplements). Surface water generally contains less than 1 ppm of Fe. Some groundwaters and acid surface drainage may water contain much higher levels of Fe, more than 2 ppm contain much cand es staining of clothes (while washing), and porcelain imparts a bitter, astringent taste. The permissible limit for filterable Fe in drinking water is 0.3ppm, or Hand pump water contains a permissible limit from above the range of 1.40 to 1.80 mg/l. While pond water permissible contains limited iron in the 0.57 to 0.82 mg/l below. range of

Iron is a mineral that the body needs for growth and development. Our body uses iron to make Hemoglobin, a protein in red blood cells that carries oxygen from the lungs to all body parts (National Institutes of Health Office of Dietary Supplements). Surface water generally contains less than 1 ppm of Fe. Some groundwaters and acid surface water drainage contain much higher levels of Fe. Water containing more than 2 ppm Fe causes staining of clothes (while washing) and porcelain and imparts a bitter, astringent taste. The permissible limit for filterable Fe in drinking water is 0.3 ppm or 1.00 mg/l. Hand pump water contains Iron much above the permissible limit in the range of 1.40 to 1.80 mg/l. While pond water permissible limit contains Iron below the permissible limit in the range of 0.57 to 0.82 mg/l

5. Conclusion

The present study provides a comparative account of physico-chemical parameters; along with it, the study provides baseline data for the conservation and monitoring of ponds in Khagaria. From the above discussion, it was observed that physico-chemical parameters such as TDS, pH, Total Hardness, Alkalinity, Chloride, Calcium, Magnesium and Arsenic, Iron content in the pond are found within the permissible limit, while handpump water contained iron above the permissible limit. Handpump water did not contain Bacterial residue, while pond water contained Bacteria. No. of Bacteria was more near the bank of the pond, which was not in use high iron in water content leads to an overload, which can cause diabetes hemochromatosis, stomach problems, and nausea. It can also damage the liver, pancreas, and heart. Excess quantities in water can harm skin cells, leading to infection and wrinkles. Moreover, such water does not rise off the body's soap residue, causing clogged skin pores and build-up of oil in the skin, resulting in many skin problems such as eczema or acne (Peninsula water conditioning Delmarva's problem water expert).

The study revealed that pond water and hand pump water is unfit for human consumption; if not filtered properly, pond water contains Bacteria and hand pump contains iron. Both pond water and handpump water can be used for aquaculture, irrigation and recreational purpose.

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