Assessment of Physico-chemical and Microbiological properties of some pond water within Midnapore sadar block of West Bengal

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Abstract: *Water is a multi-use resource and is one of the most important and abundant compounds of the ecosystem. Pond (locally called Talab/ Pukur) water is very essential constituent for living being. It maintains water table, temperature, drinking purpose, domestic and irrigation demand for the city. The present water testing aim is for evaluating the water quality of various ponds in Midnapore sadar block of Paschim Medinipur, West Bengal. Testing and analysis of pond water samples were analyzed for various physic-chemical and microbiological characteristics such as pH, temperature, total dissolved solid, dissolved oxygen, Biological Oxygen Demand (BOD), total bacteria, total coliform and total phytoplankton. Bacteria from collected pond samples were quantified by dilution plate technique and 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. All these water bodies are not suitable for domestic and drinking purposes. Out of the six ponds two ponds like Hans pukur and Laldighi were more polluted. Therefore proper treatment is necessary for domestic use of those ponds.*

Key Words: *coliform bacteria, pond water, water pollution.*

1. INTRODUCTION:

Water is one of the most essential constituents of the environments. It is the vital source of a kind of life on earth. 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 6ost responsible for maintaining ground water level and fresh water resources in the planet. A pond is referred to as a man-made or natural water body which is between 1 m² and 2 ha (~5 acres or 20,000 m²) in area, which holds water for four months of the year or more (Biggs et al., 2005). Since, ponds are favourable habitats for a variety of flora-fauna and anthropogenic society, so its regular monitoring is necessary for control. But now a day, due to over exploitation of surface water, improper waste disposal and erratic nature of rainy season, there has been depletion of surface water quality level across the world. The utility of water is limited by its quality, which may make it unsuitable for a particular purpose. Therefore, assessment of surface water quality is an important aspect of water evaluation and the standard of living of the people (Bonde, G. J. 1977). Further the quality problems of drinking water both due to geologic factors leading to chemical contamination like excess fluoride, arsenic, iron, salinity, nitrate, etc. and anthropogenic factors resulting in bacteriological contamination, pose serious public health problems surrounding to the area of pond water systems.
Assessment begins with an examination of the water's chemical, physical and biological condition, and the causality of the conditions observed. In city area most of the people are using municipality water for the drinking purpose but some people are dependent on large ponds or lake (Banejee, D. and Mandal, S. 2009). If the stagnant water systems like ponds are contaminated or become polluted than the surrounding area's ground water systems might be affected of such pollution which can be harmful to the people of those locality. 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.

All living organisms on the earth need water for their survival and growth (Kumar et al., 2010). Pond water sources are useful for diversified purposes including aquaculture and other related uses at the domestic level. Ponds are naturally formed by a depression in the ground filling and retaining water. Streams or spring water is usually fed into these bodies. Water is very essential in fish pond, water plays a vital role in the proper functioning of earth ecosystem and also essential for fish and living creatures for metabolism. The temperature of water supplied to a fish pond ranges from 25°C to 35°C as this supports the growth of the microorganisms

and fishes found in the pond. Some bacteria coliform groups like *E. coli,* in the ponds are transported from these sources of water or the media of transportation into the ponds.

There are several microorganisms found in ponds including bacteria, fungi, algae, protozoa, nematodes and viruses. Bacteria has a unique characteristics, they are ubiquitous in every habitation on earth, growing in soil, acidic hot springs, radioactive wastes, water and the live bodies of plants and animals . Thus, bacteria are important microorganisms in ponds, whereby, some are beneficial, others are not. Beneficial ponds bacteria are natural and safe for fish, pets and people. Beneficial bacteria are microorganisms that occur naturally in water gardens, streams, ponds, etc. They are responsible for maintaining crystal clear healthy water, breaking down organic waste, and breaking down ammonia from fish waste, reducing nitrite and nitrate, reducing nutrient load in ponds and balancing the ecosystem. Non-beneficial bacteria cause offensive odour to ponds and also diseases in fishes as well as the human beings who used this water. The distribution of heterotrophic bacteria and total aquatic bacteria vary with the water layers.

The number of bacteria is higher of the silt layer because the sediment contains organic matter such as food and fish manure. There are various factors affecting the distribution of bacteria in pond which includes predatory protozoa present in water. An increase in food supply also usually results in an increase in bacterial number. On the other hand, certain toxic substances such as acids and bases produced a marked reduction in the number of viable organisms.

In limnological studies, to determine of water quality and to identify of algae that composed of primer productivity and to obtain this continuity are well important. Primary productivity is the rate, at which the sun's radiant energy is stored by photosynthetic and chemosynthetic activities of producers in the form of organic substances (Odum, 1971). Phytoplankton are main primary producer in surface waters, so they circumstance are structure and density of consumers and also the physicochemical characteristics of water. The abundance and taxonomic diversity of plankton depend upon the supply of nutrient in natural waters, where abundance increases with increasing nutrient concentrations. The temperature, pH, dissolved oxygen, alkalinity etc. are also important factors for phytoplankton production.

The role of water in nature is unique not only from the point of human consideration; even numerous organisms make aquatic medium their habitat. The quality of aquatic life depends on the water quality. In order to utilize fresh water bodies successfully for fish production, it is very important to study the physicochemical factors which influence the biological productivity of the water body. Physical parameters of water quality such as turbidity, conductivity and water mass etc. influence the chemical nature (Gupte and Shaikh, 2013) of the water which regulated by various factors i.e., climatic, geochemical, geomorphologic condition and pollutants. But, it is difficult to understand the biological phenomenon fully, because the chemistry of water influences the metabolism of the ecosystem and explain the general hydro-biological relationship (Simpi et al., 2011). Recently, a lot of work has been done on changing ecological behaviour of ponds Fresh water ecosystem is exploited every possible way and one of it is fish production, which is directly dependent on the productivity of the aquatic ecosystem. To maintain the sound environment and healthy ecosystem of an aquatic body, proper management and monitoring and implementation of existing laws and regulations is necessary.

Water is one of the most important of all natural resources known on earth. It is important to all living organisms, ecological systems, human health, food production and economic development. The safety of drinking water is important for the health. The safety of drinking water is affected by various contaminants (Bhuiyan JR, 2007) which included chemical and microbiological. Such contaminants cause serious health problems. Due to these contaminants quality of drinking water becomes poor. Sometimes such poor quality water causes many diseases in the humans, so that quality of water must be tested for both the chemical as well as for the microbial contaminants.

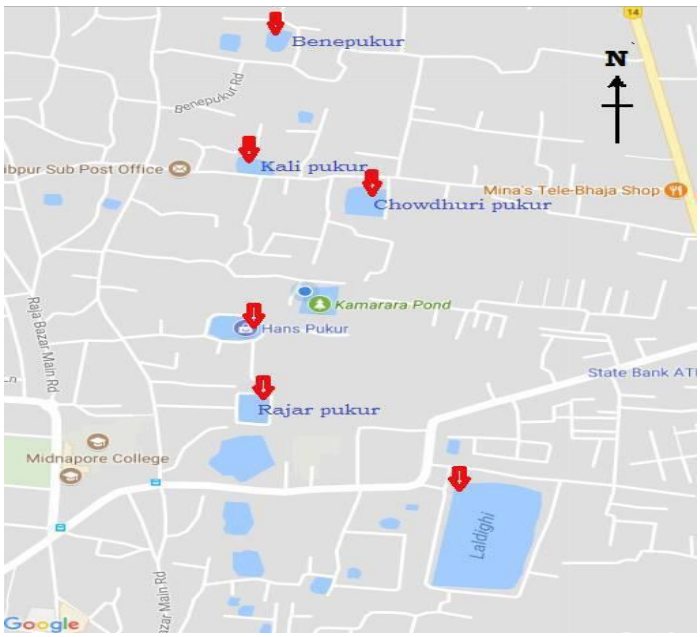
To maintain the sound environment and healthy ecosystem of an aquatic body, proper management and monitoring and implementation of existing laws and regulations is necessary. The present studies has been carried out to asses and evaluate the physical, chemical and bio- chemical characteristics of all six selected water ecosystems.

2. Material and Method:

2.1. Study Area:

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. 350Water 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 an 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. The study ponds were 1.Benepukur, 2.Kalipukur 3.Hanspukur 4.Rajarpukur 5.Laldighi, 6.Chowdhuripukur.



2.2. Sampling, Preservation and Methods of analysis:

Total 6 water samples from each pond were collected. The samples were collected during the month of January and February and March in 2017. 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) for examination of water and wastewater. Parameters like pH, turbidity, and temperature were checked 15 to 17random points of the each site and considered the average for each site while rests of the parameters were checked in laboratory and methods for analyzing these parameters are shown in table below. Some standard preservative media was used to preserve the samples till it use for analysis in laboratory.

2.3. 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 tech.
12	Total coliform bacteria counts	MPN method through MTF
13	No of phytoplanktons	Microscopic

2.4. Total Bacteria:

For bacterial analysis of water and sediments, water sample was collected in autoclaved glass bottles and sediment sample was collected in petriplate with the help of 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.

2.5. Total coliformBacteria:

Conventional MTF technique was used to determine the most probable number (MPN) of coliform bacteria present in those pond 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 theremaining 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. Presumptive test is positive for coliforms if acid and gas are produced in durham tubes.

Confirmed Test: To eliminate false-positives from non-coliform organisms, eosin methylene blue (EMB) agar plates were inoculated with a loopful 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).

2.6. Quantification of plankton:

For biological analyses collection, preservation and qualitative assessment of phytoplankton were done by following Khondker et al. (1988) 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 and F = No. of fields counted.

3. RESULT AND DISCUSSION:

3.1. Physicochemical parameters:

The colours of the investigated ponds water were observed visually. The observed colour was in majority of ponds bluish but light green in Hanspukur pond and bluish-green in Laldighi pond water. 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, red and brown is good for fishes. Higher plankton concentrations sometime are responsible for blooming, which results less oxygen in water. 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). Temperature of the investigated ponds water found to be more or less similar at different ponds (Table- 1). Water temperature range of all collected samples was 28.5-29.^{0}C during the month of February. 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).

PHYSICOCHEMICAL PROFILE: (Table-1)

Sr no	Name of the ponds	pH	Temperature (°c)	EC	TDS (3mg-1)	TSS (ppm.)	TH (ppm)	DO (mg-1)	BOD (mg-1)
1	Benepukur	7.49	28.50	220	0.11	250	398	6.32	0.65
2	Kali pukur	7.64	28.60	225	0.63	235	375	6.82	0.68
3	Hans pukur	7.35	29.00	220	0.68	272	366	5.58	1.01
4	Rajarpukur	7.68	28.60	210	0.61	120	385	6.75	0.72
5	Laldighi	7.29	28.80	228	0.67	232	370	6.57	0.87
6	Chowdhurypukur	7.72	28.50	225	0.62	228	375	6.67	0.70

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 water samples were 5.57-6.85mg-1 with an average value of 6.44±0.40 mg-1(Table 1). The trend of DO level in investigated ponds found to be almost similar, but some fluctuation observed in case of Hans pukur and LalDighi where values are 5.57 mg-1 and 5.58 mg-1 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. Similar works have done by (Mishra et al., 2009).

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 (Pathak and Limaye, 2011). 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, for fish culture 6 mg/l and 10 mg-1 for irrigation 10 mg-1 (ECR, 1997). In our observation BOD of Hans pukur is more or less higher (1.01 mg-1) than other ponds which indicates that the water is not for domestic use. Water of other ponds 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 (Mahananda, 2010). The range of TDS values were 0.11 - 0.78 mg-1.but slightly higher in Hans pukur. 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 (Kabir et al., 2002). The conductivity of Laldighi pond is higher than others pond indicates that this pond contains large amount of ionic substances.

3.2. Biological parameters –

A detailed comparative study was made using microbiological examination on selected community pond water in Midnapore sadar block for the detection of various bacteria and their population that could be found in these different ponds.Total heterotrophic bacterialload of those pond sample sources ranges from 4.93×10-4 CFU/ml (Rajarpukur) to 6.13×10^{4}CFU/ml (Hans pukur)(Table 2). This is consistent with the study of Jun et al.(2000) who reported microbial load of aerobic heterotrophic bacteria in the pond water which fluctuated between 0.01 and 8.7×10^{5}CFU /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 harmfulto 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 ascending order of bacterial contamination are Rajarpukur(4.93) <Chowdhurypukur(5.08) <Kalipukur(5.10) <Laldighi(5.56) <Benepukur(5.60) <Hans pukur(6.13).

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 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 *Enterobacter* and *Citrobacter* can originate from faecal, plant and soil materials (Stevens et al. 2003). In our observation we found MPN of coliform is high in Hans pukur and Laldighi where as Benepukur shows least amount of coliform bacteria. High level of contamination with the presence of these indicator organisms could be alarming and could be linked to neglecting sanitation practices in municipal area. It could also be as a result of increase in the rate of microbial infiltration possibly due to faecal contamination (Gogoi and Sharma. 2013) either of animal or human origin.

Ponds	Water Quantity (ml)	Total Number of Tubes	Number of positive tubes	MPN per 100 ml.
Benepukur	10 1.0 0.1	3 3 3	3 2 2	240
Kalipukur	10 1.0 0.1	3 3 3	3 2 1	460
Hans pukur	10 1.0 0.1	3 3 3	3 3 3	2400
Rajarpukur	10 1.0 0.1	3 3 3	3 3 2	1100

Laldighi	10 1.0 0.1	3 3 3	3 3 3	2400
Chowdhurypukur	10 1.0 0.1	3 3 3	3 3 2	1100

Table 2. Most Probable Number of coliform bacteria in water sample of Different ponds:

Sr no	Name of ponds	Total bacterial count (x 10^4 cfu/mL)	No of phytoplankton (orga/ml)
1	Benepukur	5.60	10
2	Kalipukur	5.10	25
3	Hans pukur	6.13	75
4	Rajarpukur	4,93	27
5	Laldighi	5.56	58
6	Chowdhurypukur	5.08	22

Table 3.Bacterial count and population of phytoplankton on different pond water:-

Attempt has been taken to evaluate the number of phytoplankton present on the above ponds on a particular time. Generally, phytoplankton or algae are indicator of water quality and indicate the suitability of aquatic lives. The ascending order of phytoplankton population: Benepukur (10) < Rajarpukur (27) < Chowdhurypukur (22) <Kalipukur(25) <Laldighi(58) <Hans pukur(75). The higher concentration of plankton in community pond indicates healthy ponds in terms of aquatic life (Airsang and Lakshman, 2013).

4. CONCLUSION:

The results obtained during the present study were compared with standards and it was found that some of the parameters in all these six ponds were near to the limits or above desirable limits. So, It can be concluded that water of all those ponds are not potable and the water quality of ponds Hans pukur and Laldighi are more polluted and are not useable for domestic purposes, bathing and recreational activities.

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