WATER QUALITY AND POLLUTION STATUS OF LAHARPUR RESERVOIR WITH SPECIAL REFERENCE TO BACTERIAL CONTAMINATION

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ABSTRACT

Laharpur dam was constructed in the southwest of Bhopal city, M.P., India with an objective to store water for irrigational purpose. At the time of planning and construction of the reservoir it was in the outskirts of township but now, with the expansion of the city the reservoir has come well within the settlement. The developmental activities and occupancy in the area is exerting pressure on the water body. Surface water in urban water bodies almost always contains some degree of contamination. This is due to exposure to animals, humans, aquatic life, etc. In addition to this, variety of other human activities resulted in increasing the bacterial concentration of reservoir. Many of these bacteria are pathogenic and spread diseases like typhoid, paratyphoid, gastroenteritis etc. Inflow of sewage in the surface water may play an important role in the transmission of pathogenic agents discharged through feces. Some

pathogenic bacteria like *Actinomyces sp., Aerobacter aerogenes, A. cloacae, Micrococcus sp., Salmonella sp., Staphylococcus aureus, Bacillussp, and Shigella species* indicate the higher level of fecal contamination of water. This untreated water poses a serious threat to the health of consumers and therefore, calls for urgent intervention by government.

Key Words: Coliform bacteria, Drainage basin, Sewage, Fecal contamination, Indicator bacteria.

INTRODUCTION

The Laharpur Reservoir was in the outskirts of Bhopal town, Madhya-Pradesh, India, but expansion of the township reached beyond the reservoir and now it is well within the settlement. It is receiving water from following major inlets.

1. Anna Nagar sewage fed drain
2. Shahpura sewage fed drain
3. Barkhera Pathani Nalla
4. Barkhera Nalla

These inlets carry untreated sewage and waste water from the southwest part of Bhopal Town. It is directly or indirectly affected with the urban wastes and often subjected to bacterial contamination[7].

Bacterial contamination is usually measured by the fecal coliform level in the water. Coliform bacteria are indicator organisms which are used in microbiological analysis. They are a group of bacteria which are readily found in soil, decaying vegetation, animal feces and raw surface water. Coliforms rather than actual pathogens are used to assess water quality because their

detection is more reliable. Water found to contain colliform is considered biologically contaminated.

Fecal Coliforms[2]

Fecal coliforms are facultative anaerobic, rod shaped, gram-negative, non-sporulating bacteria. They are capable of growing in the presence of bile-salts or similar surface. They produce acid and gas from lactose within 48 hours at 44 ± 0.5^{0}C and can grow with or without oxygen.

The coliform bacteria group consists of several genera of bacteria belonging to the family *Enterobacteriaceae*. Fecal coliform bacteria, which belong to this group, are present in large number in the feces and intestinal tracts of humans and other warm blooded animals and can enter water bodies through these humans and animals wastes. Fecal coliforms by them are usually non-pathogenic but they are indicator organisms, which mean that they indicate the presence of other pathogenic bacteria.

Bacteria are usually single celled organisms that can be seen only with the aid of very powerful microscope. However, coliform bacteria form colonies as they multiply themselves, which may grow large enough to be seen. By growing and counting the colonies of coliform bacteria from a water sample, it is possible to determine approximately the number of bacteria originally present. Fecal coliform is a type of fecal bacteria. Another type of fecal bacteria is Fecal Streptococcus. Strains of Escherichia Coli are also a type of fecal bacteria.

Fecal coliform like other bacteria can usually be killed by boiling water or by treating it with Chlorine. Washing thoroughly with soap water after contact with contaminated water can also help in preventing infections.

MATERIAL AND METHODS

The tests of water sample for pathogens being difficult, expensive and even hazardous, the researchers use indicator organisms to assess the possibility of fecal contamination.

The species such as *Escherichia – Coli*, *Citrobacter*, *Enterobacter* are often used as indicators[9]. Total coliform bacteria counts are sometimes used to test for water contamination also.

During present investigation, fecal coliform testing was performed by the method using Colisan Easy gel Agar[8, 10].

Colisan Easy gel Agar[6] (media)

It is a type of commercially available bacterial growth media that contains color producing chemicals and nutrients which results in the growth of coliform bacteria in different colors.

The Colisan media contains two color producing substrates that are acted upon by the presence of enzyme galactosidase and glucoronidase to produce pigments of different colors. The colors produced are as follows-

1. **Pink color**: Generally, colisan will produce the enzyme galactosidase (by fermenting lactose) and the colonies that grow in the medium will be pink in color. The pink color colonies will indicate the total number of general coliforms per sample.

2. **Purple color**: Fecal Coliform especially E. coli produce both galactosidase and glucoronidase and will grow as purple or purple –blue colonies in the medium. A count of number of purple colonies will indicate the total number of fecal coliforms per sample.

3. **Colorless:** Any non colored colonies that grow in the medium are not coliforms but may be other members of this family.

The combined general coliforms and fecal coliforms represent the total coliform numbers present in the sample.

Procedure[8, 10]

In the labeled petri-dishes (1, 2, 3 and 4) the Colisan Easygel was added to the 3ml of the water sample taken from the 4 different stations of Laharpur Reservoir. These 4 different stations are-

1. Anna Nagar sewage fed drain
2. Shahpura sewage fed drain
3. Barkhera Pathani Nalla
4. Barkhera Nalla

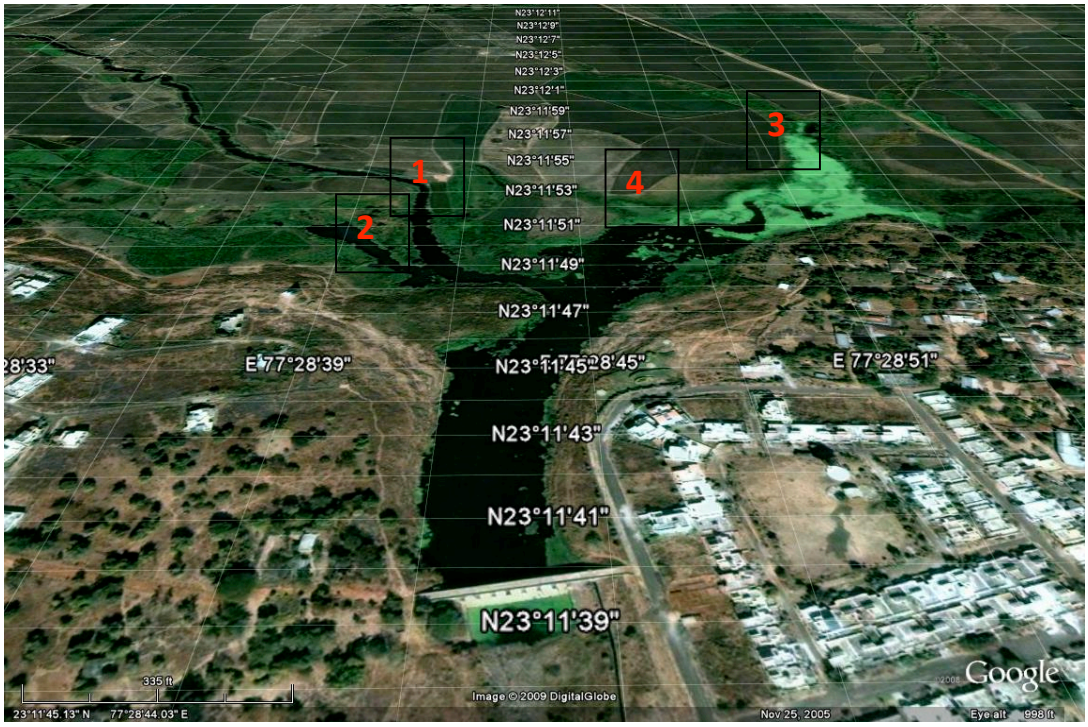

Fig.1: Satellite image of Laharpur Reservoir showing all the 4 sampling stations.

Then these labeled Petri-dishes were allowed to solidify for about 40 minutes and then incubated at 37^0C for 15 minutes.

After, 24- 48 hours the colonies of cultured bacteria were counted. The resulting colonies indicate the total number of bacteria present in the water sample. The results obtained are shown in Table 1. This test was conducted along with the blank test. In blank test the sterile water was used, which shows the negative tests.

With the tests for bacterial contamination in water sample, the other parameters like pH, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Turbidity and Alkalinity were also analyzed. The pH and DO of the water sample were monitored by using portable pH meter and DO meter respectively. Beside this, the BOD, COD, turbidity and alkalinity were analyzed by the general methods[1] **(Table 2).**

RESULTS AND DISCUSSION

Laharpur Reservoir is receiving untreated sewage through number of inlets **(Fig-1).** The surface water drainage system carrying untreated sewage and its resulted accumulation in the reservoir provides sufficient retention for charging the ground water[3]. The average sewage inflow in the reservoir at present is 25mgd, which may increase up to 65 mgd in the forth coming years[7].

Along with the bacterial analysis physico-chemical analysis was carried out on samples collected from different stations during different seasons. The study indicates that temperature during the period of investigation varied from 25-30^0C whereas, the pH values did not show remarkable differences between different stations. Highest concentration of Dissolved Oxygen

was observed at the station: 1, which is subjected to minimum discharge of effluent while the lowest value of Dissolved Oxygen was recorded at station 4 where maximum discharge of sewage effluents was observed. Contrary to this, BOD was found maximum at station 4 and minimum value was recorded at Station- 1[7] **(Table 1).**

Table 1: Different parameters from different stations of Laharpur Reservoir, Bhopal, India.

Parameters	Station: 1	Station: 2	Station:3	Station: 4
Temperature	25^{o}C	27^{o}C	28.5^{o}C	30^{o}C
pH	7.01	7.12	6.94	6.52
DO (mg/L)	10.5	9.6	8.9	8.0
BOD (mg/L)	94	96	102	108
COD (mg/L)	284	298	312	320
Nitrate (mg/L)	1.28	1.64	3.38	4.20
Phosphate (Mg/L)	3.64	4.79	3.82	3.32
TC (mg/ml)	180 x 10^3	190 x 10^3	180 x 10^5	200 x 10^5
FC (mg/100ml)	130 x 10^3	140 x 10^3	160 x 10^5	170 x 10^5

High amounts of sediments are often related to high concentration of pathogenic bacteria. The growth rate fastens at higher temperature whereas it slows down drastically at very low temperature[3, 4]. The growth rate of bacteria was also found increased at higher levels of nutrients.

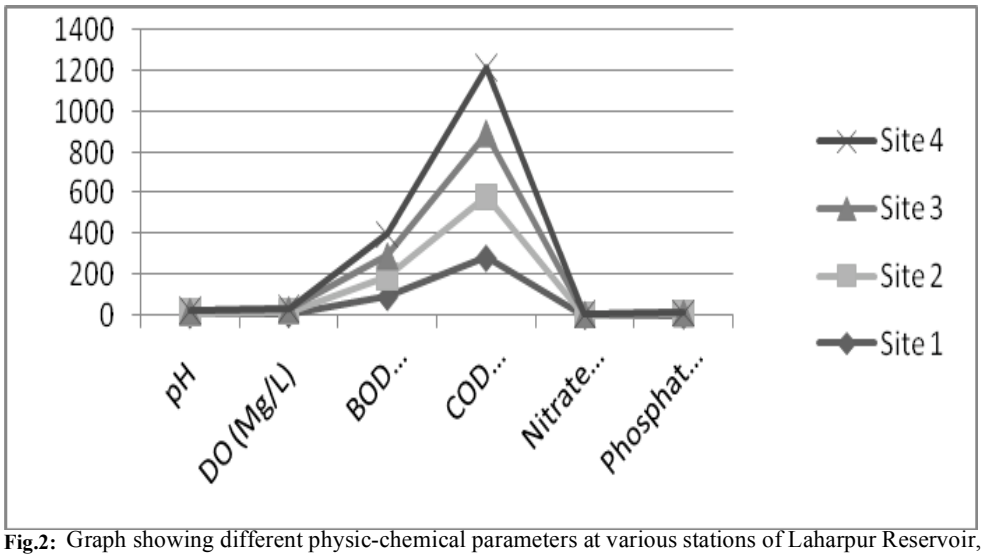

Fig.2: Graph showing different physic-chemical parameters at various stations of Laharpur Reservoir, Bhopal, India.

Bacterial concentration at different stations of Laharpur Reservoir is shown in **Table 2.** Total bacterial count is a reliable indicator as the number of bacteria present in the water sample depends upon the degree of contamination. Coliform bacteria are a reliable indicator of organic pollution as they are unable to survive in clean water beyond a limited time. Another reason is that other bacteria like E coli (EC) are unable to multiply outside the body of human and other warm blooded animals. *Clostridium perfringens* (CP) is also another bacterial species which survive in water for a longer period than other bacteria[5].

Table 2: Variation in different bacterial parameters at different stations of Laharpur Reservoir, Bhopal, India

A - Surface water B- Bottom water	TBD-Total Bacterial density	TC Total coliform	FC Fecal coliform	EC Escherichia-Coli	CP Clostridium perfringens
Station- 1					
A	17.62	1456	1653	1663	14999
B	18.10	1544	1623	1670	15640
Station-2					
A	14.5	1642	469	864	4200
B	16.62	1630	586	958	2986
Station- 3					
A	10.50	798	866	459	3896
B	9.06	543	630	545	4900
Station- 4					
A	8.59	12604	1028	1041	14321
B	9.60	11963	982	945	15800

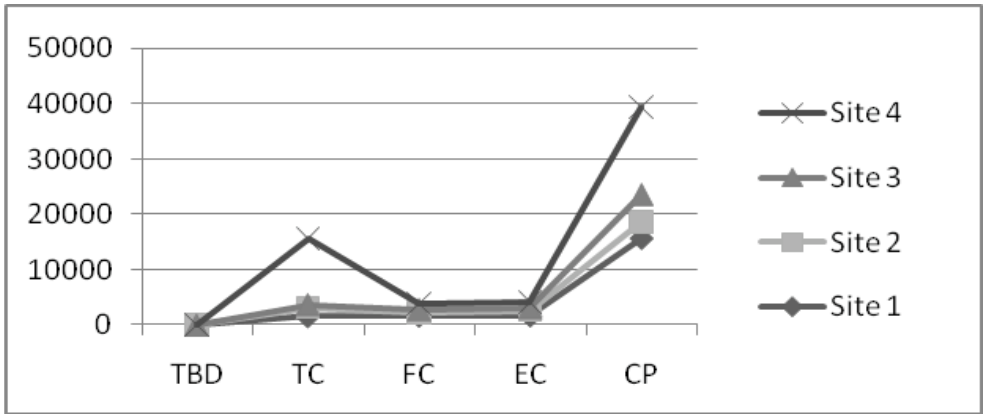

Fig.3: Graph showing different bacterial parameters at different stations of Laharpur Reservoir, Bhopal, India.

In general, maximum bacterial species are found in rainy season because the increased organic matter usually enhances the bacterial growth and multiplication[7]. Presence of E.-Coli was similar in every month. The fecal coliform counts were found high[7]. It indicates that there is a greater chance of presence of pathogenic organisms.

A person swimming in such water has a greater chance of getting sick from swallowing these diseases causing organisms; or from pathogens entering the body from cuts in the skin. Diseases and illness such as typhoid, fever, hepatitis and gastroenteritis, dysentery can be spread by this bacterial contamination[4].

Fecal coliform like other bacteria can usually be killed by boiling water or by treating it with chlorine. Washing thoroughly with soap water after contact with contaminated water can also help in preventing infections.

CONCLUSION

As per the water quality analysis report, the present water quality of Laharpur Reservoir does not qualify BIS (Bureau of Indian Standard). The present water quality of this reservoir is below the Category of "D" and it will be difficult to upgrade and maintain its quality to "A" Category[7].

The water quality of surface of Laharpur Reservoir at some places is slightly acidic in nature while the bottom recorded high values of BOD and COD. Presence of higher values of phosphate in almost all the sampling points shows that the water is highly enriched with nutrients and is prone to bacterial contamination. The higher concentration of nitrate and phosphate in the water of reservoir contaminates the ground water also. The inflow channels

carrying waste and sewage water are mainly charging the ground water that may be controlled before the entry to the reservoir.

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