

# Physico-chemical and Microbial Quality Assessment of Khadan lake, Ambernath, Thane District

Kimaya chaudhari<sup>1</sup>, Shrutika Musale<sup>1</sup>, Ruchika Bhoge<sup>1</sup>, Sakshi Bhalerao<sup>1</sup>, Prajakta Chikane<sup>1</sup>, Kirubha Pauldas<sup>2</sup>, Shweta Humbarwadi<sup>2</sup>

<sup>1</sup>UG students, Departement of Microbiology, S.I.C.E.S. Degree college of Arts, Science & Commerce, Ambernath, Thane Dist.

<sup>2</sup>Assistant Professor, Department of Microbiology, S.I.C.E.S. Degree college of Arts, Science & Commerce, Ambernath, Thane Dist.

## Abstract:

Water and life go hand to hand. Water pollution is a major global problem. It is the contamination of water bodies, usually by different human activities. Water bodies include lakes, rivers, oceans, and groundwater. Microbial pathogens are one of the major health risks associated with water. This can lead to public health problems for people living downstream. Animal washing, car washing, clothes washing are the factors contribute to lake pollution. Domestic sewage, industrialization, population growth, pesticide and fertilizers, urbanization and weak management system are the major sources of water pollution. There is greater association between pollution and health problem causing pathogens.

The aim of the present study was to assess the Physico-chemical and microbiological quality of water in Khadan lake. Water samples were collected and analyzed by qualitatively and quantitatively. The Physico-chemical properties like Temperature, Colour, Dissolved oxygen, BOD, pH, Turbidity, Total suspended solids and Total dissolved solids were studied to evaluate the quality of water. Microbiological study includes total microflora, coliform count and study of aerobic and anaerobic flora of lake. Physico-chemical and microbiological study shows high level of pollution and microbial contamination which may leads to high incidences of waterborne diseases in nearby community.

However, improving the quality of water should include spreading awareness to the public regarding proper waste disposal system and the importance of cleaning their surrounding area.

**Key words:** water pollution, Physico-chemical study, microbiological study, public awareness

## INTRODUCTION:

The earth is covered with 71% of water. Water is an essential component of the environment and it sustains life on the earth. All organisms depend on the water for their survival. The environmental quality is greatly focused on water due to its importance in maintaining the human health and health of the ecosystem. Water is not only important for human consumption but also plants, animals and other living organisms depend on water for their survival and development. Globally, the pressure on water resources has mainly increased due to the growing demands and degradation of water quality.

Water bodies include lakes, ponds, rivers, oceans, and groundwater. Due to the increase in the pollution and growth of urbanization water gets contaminated by various human activities (Wakode, 2018). Water bodies can be polluted by a wide variety of substances, including pathogenic microorganisms, organic wastes, domestic sewage, industrial effluent, etc. Water pollution has increased the problem of water scarcity throughout India (Rana, 2018).

Waterborne diseases are caused by drinking contaminated or dirty water. Contaminated water can cause many sorts of gastrointestinal tract infections, including diarrhea, dysentery and other serious illness like Cholera and Typhoid which are caused by pathogenic microorganisms like *Escherichia coli*, *Salmonella typhi*, *Shigella* etc. (Pandey, 2014). The pathogen can cause disease to human beings who are exposed while bathing, washing or eating food exposed to contaminated water.

The Indian legal system provides four major sources of law for addressing problems related to water pollution: (1) Water (Prevention and Control of Pollution) Act, 1974 which regulates prevention, preservation and abate of water pollution (2) Environment Protection Act, 1986 also covers water related issues; (3) public nuisance action against polluters; (4) public interest litigations under the aegis of Article 32 and 226 of the Indian Constitution (Pathak, 2013).

In the present study, Khadan Lake was selected as the study site for determining water pollution. The Khadan lake water is polluted due to human activities like the immersion of idols of a large number of devotees, washing of clothes, washing of utensils and animals, disposal of organic materials like flowers, ghee, curd, banana & solid household wastes. Physico-chemical and microbial analysis of the lake water was carried out. The physico-chemical properties like temperature, pH, color, turbidity, TDS, TSS, BOD, hardness and conductivity of the water sample of the Khadan Lake were determined to evaluate the quality of water. The microbiological study includes standard plate count, coliform count, yeast and mold count, isolation and identification of disease-causing pathogens present in the water samples.

## I. MATERIALS AND METHODS

### 1] Sample collection:

The samples from water surface of three different locations of the Khadan lake were collected in clean plastic bottles and were brought to the laboratory for physico-chemical and microbial analysis. The samples were stored in refrigerator below 10°C until use.

### 2] Physico-chemical analysis of water:

Monitoring water pollution in lake requires many different parameters which were analyzed in the laboratory using standard methods (Gu, 2014). The parameters analyzed in this assessment include-

#### 2.1 Temperature:

Temperature of the freshly collected water sample was measured in the sample collection site itself by using a digital thermometer.

#### 2.2 pH:

The pH or concentrations of hydrogen ions ( $H^+$ ) present in water is a measure of acidity and alkalinity. Dissociation of water results in the formation of  $H^+$  and  $OH^-$  ions.  $H^+$  ions are responsible for acidity and  $OH^-$  ions for basic property. The pH was determined by digital pH meter.

#### 2.3 Color:

Color was observed and recorded by visual observation.

#### 2.5 Total Suspended Solids (TSS):

TSS is the dry weight of suspended particles that are not dissolved, in a sample of water that can be trapped by a filter that is analyzed using a filtration apparatus. It is water quality parameter used to assess the quality of specimens of any type of water body, ocean water.

TSS of water sample is determined by pouring a carefully measured 10 ml volume of water through a pre-weighed whatmann filter paper, then weighing the filter again after drying process that removes all water on filter.

#### 2.4 Total Dissolved Solids(TDS):

The solids refer to suspended or dissolved in water. Water with high dissolved solids generally is non-potable and may induce an unfavorable physiological reaction in the transient consumer. The collected sample was filtered with whatmann filter paper. The filtrate was evaporated at 100°C for 2-3 hours in pre-weighed porcelain dish. The porcelain dish was brought to room temperature and then its weight was recorded.

$$\text{Total dissolved solids (TDS)} = W_1 - W_2$$

Where,  $W_1$  = Weight of Porcelain dish + filtrate (residue after drying),

$W_2$  = weight of Porcelain dish

#### 2.6 Biochemical Oxygen Demand (BOD):

Biochemical Oxygen Demand, BOD is defined as the amount of dissolved oxygen required by bacteria while decomposing organic matter under aerobic conditions. BOD is the most commonly used parameter to define the strength of lake water sample.

The BOD bottles are filled with a carefully with 1:100 diluted water sample which was collected from lake. A bottle containing distilled water was kept as a blank. One set of the bottles were incubated for five days. For estimation of dissolved oxygen, 2ml each of  $MnSO_4$  and alkaline iodide solution were added into the BOD bottles. After the precipitate is settled, 2ml of concentrated  $H_2SO_4$  was added into the BOD bottles. 50ml of sample water is taken in a flask and titrated with 0.025N  $Na_2S_2O_3$  using starch indicator. The end point of the titration is blue to colorless. The bottles kept for incubation was also processed similarly. BOD was calculated using below formula:  $BOD = DO_5 - DO_1$ , where DO is the dissolved oxygen calculated on day 1 & 5.

$$DO = \frac{(\text{Blank} - \text{Sample}) \times \text{Normality of } Na_2S_2O_3 \times \text{Mol. Wt of } O_2 \times 1000 \text{ ml} \times \text{dilution factor}}{\text{Volume of sample}}$$

#### 2.7 Hardness of water sample:

Hard water contains dissolved salts of calcium and magnesium in the form of bicarbonates, sulphates and chlorides. Hardness is the sum of calcium and magnesium ion concentration – both expressed as  $CaCO_2$  in parts per million (ppm).

Hardness in water gives insoluble precipitates with soap and interferes with the normal domestic and industrial uses (Anantnarayan, 2018).

A direct method of estimating the total hardness involves EDTA titrations using Eriochrome Black T indicator. This values gives total hardness of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions. For the determination of the total hardness of water sample, about 1ml of buffer solution was added to 10 ml of sample and titrated against 0.01 M EDTA solution using 2 % Eriochrome Black T indicator at pH 10. And the titrations readings were recorded. End point will be wine red to blue.

Hardness of the water sample was calculated using below formula:

$$\text{CaCO}_3 \text{ mg/dm}^3 = (\text{burette reading} \times 100 \times \text{Molarity of EDTA}) \times 1000 \text{ ml} / \text{volume of water sample}$$

## 2.8 Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. It is used to estimate ionic concentration in water sample. Conductometer helps to measure the resistance provided by water between two platinised electrodes instrument is standardized with known values of conductance observed with standard KCl solution. Conductivity is measured in laboratory by using conductometer and the conductances of water samples were recorded.

## 3] Microbiological analysis:

### 3.1 Standard plate count (SPC):

The SPC is designed to enumerate total viable populations that may be present in the given sample. The standard plate count method consists of ten- fold diluting serially a sample with sterile saline until the bacteria are dilute enough to count accurately. The serial dilutions of the given water sample upto  $10^{-6}$  were prepared and aseptically 0.1ml were transferred of each dilution onto sterile petri dishes containing Sterile Nutrient Agar. The petri dishes were incubated at  $27^\circ\text{C}$  for 24 hrs and cfu /ml were calculated (Haque, 2019).

### 3.2 Coliform count:

Human pathogens that are transmitted by water include bacteria, viruses, and protozoa. If such water is used for drinking purposes it can create health hazards. The presence fecal indicator organisms in water are an evidence of fecal contamination and therefore, of a risk that pathogens are present. If indicator organisms are present in large numbers, the contamination is considered to be recent and severe. Typical coliforms (*Escherichia coli*) are present in large numbers among the intestinal flora of humans and are thus used as an indicator of fecal contamination (Rajiv, 2012).

MacConkey's agar plate were inoculated by spreading of diluted water samples and incubating the plate at  $27^\circ\text{C}$  for 24 hours. MacConkey's agar is used in the differentiation of lactose fermenting from lactose non-fermenting and to selectively isolate Gram negative bacteria. It is also used for isolation of coliforms and intestinal pathogens in water. After incubation cfu/ml were counted.

### 3.3 Yeast and Mold Count:

Yeast and mold are the types of fungus. Molds can be hazardous to human health in large quantities and can cause allergic reactions and respiratory problems. Also yeast can cause infection in people with compromised immune systems.

For isolation of yeast and mold, Sabourauds agar plate was used. Water sample were inoculated by spreading method. The plates were incubated at  $27^\circ\text{C}$  for 48 hours. After incubation cfu/ml were calculated.

### 3.4 Isolation and identification of Pathogens:

Water contamination occurred due to the presence of water borne pathogens in water bodies are a major quality concern throughout the world. To detect the presence of pathogens in water, the samples were inoculated in following media's:

**3.4.1 MacConkey's agar:** Pancreatic digest of gelatin and peptones are present in MacConkey's agar provides the essential components like nutrients required for growth of microorganisms (Aryal, 2018). Water sample were inoculated by streaking on sterile MacConkey's agar plate to detect the presence of *E.coli*. Most of the strains of *E. coli* can cause illness in humans, including diarrhea, abdominal pain, and fever. Isolated colonies were observed, colony characteristics were studied and Gram staining was performed.

**3.4.2 Salt Mannitol agar:** Water sample were inoculated by streaking on sterile Salt Mannitol agar plate to check the presence of *Staphylococcus aureus*. *S. aureus* can cause skin infection, food poisoning & bone or joint infection or also animal infection. Isolated colonies were observed, colony characteristics were studied and Gram staining was performed.

**3.4.3 Salmonella Shigella agar:** It is used as a selective and differential medium for the isolation of *Salmonella* and some *Shigella* species from clinical and non-clinical specimens. The inclusion of Bile Salts, Sodium Citrate and Brilliant Green serve to inhibit Gram-positive coliforms allowing *salmonella* spp. to grow. Water sample were inoculated by streaking on Salmonella Shigella agar plate to check the presence of *Salmonella* and *Shigella* species which are known to cause Typhoid fever,

food poisoning, gastroenteritis, enteric fever. Isolated colonies were observed, colony characteristics were studied and Gram staining was performed.

**3.4.4 Cetrimide agar:** Cetrimide is the selective agent and inhibits most bacteria by acting as a detergent. The addition of magnesium chloride and potassium sulphate stimulates pyocyanin production. When in contact with bacteria, cetrimide causes the release of nitrogen and phosphorous from the bacterial cell other than *Pseudomonas aeruginosa*. Water samples were inoculated by streaking on Cetrimide agar plate to check the presence of *Pseudomonas aeruginosa*. *Pseudomonas* is the opportunistic pathogen which causes Cystic fibrosis, Swimmers ear or otitis externa, Pneumonia, Bloodstream infections. Isolated colonies were observed, colony characteristics were studied and Gram staining was performed.

## II. RESULT AND DISCUSSION

In present study Physico-chemical and Microbial examination of the contaminated Khadan Lake water at all the three sampling sites [fig 1 & 2] are carried out. Samples are brought to laboratory for analysis of various water quality parameters and the results obtained are in tabulated form.

Sampling Location: Khadan Lake, Mahalaxmi nagar, Ambarnath, Latitude: 19°11'45"N Longitude: 73°11'24"E , Area covered: 6300 m.



Figure 1: Picture showing the sampling site



Figure 2: Pictures showing sampling sites of polluted water of khadan lake

## Physico-chemical Analysis

Table no.1: physicochemical analysis result

Parameters	Sample 1	Sample 2	Sample 3
Temperature (° C)	27.5	27.3	26.8
pH	7.5	7.8	7.7
Color	Blackish brown	Blackish brown	Blackish brown
TSS (mg/L)	680	700	650
TDS (mg/L)	950	1025	1100
BOD (mg/L)	1.5	1.7	1.6
Hardness (mg/L)	270	300	290
Conductivity (Ω/cm)	4.15	4.05	3.95

The physico-chemical analysis results is shown in table no. 1. In the present study the temperature of water noted at the time of sampling .It is basically important parameter because its affects the conductivity and solubility (Manjare, 2010). The temperature of khadan lake water is found to be 26-27°C. The pH is an important factor which measure alkalinity or acidity of water. The pH of khadan lake water is found to be slightly alkaline. TSS is water quality parameter used for identify the wide variety of materials such as sewage. The total suspended solids of samples of Khadan Lake were in the range of 650-700 mg/L. TDS values in the samples observed in the range of 900-1100 mg/L across all location. The value of TDS are found to be much higher due to high disposal of organic material and waste material. These parameters indicate pollution of lake water (Devangee, 2013).

## Microbiological analysis:

Table no.2: Colony count

Samples	Standard plate count	Coliform count	Yeast and mold count
Sample 1	$7.3 \times 10^8$ Cfu/ml	$1.5 \times 10^5$ Cfu/ml	$3.1 \times 10^3$ Cfu/ml
Sample 2	$8.1 \times 10^8$ Cfu/ml	$1.3 \times 10^5$ Cfu/ml	$3.8 \times 10^3$ Cfu/ml
Sample 3	$8.6 \times 10^8$ Cfu/ml	$1.1 \times 10^5$ Cfu/ml	$3.6 \times 10^3$ Cfu/ml

In this microbiological analysis, standard plate count for bacteria, coliform count which is an indicator of fecal contamination and yeast and mold count were determined. The results obtained is shown in Table. no. 2, which clearly indicates high level of sewage and fecal contamination in the lake water (Sailaja, 2015). The disturbance in this biological system and ecological system can affect health of animals, birds and aquatic life. Some microorganisms even produce toxins that are harmful to higher forms of life.

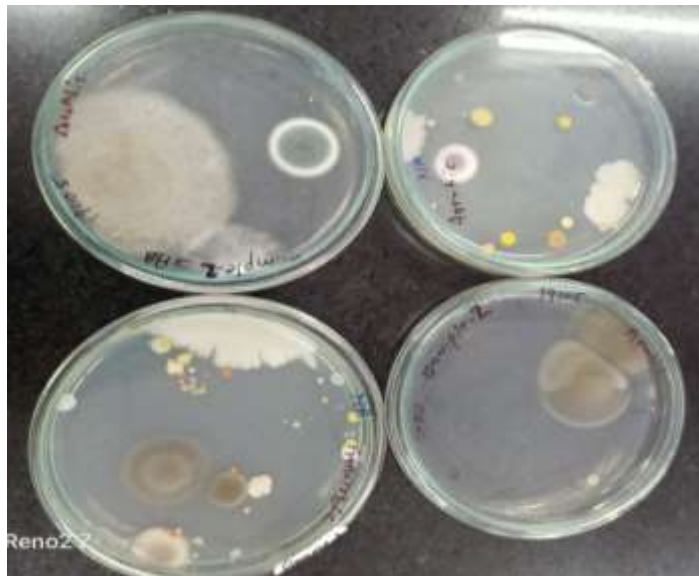


Figure.4: Microbial growth on media plates.

**Identification of pathogens:**

The colonies obtained on the selective medium were identified further by colony characteristics [Table 3] and Gram staining. The identified microorganisms that may cause infection to humans like *Escherichia coli*, *Staphylococcus aureus*, *salmonella species*, and *pseudomonas aeruginosa* were found [Fig 5 & 6].

Table no.3: Physiological and morphological characteristics.

Colony characteristics	MacConkey agar plate	Salt mannitol agar plate	Salmonella-shigella agar plate	Cetrimide agar plate
Size	Small, 1-2 mm	Pinpoint	Small, 1-2 mm	Small, 1-2 mm
Shape	Circular	Circular	Circular	Circular
Color	Pink	Yellow	Black centered colony	Green
Margin	Entire	Entire	Entire	Entire
Elevation	Convex	Convex	Convex	Raised
Consistency	Smooth	Smooth	Smooth	Smooth
Opacity	Translucent	Translucent	Opaque	Translucent
Change in media color	Red to pink	Red to yellow	Yellow to red	Colorless to greenish blue
Incubation time and temperature	24 hours at 37°C	48 hours at 37°C	24 hours at 37°C	72 hours at 37°C
Gram character	Gram negative coccobacilli	Gram positive cocci in clusters	Gram negative short rods	Gram negative rods

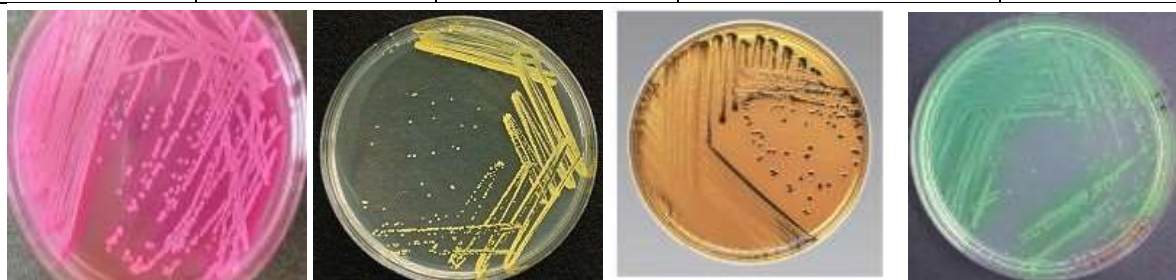
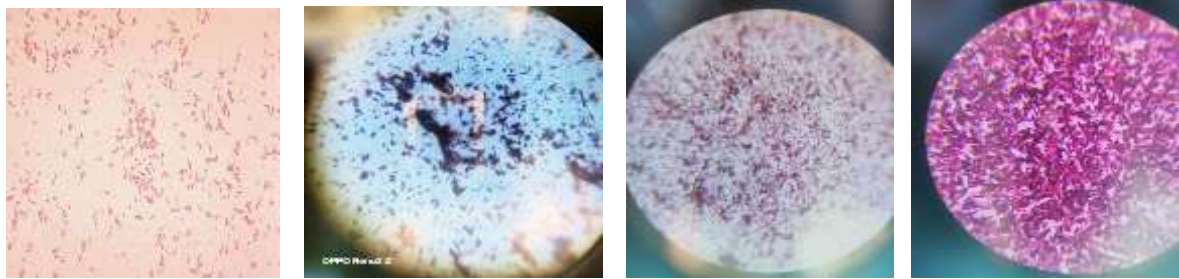


Figure 5: 1. Pathogenic isolates obtained on 1. MacConkeys agar plate, 2. Salt mannitol agar, 3. Salmonella- shigella agar, 4. Cetrimide agar media



Gram negative coccobacilli

Gram positive Cocci in cluster

Gram negative short rods

Gram negative rods

Figure 6. Gram staining results

### III. CONCLUSION

Water pollution is a global issue and the world community is facing the worst results of polluted water. Major sources of water pollution are discharge of domestic and agriculture wastes, population growth and Urbanization. In the present study, results of Physico-chemical and microbial parameters of Khadan lake, Ambarnath clearly shows that water is harmful to people residing in the surrounding area and can serve as a reservoir of pathogenic diseases. Improving the quality of water should include spreading awareness to the public regarding proper waste disposal systems and the importance of keeping their surrounding area clean.

### IV. ACKNOWLEDGEMENT

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