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Review Article

A Review On Bacteriological Evaluation Of Drinking Water Sample

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ABSTRACT

Water is essential to life, and its quality serves as a gauge of human society's environmental health. Over the past three to four centuries, urbanization and industrialization have impacted water bodies, which are typically used to discharge domestic and industrial wastes. River water pollution has a negative impact on people's hygiene and environmental health in the areas surrounding the river.The water samples were tested for presumed coliform count and confirmation of Escherichia coli using the multiple tube technique on OXOID MacConkey Broth (Oxoid Ltd, Basingstoke, Hampshire, England).The present investigation reveals bacteriological evaluation of drinking water sources in and around Pune City, Maharashtra, India. Wells, bore wells, hand pumps, treated water from corporation purification plant, and other sources are some of the sources from which residential areas of Pune obtain their drinking water supply. Bacterial contamination of potable water resources is the most frequent health hazard .Although groundwater is widely used as one of the main sources of drinking water in developing countries, it is generally thought to be the least polluting source of water. However, the stress on water reservoirs resulting from unplanned urbanization has increased recently, with improper and incomplete waste treatment by industries, agricultural practices, and domestic users, and with no adequate provision for disposing of generated wastes.According to the World Health Organization, water diseases caused by poor drinking water quality and inadequate hygiene and sanitation account for about 5% of all deaths in these countries, which is why this study was conducted.One aspect of water quality is represented by bacterial water analysis, a microbiological analytical procedure that uses water samples to determine the concentration of bacteria from which conclusions about the suitability of the water for use can be drawn. Bacteriological water analysis estimates the number of bacteria present and, if necessary, determines what kind of bacteria they are.

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INTRODUCTION

Despite the fact that human beings continue to pollute water sources, which causes water- related illnesses, water is one of the most essential elements for all forms of life. It is indispensable in the maintenance of life on earth and is also necessary for the composition and renewal of cells1.Around 25 years ago, credible estimates suggested that each year around 500 million people are affected by water-borne or water-associated disease, and as many as 10 million of these die2. A recent estimate based on WHO reports suggests that 80% of all human illnesses in the developing world are caused by sewage, other wastes, or human and animal excrement.2According to the World Health Organization (WHO, 1993), drinking water is essential for human survival and should be "suitable for human consumption and for all usual domestic purposes including personal hygiene." However, according to a 2008 WHO report, three out of every five people in developing countries lack access to safe drinking water.3 After air, potable water is the second most important requirement for maintaining human life on this planet after air. Life itself originated in ocean water, approximately 3.2 billion years ago. Groundwater, which makes up about 20% of the world's fresh water supply and is one of the most essential requirements for all kinds of life, could not be replaced by any other known natural or man- made compound because it has its unique physical and chemical properties.4 Water is the most prevalent chemical in the human body and is crucial for the control of nutrient transport, toxic waste removal, thermal regulation, digestion, organ functioning, and metabolic activities. However, if water is focally polluted, it spreads diseases to large numbers of consumers, putting them at risk for contracting them.

It is well known that infectious diseases are primarily transmitted through water supplies contaminated with human and animal excreta, particularly feces. Outbreaks of water borne diseases continue to occur throughout the world but are especially serious in developing countries. The World Health Organization estimated in 2000 assessment that there are four billion cases of diarrhea each year in addition to millions to other cases of illness associated with the lack of access to clean water.

Fig 1: water sample

Safe drinking water is necessary to protect the public and the environment, which means that it must be sterile and devoid of pathogenic bacteria.5 Fresh water is found as underground water in enormous reservoirs surrounded by rock, which are called aquifers, and has long been regarded as one of the purest forms of water available in nature to meet the overall demand of rural and semi-urban people.1 In India, the majority of the population is dependent on groundwater as it is the only source of drinking water supply. Salmonella species, Shigella species, pathogenic Escherichia coli, Vibrio cholerae, Yesinia enterocolitica, Campylobacter species, various viruses such as Hepatitis A, Hepatitis E, Rota virus, and parasites such as Entamoeba histolytica and Giardia species are among the human pathogens that pose a serious risk of disease whenever they are present in drinking water.6 The current work deals with the physico-chemical and bacteriological status of ground water of industrial-area to compare it with

ground water of residential area. The quality of water was studied from drinking point of view. Heterotrophic and coliform bacterial flora was detected in shallow ground water (Rao and Reddy 1996)7

Objective of bacteriological drinking water

In India: Assessing the side-by-side performance of three different H2S tests (laboratory-made H2S, TARA Aquacheck, and ORlab H2S) via the Presence/Absence (P/A) method against a standard product (IDEXX Quanti-Tray® 2000).8 When it comes to drinking water superiority, Pakistan is ranked 80th out of 122 countries .Coli forms have been discovered in drinking water sources across the country, as well as surface and groundwater. A variety of WHO drinking water quality criteria are regularly broken down. In Pakistan, water contamination is one of the most serious risks to communal life because the quality of the intake water is not properly maintained or checked.9 Due to unplanned urbanization, industrialization, and the unchecked use of agrochemicals, Bangladesh's surface waters are becoming increasingly polluted with heavy metals. The inadequately treated waste dumped from various industries into the river water causes serious problems for aquatic flora and fauna. Photosynthetic activity is inhibited in polluted water due to reduced light penetration.10 In developing nations, biological contamination of drinking water is a major concern for public health authorities. According to the World Health Organization, about 5% of all deaths in these countries are directly related to water diseases caused by poor drinking water quality and a lack of hygiene and sanitation. Potable water is an essential component for good health and the socioeconomic development of man.11 Human health depends on having access to safe drinking water in both development and humanitarian emergency settings. In these contexts, bacteriological water quality testing is crucial because it offers crucial information on the microbial safety of drinking water resources. However, due to resource constraints, adequate water quality testing is frequently challenging to accomplish in humanitarian emergency and development settings.12 Natural mineral water is characterized as microbiologically pure because, according to experience, the inherent physical properties of the aquifer material shield it from any risk of contamination.13 Presently, only 0.5%-1.0% of the total available water resources can be considered suitable for drinking (Yan et al., 2016; Kausley et al., 2019). Water is an essential natural resource that needs to be protected from pollutants (Megersa et al., 2014; WHO, 2017; EA, 2019).14 Water quality is a critical factor affecting human health and welfare [4,5]. Access to safe drinking water is an important global public health concern. Improving access to safe drinking water can result in tangible health benefits, can boost countries' economic growth, and can greatly contribute to poverty reduction. Water is the essence of life, and safe drinking water is a basic human right essential to all, and for sustainable development.15

Bacteriological evaluation of drinking water in different city are following :

1. **Pune**

Material and method

Study area :

The research area included the surrounding districts of Pune and Satara in western Maharashtra, India. Twenty villages were selected based on historical mean rainfall from the Indian Meteorological Data center (IMD) in Pune for the years 1946 to 2006, which was then classified into low and high rainfall zones based on the annual amount of precipitation measured in millimeters (mm). The IMD categorizes rainfall zones as heavy (2000 mm and above), moderate (1000–2000 mm), and low (500–1000 mm) rainfall regions.1 With two connecting reservoirs situated 75 km apart in north central Nigeria, the Gurara

water transfer system is a multipurpose system that transfers raw gravity to and from the Lower Usuma reservoir via a conveyance pipeli2.

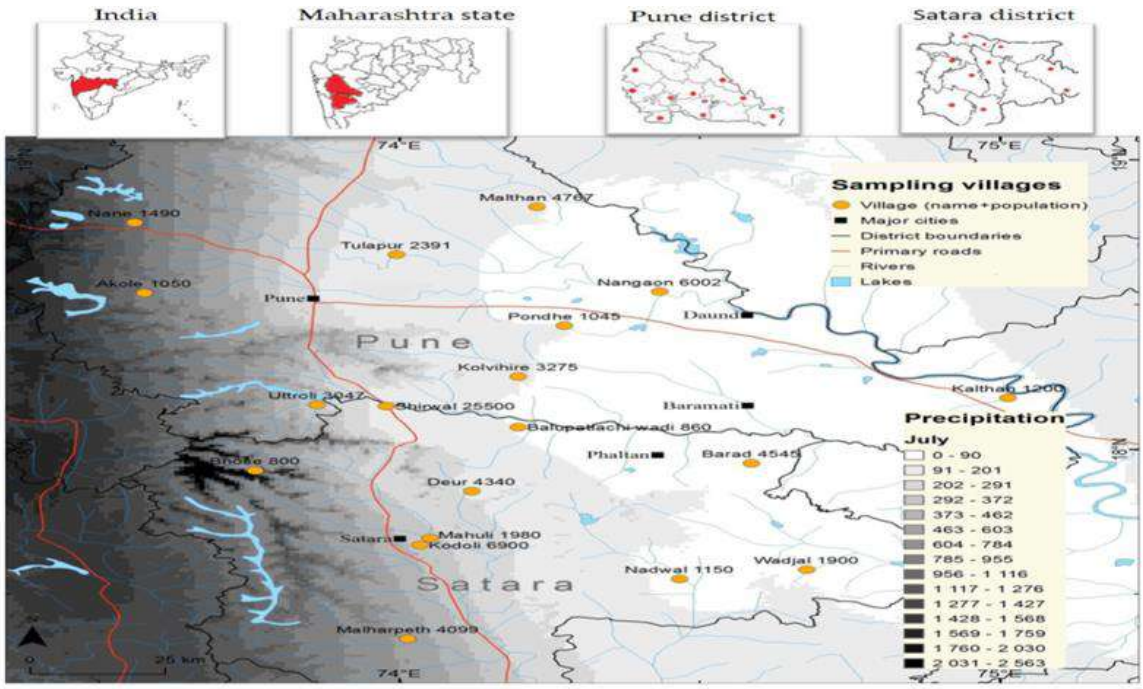

Fig 2: study area of Pune

Classify of sampling area:

The sampling sites were separated into two subgroups: (1) Ground water, which included Bore wells and Open wells; (2) Rivers, which included lakes, rivers, and backwaters from dams; and (3) Open wells, which included underground seasonal and annual springs with a small opening above the surface from which water is collected, as well as storage tanks into which water from open wells is pumped.[1]

Sample collection:

The central Pune city and the areas from Kothrud to Aundh, Pashan to Katraj, Bhosari, Pimpri, Chinchwad, Nigdi, and other places were covered by the collection of 240 sample.

Sr no	Sources Of Water	Number of samples
1	Pune Municipal Corporation	114
2	Pimpaari Chinchwad Municipal	73
3	Public bore wells	30
4	Private bore Wells	23
	Total Samples	240

Bacteriological data analysis:

According to previous WHO drinking water guidelines, FC counts of 0, 1–10, 10–100, 100–1000, and >1000 per 100 ml were correlated with no risk, low risk, intermediate risk, high risk, and very high risk, respectively. This information was used to characterize major drinking water sources, such as open wells and bore wells.[1]

Determination of ph:

Using a pH meter, the pH of each water sample was determined.

Physical parameter:

Ph – 7.5[4]
Temperature – 25 -25.5
Turbidity – 10-120 NTU
Electric conductivity – 300-450 µS/cm
Chloride- 3.3 -120 mg/ L
Alkalinity–15-80mg/L[5]

Drinking water supply system

Chemical oxygen demand:

The analyzed water samples had COD values between 48 and 50 mg/L, which is within the permissible limit of 255 mg/L for drinking water. The purpose of the COD test is to measure the oxygen equivalent of organic matter that can be oxidized in an acidic medium using a strong chemical oxidizing agent like potassium dichromate.

Determination of method:

The values for water samples show that the iron content was in the range of 0 to 3 mg/l, the zinc content is 0.1 to 2 mg/L, and the copper content ranges from 0 to 0.2 mg/L. The metal contents in the waste water sample are found using an atomic absorption spectrometer.

Method of analysis:

Water bacteriology standard tests included the following:

(a) Presumptive coliform test

(b) Two methods for estimating the likely number of coliform bacteria in water

Multiple tube method:

In this test, the most probable number (MPN) of coliform organisms was found in 100 ml of water sample. Media: double strength and single strength MacConkey's broth containing bromocresol was sterilized in test tubes containing Durham's tube for indication of gas production. Procedure: Measured amounts of water sample were added by sterile pipettes in the following ways:

1)50 ml of water sample to 50 ml double strengths medium

2)10 ml water to 10 double strength medium

3)Five 1 ml quantities of water sample each added to 5 ml single strength medium.

The tubes were then incubated at 37 centigrade degrees for 48 hours. The tubes showing acid and gas production were used to estimate the coliform count using a statistical table probability table according to McCrady.

Filter paper preparation:

Preparing the filter paper involved autoclaving it in a plastic filter with the lid slightly ajar, transferring the filter paper aseptically into a membrane filter folder, and then securely closing the lid. After autoclaving, a new membrane filter was used for each sample, and each water sample required a different membrane filter.

2. Kolhapur

Material And Method

Study area:

The city of Kolhapur is located in south-east India at 16.41°N 74.13°E. It is on the banks of the holy Panchganga river, which flows through the south-west of the state. Kolhapur is higher than Pune at an elevation of 569 meters (1867 feet), so its climate is generally pleasant. The water supply to Kolhapur city is primarily from surface and ground water sources; the demand is satisfied by municipal supply distribution to 135 MLD of the city from Bhogavati River (Balinga), Panchganga

River (Shingapur), Kasaba Bavada, and Kalamba talav. The total number of bore wells constructed by municipalities is 200 in various localities. The quality of the water depends on the location of the source and the state of the environment.7 During the summer, monsoon, and winter seasons of 2013, sampling was conducted from four distinct nullhas: Jayanti, Dudhali, Line Bazaar, and Bapat Camp.8

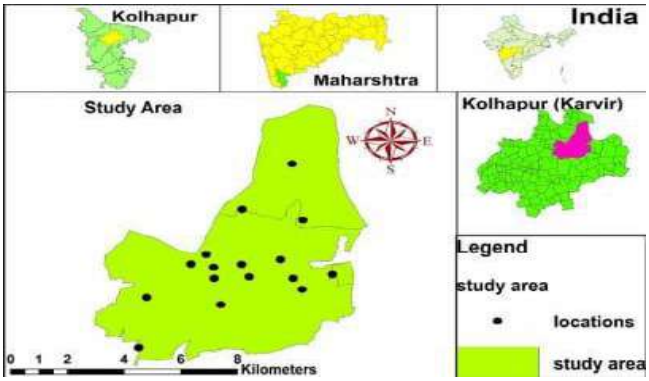

Fig 4: study area of Kolhapur

Collection of sample:

The water samples were collected in new Polypropylene bottles (2 L) capped with double stoppers. Several steps were followed to prepare the polypropylene bottles for collecting water samples such as treating with detergent, washing with plenty of running tap water , immersing in 5% HNO3 (Merck, Germany) overnight, rinsing with deionized water, and finally drying in the air. To distinguish the collected samples, the dried bottles were labeled with special identification number. Samples were collected from 12 different points along the Halda River at a depth of 10–15 cm below the water surface. During sampling, bubble formation and suspended particles were carefully avoided. The collected samples were placed in polypropylene bottles containing 0.4% ultra-pure HNO3 (Assay: 68–70% Merck, Germany) and were stored in a refrigerator.9

Bacteriological analysis:

Ten tubes of MacConkey's broth (Hi media Pvt. Ltd., Mumbai) were arranged in two rows with a 100 ml blood culture bottle. The first row contained 10 ml of double strength MacConkey's broth, and the second row contained 1 ml single strength MacConkey's broth medium, which was inoculated with 1 ml water sample, respectively. The tubes were incubated in an incubator at 44°C for 24 hours. Following incubation, the number of bottles in which lactose fermentation with acid and gas production had occurred was counted. Lastly, by consulting the probability table (Macrady table-2), the results of the bacterial analysis were obtained for indicator organisms, namely total and fecal coliform (E. coli).10The most probable number (MPN) method was used to conduct a bacterial analysis for indicator organisms, specifically total and fecal coliform (E. coli)12,13. Three rows of 15 tubes of MacConkey's broth (Hi Media Mumbai) were used. The first row, which contained 10 ml of double strength MacConkey's broth, was inoculated with 10 ml of water sample, and the second and third rows, which contained 10 ml of single strength MacConkey's broth medium, were inoculated with 1 ml and 0.1 ml of water sample, respectively. Following a 24-hour incubation at 44 °C, the coliform number was calculated using the following formula: (No. of ve+ tubes 100) is divided by square root of {(ml of water sample in all tubes) (ml of water sample in ve_ tubes). Fecal coliform (E. coli) was counted using SPC technique, employing Endo agar as a selective and differential medium for E.11

Determination of ph :

The ph value of sample is 7.5 – 8.5.

Physical and chemical analysis:

Temperature: The water temperature in the current study ranges from 22.5°C to 26°C.

Turbidity: Water's turbidity varies between 0.4 and 12.41 NTU.

Totle dissolved solid : The range of total dissolved solids is 0.1–2.2 grams per liter.

Chlorids: Chlorides range in value from 31.06 mg/l to 57.61 mg/l.

Alkalinity: The range of total alkalinity is 121.25 mg/l to 200 mg/l.

Phosphate: Phosphate varies in value from 0.12 mg/l to 12.38 mg/l.

Nitrates: Nitrate levels range from 4.40 mg/l to 37.5 mg/l.12

Determination of water quality index:

In order to conduct this investigation, we have chosen nine physio-chemical and biological parameters related to drinking water: pH, dissolved oxygen (DO), turbidity, total dissolved solids (TDS), total alkalinity, total hardness, chlorides, nitrates, and MPN coliform. We have calculated the water quality index using a method akin to that of Horton (1965), who made one of the first attempts to do so. These parameters are the ones that have the greatest impact on the quality of drinking water. 7

Water pollution and public health issue:

Domestic sewage accounts for 75–80% of water pollution by volume; the remaining portion is thought to be more toxic industrial wastewater from industries such as sugar, textiles, distilleries, electroplating, pesticides, pharmaceuticals, pulp and paper mills, tanneries, dyes and dye intermediates, petrochemicals, steel plants, etc. Nonpoint pollution sources include fertilizer and pesticide runoffs from agricultural fields in rural areas; only 60% of chemical fertilizers are used in soils; the remainder is leached into soil, polluting ground water. Excess phosphate run-off is contributing to eutrophication in lakes and other bodies of water.13

Collection of ground water sample:

Each month, pre-sterilized polythene bottles were used to collect samples of groundwater from bore wells, government hand pumps, and privately owned bore wells. The samples were analyzed for elements like calcium, magnesium, sodium, and potassium as well as physico-chemical parameters like pH, acidity, alkalinity, total dissolved solids (TDS), hardness, nitrate, and chlorides, as well as a microbiological parameter called the Most Probable Number (MPN) for the detection of coliform. 14

Fig 5: water sample

Sample frequency:

Groundwater samples were taken at 16 sites, almost all of which covered all five wards, over the course of an almost seven-month study, or once every month. 14

Qualitative analysis:

To confirm fecal coliform, a loopful suspension from a positive MPN tube was streaked on Endo agar. An IMVIC test was conducted to confirm the presence of E. coli. Concurrently, a loopful was streaked on Wilson and Blair medium for Salmonella species, TCBS agar for Vibrio, and Peptone water for Shigella species.

Statistical analysis :

It is performed to determine the average geometric mean of coliform bacteria per 100 ml in each month. 11

3. Delhi

Material and method

Study area :

For testing, DW samples were gathered from various parts of Delhi and the National Capital Region.15 Delhi, the capital city of India, and its sprawling suburbs are home to about 22.7 million people, according to a 2013 world population data sheet released by the US Population Reference Bureau. The Yamuna River flows through the territory of Delhi, entering at the Wazirabad

barrage and exiting at the Okhla barrage. The river serves as the city's primary source of drinking water, and although the city contributes only 0.4% of the river's catchment area (CPCB, 2006–07), it releases 70% of all pollution from the region. The river Yamuna is severely degraded by eighteen drains and industrial effluents that continuously flow into the river.16

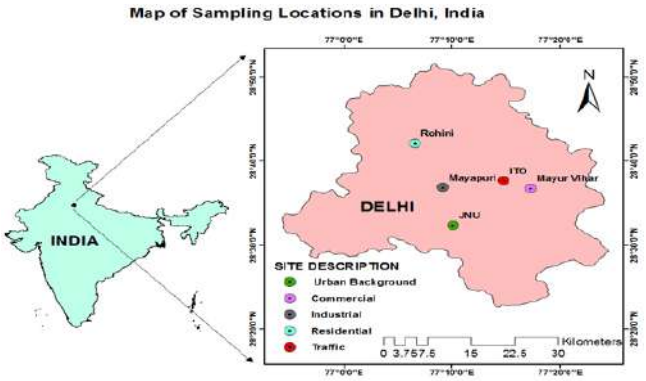

Fig 6: study area of dilhi

Sample collection:

The three areas from which the drinking water samples were primarily collected were NOIDA, West Delhi, and Meerut.15 Throughout July and August of 2013, the current study was carried out in six distinct aquatic regions of Delhi. Samples Mkt, Kg, and Ob were taken from surface water of the river Yamuna near Majnu ka Tila, Kashmiri Gate, and Okhla barrage, respectively; samples Skk, Nd, and Ltw were taken from the Yamuna flood plain near Saraj Kale Khan, surface water of the Najafgarh drain near Vallabhbhai Patel Chest Institute, and tap water of our laboratory, respectively. All samples were collected in sterile bottles and stored at 4 °C. 16 Between April and August of 2004, bottled drinking water samples were collected from retail outlets across India: eighteen samples came from states other than Kerala, including Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Maharashtra, Uttar Pradesh, and the Union Territory of Delhi; eighty-seven samples came from different retail outlets within Kerala.17 Samples were collected using seepage water and tap water samples from individual sites selected by team members within a 12-kilometer radius of central New Delhi. The team was supervised by a Channel 4 News employee with a degree in biology from the United Kingdom, and they were provided with stringent written and verbal instructions on sample collection. 18

Chemical parameter:

All of the instruments (pH meter, conductivity/TDS meter, and nephelometer) were calibrated before use, and all of the chemicals and standards used during preparation and analysis were of analytical grade. The pH, alkalinity, electrical conductivity, total hardness, turbidity, and total dissolved solids values were evaluated for the collected and processed samples using standard protocols (Standard Analytical Procedures for Water Analysis, 1999; Perlman, 2014). Their calcium content was determined using standard EDTA titrimetric methods in accordance with APHA (1998) (1). 19

Physical parameter:

Ph – 7.83

Chloride: 130

Nitrates: 4

Alkalinity: 70 16

Analysis of drinking water:

Within 48 hours of collection, drinking water samples were subjected to a bacteriological analysis; the Most Probable Number 6 (MPN) test, which was conducted using McCrady's 1915 method, was employed, along with a prevalence analysis of various water-borne pathogens and indicator organisms that were examined using specialized media and biochemical tests for the identification of bacteria.15

Statistical analysis :

The heavy metal association in water samples was determined using Pearson product-moment correlation analysis, with a statistical significance threshold of $P < 0.05$.16

Sampling techniques:

Water samples were obtained following the standard protocol of the APHA (1992) in sterile bottles. 15

Bacteriological analysis:

The THB load classification of the water samples is shown in Table 1. The results showed that 15% of the samples had bacterial counts higher than 1000 cfu/ml. The bacteriological quality was better than that reported by Warburton et al. (1986), who had reported that 16% of the bottled water samples had bacteriological loads above the permitted limits and others showed great variation in THB load. There was a 40% variation in THB load. 17

Spreading awareness:

The development of evaluation tools, or questionnaires, was motivated by the desire to inform and educate the public about the value and necessity of safe drinking water as well as the range of commercially available solutions that can be used to further improve the water's safety.19

Hemolytic test:

Lamb blood agar plates (HiMedia, India) were streaked with freshly cultured bacteria, and the bacteria were left to incubate for 18 to 24 hours at 37 °C. The bacteria were then classified for pathogenicity based on changes in blood color in the medium; changes in blood color from red to yellow gray/dark green and yellow/transparent were classified as α-hemolysis and β-hemolysis, respectively; no change in blood color was classified as γ-hemolysis. 17

4 . Nagpur

Material and method

Study area:

Sample A is well water from the TSM colony of the MKD mining area, which is 1.5 km from the mines; Sample B is water from the canal, into which waste is discharged, and which joins the Aam River; Sample C is well water from the MKD – II mine field area; and Sample D is well water from an agricultural field near MKD – II mine, which is 4 km from the MKD – II mine.20

The study area, or the area that is taken into consideration for the physicochemical analysis of groundwater quality, was chosen in this phase with the help of our guide. Next, we decided on twelve different locations in Khapri Village, Kalmeshwar, Nagpur District, and Maharashtra State, India. The study area is located 31 KM west of the district headquarters in Nagpur, 791 KM from the state capital Mumbai, and is surrounded by Saoner Taluka to the north, Katol Taluka to the west, Hingna Taluka to the south, and Nagpur Taluka to the east. The study area of Khapri Village, latitude 21°14'35"N and longitude 78°51'14"E, was used. 21

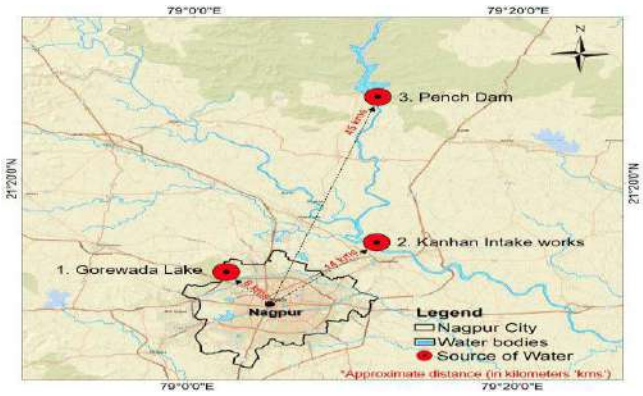

Fig 7: study area Nagpur

Sample location:

In order to conduct a comprehensive study on the quality of water in this area, a total of 1036 samples were collected from various locations within different blocks of basti, with a minimum of 2-3 km separating each location from another. The sample collection area has been designated as sample points. The samples were collected in autoclave sterilized plastic bottles that were cleaned with acid water and then rinsed twice with distilled water.[22]

Five different sites within the mining area provided water samples for physico-chemical analysis. The samples were collected in two-liter plastic bottles, and the temperature, pH, electrical

conductivity, and total alkalinity were measured using a mercury thermometer, pH strip, and pH pen. The titrametric method used methyl orange as the indicator. The field-fixed dissolved oxygen samples were brought to the laboratory and analyzed using an azide modification of the Winkler's method APHA (2005); NEERI (1987) manual. The other water quality parameters were examined in accordance with the standard procedures APHA (2005).[20]

Determination of pH:

Since pH affects the chemical and biological properties of liquids and is used in many calculations in analytical work, its determination is crucial. The pH of natural water typically ranges from 4.4 to 8.5 and is primarily determined by the carbon dioxide / bicarbonate / carbonate equilibrium. It may be affected by humid substances by changes in the carbonates equilibrium due to plant bioactivity and in some cases by hydrolysable salts. The electrometric method is the most accurate and interference-free method for determining pH.[23] A total of 1036 drinking water samples from various water sources of all 14 blocks of the Basti district received between June and July 2018 were analyzed in the WT and MD department at CSIR-NEERI Nagpur. The samples were collected aseptically in sterilized plastic bottles and tested by myself using a predefined laid down guidelines by WHO and ICMR in "WHO guidelines for Drinking Water Quality" and "Manual of Standards of Quality for Drinking Water Supplies." If the pH is below 6, water is corrosive.[22]

Bacteriological analysis:

Water samples were taken in sterile glass bottles, transported in an ice box to the laboratory, and processed in less than a day. Coliforms and fecal coliforms were identified in accordance with the APHA-AWWA (2005) guidelines.[20]

Fig 8: bacteria

Method:

448 water samples (425 from households and 23 from water sources) were collected and analyzed by the membrane filtration method to identify Thermotolerant coliform. Binary logistic regression was performed to assess the association between each independent and dependent variable. Adjusted Odd Ratios along with 95% Confidence intervals were estimated to identify factors associated with the outcome variable. This community-based cross-sectional study design was carried out among 425 households in Eastern Ethiopia.24

Physical parameter :

Alkalinity: Alkalinity is the measure of the water's capacity to neutralize acids. The majority of alkalinity in natural waters is caused by carbonates, bicarbonates, and hydroxides. It affects the boilers by forming scales on them.

Sulfate: Sulfate is one of the main ions that occur in natural water. Sulfate is one of the major dissolved components of rain

Nitrates: Nitrates may be present in excess in ground water if sewage seeps into the ground as a result of improper sewage disposal management

Total Hardness: Hardness in water is that property that keeps the water from producing enough lather with soap. Usually caused by the presence of calcium and magnesium salts in the water 21

Acidity: Acidity can be calculated by neutralizing samples to pH. Water with mineral acidity (caused by H_2SO_4, HCl, and HNO_3) is unacceptable. Acid

water also causes corrosion issues and interferes with water softening.

Chloride: Chloride is measured by titration with standard silver nitrate. The presence of chloride in natural waters can be attributed to the dissolution of salt deposits, effluent discharges from chemical industries, oil well operations, sewage discharges, irrigation drainages, etc. Each of these sources may result in local contamination of both surface water and ground water.

Flurides: Fluoride ions are important in water supplies for two reasons: first, high concentrations of fluoride lead to dental fluorisis (tooth disfigurement); second, low concentrations cause dental caries. For this reason, it's important to keep fluoride levels in drinking water between 0.8 and 1.0 mg/L. The most reliable method for determining fluoride ions in water is colorimetric analysis (SPADNS), which works well with a range of samples. In acidic conditions, fluorides (HF) react with zirconium SPADNS solution, causing the reagent's color to bleach owing to the formation of ZrF6. Since bleaching is a function of fluoride ions, it is directly proportional to fluoride concentrations.

Conductivity: A quick and accurate estimate of the fluctuations in the dissolved mineral contents of water supplies can be obtained through conductivity measurement.

Floatable: The quantity of floatable materials in the waste which is measured using a floatable sampler with mixer and a floatable oil tube is one of the key factors in determining the potential impact of waste disposal into surface waters. Particulate matter, which includes "grease balls," and liquid components that can spread as a thin, highly visible film over large areas are the two general types of floatables. The minimum detectable concentration is roughly 1 ppm.

Solid: Everything is measured gravimetrically, with the exception of total dissolved solids by specific conductance and settleable solids by volume.23

Biochemical oxygen demand:

The Biochemical Oxygen Demand (BOD) test is primarily a bio-assay procedure that involves measurement of O2 consumed by bacteria while stabilizing organic matter under aerobic conditions. It is widely used to determine the pollutional load of waste waters, the degree of pollution in lakes and streams at any given time, as well as their self-purification capacity and the efficiency of waste water treatment methods.

Chemical oxygen demand:

With the aid of a strong chemical oxidant, the Organic Matter is completely oxidized by K2Cr2O7 in the presence of H2SO4 to produce CO2 and H2O. The excess K2Cr2O7 that remains after the reaction is titrated with Fe(NH4)2(SO4)2, which provides the O2 needed for the oxidation of the Organic Matter. This process is known as the Chemical Oxygen Demand (COD) test.

Metal analysis :

The estimation of metals in potable water, household waste water, and industrial effluents is crucial because certain metals are necessary, while others may negatively impact water users, waste water treatment systems, or the biological systems of water bodies. Metals can be satisfactorily determined using Atomic Absorption Spectrophotometer, Polarography, or Collimetric methods.

Arsenic: Arsenic is naturally occurring in all environmental media and is primarily present in compounds with sulfur and with many metals. The majority of arsenic found in water comes from industrial discharges; the higher concentrations, aside from those occurring naturally in spring waters, are typically in areas with high industrial activity.23

5. Mumbai

Materials and method

Study area:

Mumbai, the capital of Maharashtra state, is located along the west coast of India. It is surrounded by water bodies and connected to the mainland by a number of bridges. According to census records from 2001, Mumbai's population was 11.9 million. The city's sewerage system is divided into seven service zones. Currently, the west coast of Mumbai receives wastewater from Lovegrove, Bandra, Versova, and Malad service zones, with the remaining wastewater being discharged into Thane Creek (Mukherji 2002; Samant 2002). The study area for the present simulation lies between latitudes 18 855 0 to 19 820 0 N and longitudes 72 845 0 to 73 800 0 E . . This includes the west coast, drains/nallhas, and creeks Malad and Mahim.25

Fig 9: study area of Mumbai

Sample collection:

Eighteen samples were collected from states other than Kerala, including Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, and the Union Territory of Delhi. Eighty-seven samples were collected from the various retail outlets in Kerala. A total of 105 samples, representing 30 different brands, were analyzed. Bottled drinking water samples were collected from the retail outlets in India between April 2004 and August 2004.26

Bacteriological analysis :

Coliform bacteria were counted using the membrane filter method using m-FC medium, and 250 milliliters of the sample were filtered through sterile bacteriological filters (0.45 mm, Sartorius, Germany). The samples were analyzed for total plate count by the pour plate method, using tryptic soy agar (TSA). One milliliter and 0.1 ml of the undiluted water samples were aseptically plated in TSA and incubated at 25 1C for 96 h. All samples were plated in duplicate. The confirmation of coliform isolates was carried out in brilliant green lactose bile broth (BGLB). The isolates were inoculated into 10 ml sterile BGLB tubes and incubated at 37 1C for 24 h and checked for gas production. Gas production in Durham tubes submerged in BGLB medium was considered confirmatory for coliform bacteria. The filter was filtered using a sterile all glass membrane filter assembly (Whatman, UK). After filtration, the filter was aseptically transferred onto a surface dried sterile m-FC agar plate and incubated at 37 1C for 24 h. Typical coliform like colonies developed on m-FC agar were isolated, restreaked to ensure purity and maintained on sterile nutrient agar slants.26

Physical parameter:

Temperature and ph :

The temperature ranged from 26–34 C, with higher values in the summer; the observed pH was in the range of 7.0–8.2, which is within the recommended SW II standard. This pH range was favorable for the propagation of aquatic lives and did not cause either skin or eye irritation. The results for pre- and post-commissioning studies were comparable.

Dissolved oxygen:

At Breach Candy, the dissolved oxygen level consistently exceeded the SW II standard of 4 mg/l. Only 4% of samples had DO less than 4 mg/l, indicating minimal decline from the pre-commissioning status where all values complied with SW II. At Worli, only 10% of values are below the SW II Standard, compared to 14% in the pre-commissioning survey, indicating improvement. A mixed trend with minimal

variation in absolute DO values is observed when comparing pre- and post-commissioning data. Low DO even after moving the near-shore outfall can be ascribed to non-point sources of pollution from slums. At Bandra, DO consistently met the SW II standard and was comparable with the pre-commissioning phase. At Dadar, water was characterized by DO<4 mg/l in 25% of LT observations and 17% in HT.

Phosphate :

One nutrient parameter, the concentration of soluble phosphate (PO 4-P), was found to be in the range of less than 0.04–0.6 mg/l at almost all seafronts and beaches, with higher values recorded at Mahim and Dadar. Pre- and post-commissioning data showed a mixed trend, with no clear indication of improvement or deterioration.27

Most probable number (MPN) method:

For the presumptive test, test tubes containing Lauyrl-tryptose broth of single strength and double strength media were filled with water samples of volumes 10 ml, 1 ml, and 0.1 ml. The test tubes were then incubated at 37 °C for 24 hours. If the test tubes produce gas after 24 hours, the test is positive, and the MPN index is computed.

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Method and material: Area of Study: The hills in the "Sanjay Gandhi National Park," which are 246 meters above sea level, are home to the Mithi River, which flows through the center of Mumbai City, a metropolis and premier city of India. The river has come to be associated with all the problems that a river can have, including the encroachment of flood plains, storm water drainage, the disposal of untreated sewage, and the dumping of liquid and solid waste.29

Methodology :

According to SW II standards (CPCB1993), fecal coliform (FC), DO, and BOD are critical water quality parameters that are designated for bathing, contact water sports, and commercial fishing. DO and BOD are needed to evaluate the coastal waters' waste assimilative capacity, while FC is used as an indicator organism for water quality (Hacioglu & Dulger 2009). Hydrodynamics and water quality observations were conducted in May 2007 in order to conceptualize a preliminary model for a low discharge regime and generate a critical scenario for water quality.25

Fig 10: sources of water

6. Amravati :

Material and method

Study area:

AMARAVATHI is a town in the Guntur district of the Indian state of Andhra Pradesh, on the banks of the Krishna River. It is the headquarters of the AMARAVATHI mandal and is part of the Andhra Pradesh Capital Region. It is spread over an area of 1,524 ha (3,770 acres) and is 18.9 km from Vijayawada. The postal head office is AMARAVATHI, and the pin code is 522020. The local language is Telugu. The total population of AMARAVATHI is 13,400, with 3,316 households; 6,432 males and 6,958 females, representing a sex ratio of 1,082 females per 1,000 males; 1,321 children are between the ages of 0 and 6 years old, of which 647 are boys and 674 are girls, representing a ratio of 1,042 per 1,000; the average literacy rate is 71.34% with 8,617 literate, higher than 30 Amaravathi River lies between latitudes 11.20°N and 12.00°N and longitudes

77.28°E and 78.50°E in Karur district. It rises from Naimakad at an elevation of 2300 m above mean sea level in the Western Ghats in Idukki district of Kerala state. It flows toward northeast and eventually merges with the river Cauvery on its right bank. Amaravathi is a tributary of the Nankanchi, Shanmuganadhi, and Kodaganar Rivers, which join at 60, 40, and 20 km upstream of Karur town, respectively. It enters Karur district near Aravakurichi and merges with the river Cauvery near Kattali village. It receives water from numerous small streams over a course of 282 km and covers a total area of 8280 km2, primarily constituting four districts in Tamilnadu, namely Coimbatore, Erode, Dindigul, and Karur.31

Fig 11 : study area of Amravati

Methodology :

Raw water is collected (sampled) from the study area and analyzed to determine physic-chemical parameters (pH, electrical conductivity, hardness, chlorides, D.O., BOD, color, taste, odor, alkalinity, turbidity, TDS, etc.). The observed results are then calculated to compare the results with the Nemerov's pollution index method and the water quality index in order to rate the water quality.30 The characteristics that were analyzed included pH, odour, taste, color, transparency, total dissolved solids, conductivity, dissolved oxygen, salinity, total hardness, total alkalinity, total acidity, and fluorides . The World Health Organization's recommendations were the standard taken into consideration for the present study. The sampling locations of Amravati city of Maharashtra state in India have been studied.32

Physical parameter:

Water temperature: Although the weather is generally quite cool, the temperature of the water has a significant impact on the chemical and biochemical characteristics of the body of water. In 2012, a maximum temperature of 290 degrees Celsius was recorded in May, and a minimum temperature of 200 degrees Celsius was recorded in December. The summertime high temperature was caused by low water levels, high temperatures, and a clear atmosphere. Turbidity: Due to human activity and suspended particulate matter, the turbidity of water varies greatly, ranging from 30.9 NTU to 33.9 NTU. Total Dissolved Solids: This parameter varies between 600 mg/lit and 770 mg/lit, with a maximum of 770 mg/lit recorded in June due to heavy rainfall and a minimum of 600 mg/lit in May.

Dissolved O2: The value of the DO fluctuates from 7.65 mg/lit to 16 mg/lit. The maximum value 16 mg/lit was recorded in the month of May and the minimum value 7.65 in the month of November. The high DO in summer is due to increase in temperature and duration of sunlight has influenced on the of soluble gases O2 and CO2.

PH: the alkaline values range from 7.05 to 7.85. The maximum value was recorded in the month of April and the minimum 7.05 in the month of October. Most biochemical and chemical reactions are influenced by the PH.

Hardness: The hardness varies between 79 and 140 mg/lit. The maximum value of 140 mg/lit was recorded in the month of May, and the minimum was 79 mg/lit in the month of October. The reason for the high hardness during the summer is the decrease in water level and the increase in the rate of water evaporation.

Alkalinity: The total alkalinity varies between 118 and 165 mg/lit. The maximum value of 165 mg/lit was recorded in the month of May, and the minimum value of 18 in the month of January. The

alkalinity was maximum in May owing to an increase in bicarbonate in the water, and the lowest in winter owing to a high rate of photosynthesis.

Chloride: The value of chlorides varies between 22 mg/lit and 32.5 mg/lit, with the maximum value occurring in the month of May and the minimum in the month of January.33

The Kondeshwar Lake was the site of the current study. Water samples were taken in dark black 1-liter polythene bottles at monthly intervals between 9:00 am and 10:00 am. The spot parameters, such as pH, humidity, water temperature, and air temperature, were recorded at the sampling spot using a thermometer and a pocket digital pH meter. The water samples were then brought straight to the laboratory for the estimation of various physicochemical parameters, such as conductivity, TDS, dissolved oxygen, total alkalinity, total hardness, calcium, and magnesium. The physicochemical parameters were estimated using standard methods recommended by Kodarkar (1992)

CONCLUSION

The results were compared to the WHO and ISI 10500-91 water quality standards, and it was discovered that all of the samples under investigation had EC, PH, and turbidity values that were above the allowable limit. This indicates that the remaining parameters, such as BOD, COD, TDS, Alkalinity, Total Iron, DO, Zinc, Copper, Chloride, and Potassium, are all within allowable bounds. The presence of coliforms in household tap water may be caused by ineffectiveness in the manufacturing process of the treatment plant's treatment process. Further investigation is necessary. The detection of coliforms and E. Coli in the water reservoir itself is an indication of focal contamination of water from original source. The finding that the Municipality treated drinking water supply in Delhi-NCR was safe to drink, adequately treated, and of reasonably good quality was reassuring. The MCD water supplies' chemical parameters, including pH, total hardness, conductivity, turbidity, and TDS values, were mostly found to be within permissible limits .The findings show that the concentration levels for a number of physiochemical parameters are higher than the uppermost amounts that are allowed

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