Physico-Chemical and Bacteriological Assesement of Water Quality in Dindori Regions

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Abstract: **This study presents a comprehensive analysis of the physicochemical and bacteriological quality of drinking water across 118 villages in the Dindori district, Madhya Pradesh. Key water quality parameters, including pH, electrical conductivity, chloride, sulphate, and alkalinity, carbonate, bicarbonate, sodium, calcium, and magnesium as well as residual sodium carbonate, sodium adsorption ratio, dissolved oxygen, and biochemical oxygen demand were evaluated. While some parameters met the guidelines set by the World Health Organization (WHO) and Bureau of Indian Standards (BIS), several samples exhibited elevated levels, signaling potential health risks.**

The bacteriological analysis revealed alarming contamination, with a dominance of pathogenic bacteria such as Escherichia coli and Bacillus cereus, both indicators of severe faecal pollution. The widespread presence of coliform bacteria in many water samples confirmed the water's unsuitability for human consumption, posing a significant threat to public health. The findings underscore the urgent need for immediate intervention, including rigorous water treatment protocols like chlorination, to curb bacterial growth and prevent the spread of waterborne diseases. The study also highlights the critical role of public education on hygiene and sanitation in mitigating contamination, as anthropogenic activities, including improper waste disposal, have heavily polluted the groundwater systems. Without swift corrective measures, the region faces a heightened risk of disease outbreaks and long-term water insecurity.

INTRODUCTION

Water is most abundant and is an essential part of our life supporting systems. But due to the rapid growth of population, urbanization and industrialization the water has become polluted [1,2]. Water dissolves more substance than any other liquid, which is why it is known as the "Universal Solvent." This implies that water takes important chemicals, minerals, and nutrients with it wherever it travels—through the earth or into our bodies. The pH of pure water is 7, making it neither basic nor acidic. H_2O is the chemical formula for water. In recent years, ground water has quickly come to dominate India's agricultural and food security. Over the past three decades, it has emerged as the primary driver of irrigated area growth, and today it makes up more than 60% of all irrigated land in the nation. It is believed that irrigated agriculture, which heavily relies on ground water, produces more than 70% of India's food grains [3].

Geographical location too is quite important to make note of Dindori district, is located at 81 degree 34 minutes longitude and 21 degree 16 minutes latitude. Dindori district is surrounded by the Satpura mountain range and Jabalpur, Mandla, Shahdol and Umaria district of Madhya Pradesh and Bilaspur district and Kawardha district of Chhattisgarh. As a whole, the Dindori district covers a geographical area of approximately 6,128 square kilometers. Narmada River passes through the district. Dindori district is situated at a height of 1100 meters above sea level. In the Dindori district, soil is less fertile and divided into five parts. Domat soil area covers Kaudiya, Banja and Jaitpuri so this part is fertile. Narmada fertile area covers Jaitpuri, Umardha, Kudwari and Dindori. There are no rocks or gravelly soils in this district. In the irrigated tracts, soil under irrigation by river is sandy loam to alluvial sierozem. There is a seasonal river Narmada, which passes the district through Jabalpur.

During the summer, strong winds persist, dislodging the previous sand dunes and forming fresh ones. Since Dindori district is a part of the Great Indian district, may and June have the highest recorded temperatures, with a maximum temperature of 48.7°C and a minimum temperature of 18°C, while December and January have the lowest recorded temperatures, with minimum temperatures dropping as low as 2°C. Dindori average lowest temperature is 17.1°C in December and its average maximum temperature is 43°C in June. Dindori experiences a somewhat semi-arid climate.

Micro-organisms threat to the safety of drinking water is a growing peril even in industrialized nations that have long regarded themselves as immune to wide spread water borne illnesses and carriers so common in developing countries [4,5]. Microbiological pathogens including bacteria *(E. coli, Salmonella, Shigella, Vibrio 4150 eptica, Campylobacter, Yersinia, Klebsiella* etc.) and viruses (Hepatitis, *Cryptosporidium* etc.) are major health risks associated with water and waste waters [6-10]. Human or animal feces contaminating drinking water is the most frequent and widespread health danger. Water that is consumed by humans can likewise be contaminated with pathogenic microorganisms and may become a vehicle for human infection through *E. coli, Y. enterocolitica and Salmonella enteritidis* and many others also suggesting that the presence of high numbers of coliforms, heterotrophic indicator microorganisms and pathogenic strains indicate poor hygienic conditions of ice production and may represent a potential hazard to the consumers.

REVIEW OF LITERATURE

Water is basic continent of body mass in living cells. It covers 71% of the earth's surface and make up 85% of over bodies. Unsafe drinking water and poor environmental sanitation cause major health problems to the community. Safe drinking water must be free from bacteriological and chemical contamination. The bacteriological contamination in drinking water may cause diarrhea, dystentry, typhoid fever, cholera, jaundice etc. Dental, skeletal and non-skeletal fluorosis may be caused due to presence of excess fluoride in drinking water. Arsenic contamination in drinking water causes dermatosis. Methaemoglobinaemia (Blue Baby) among new born babies may be caused due to presence of excess nitrate in drinking water [11]. The biological contamination in water is major problem of public health in developing world. The fecal indicator bacterium (*E. coli*) has been considered as a bio indicator of fecal contamination of drinking water. It is excreted in the feaces of all warm-blooded animal and some reptiles. The major pathogenic bacteria responsible for water-borne diseases are spread by the fecal-oral rout in which water may play an intermediate role [12]. According to WHO estimate about 80% of water pollution in developing country, like India is carried by domestic wastes. The improper management of water systems may cause serious problems in availability and quality of water [13].

The biological contamination in water is major problem of public health in developing world. WHO estimates that about 1.1 billion people globally drink unsafe water and vast majority of diarrheal disease in the world (88%) is due to unsafe water, sanitation and hygiene [14]. Harish *et al*., [15] observed the status of drinking water in Tarikere Taluk special reference of fluoride concentration. It was estimated that ground water quality in the study area was much suitable with respect to fluoride concentration but as more than 65% of the samples have fluoride concentration above the permissible limits. Janardhana *et al*., [16] estimated TDS from EC and silica of ground water of Andhra Pradesh. He found that the multiple regression models did not improve the predictability of TDS values over the linear regression models for both post monsoon and pre-monsoon seasons. Joshi and coworker collected groundwater samples from different locations of Sambhar lake city and its adjoining area for their physico-chemical studies. Laboratory tests were performed for analysis of samples for total dissolved solids, EC and major ions e.g., Ca^{+2}, Mg^{2+}, NO_3^-, F^-, Na^+ and K^+. In this analysis, results for main ions contributing towards TDS and NO_3^- are being reported. On comparing the results against drinking water quality standards laid by Indian Council of Medical Research (ICMR) it is found that most of the water samples are non potable for human beings due to high concentration of one parameter or the other. Most of the samples have total dissolved solids values much higher than maximum permissible levels by ICMR, which is 1500 ppm. The high value of these parameters may have health implications and therefore, needs attention.

Bacteria as indicator species of organic pollution are a subject of topical interest. Clark *et al*., [18] worked on the municipal water supply to test the presence or absence of pollution indicating bacteria and found that the species of endemic nature were *E. coli, Enterobacter aergenes, Aeronomas hydophilla, Klebesiella pneumoniae* and *Citrobacter peundii,* Keswick and others 1982 worked on the continued existence of indicator bacteria and intestinal viruses in ground water. It is now almost certain that the surface wash off containing bacteria of all kinds, metallic and toxic effluents, gradually percolate in the earth stratum and reach the water table below. Faecal coliform are the coliform that ferment lactose in a medium with bile salt. The ratio of count of faecal coliform to faecal Streptococci projected as a mean

to differentiate between infectivity from human and animal source.

MATERIALS AND METHODS

The present investigation entitled "Physico-chemical and bacteriological study of drinking water in different areas of Dindori district, Madhya Pradesh" contains necessary details about the materials and methods used in the present investigation are as given below.

3.1 Study area

The ground water of Dindori is used for agricultural as well as drinking purpose. In the present study, 20 samples were obtained from various resources of Dindori district Madhya Pradesh

3.2 Glassware and plastic-wares used in study

Glassware of Borosil grade was employed in a number of investigations.

Beakers, Erlenmeyer flasks, Measuring cylinders, Micropipettes , Volumetric Flasks,Test tubes, Petridishes, Funnel, Spatula, Burette, Others

3.3 Equipment's used in study

The following Equipment's were used

S. No.	Equipment's
1.	Autoclave
2.	Colony counter meter
3.	Hot Air Oven
4.	Hot Plate
5.	Humidifiers
6.	Incubator
7.	Inoculation loop
8.	Laminar air flow chamber
9.	Loop Sterilizer
10.	Master plate
11.	Micropipettes
12.	Microwave oven
13.	pH meter
14.	Refrigerator
15.	Spreader
16.	Stirrer cum hot plate
17.	Water bath
18.	Water distillation unit
19.	Weighing balance

3.4 Sample collection

Samples of potable water were taken from the Dindori district of Madhya Pradesh's canal system. Sterilized sealed containers were used to gather these samples. When sampling water, disposable gloves cleaned with HCL (1N) were worn to prevent contamination. The water containers were transferred to the biotechnology lab for additional processing in less than six hours after being stored in airtight, sizable plastic ice-cold containers.

3.5 Physico-chemical analysis

Analyzed were the following physico-chemical parameters: pH, electrical conductivity, chloride, alkalinity, sulphate. Following methods were used to assess the quality of ground water.

3.6 Microbiological analysis

The work methodology utilized in the whole bacterial analysis is completed in the following manner. It includes enumeration, isolation, characterization and identification of microorganisms. Potable samples of water were gathered from canal water covers up to 26 km area of Dindori district.

3.6.1 Enumeration

Water sample dilutions of 10-6, 10-7, and 10-8 were utilized for counting. One millilitre of the suitable diluted suspension was added to petriplates that had 45°C melted agar medium in them. For every sample, duplicates of the experimental petriplates were raised. For a full day, the plates were incubated at 37°C in order to produce a viable colony. Using the spread plate and streak plate methods, individual colonies of the total coliform count were obtained on nutritional agar to determine the amount of coliform contained in the water sample.

3.6.2 Isolation

Three methods were used to finish the isolation process: spread plate, streak plate, and serial dilution

(Aneja et al., 2004). Not many of the bacterial colonies were added to the soup. The right amount of incubation, temperature, and growing time were used during the cultivation process. Using NA media (pH 7.0), the spread and streak plate method was used to finish the isolation of pure culture. After transferring a single colony, gram staining was performed at each stage to verify the culture's purity. After removing the bacterial colonies from NA, additional cultivation and biochemical testing were carried out, and the ideal conditions needed for the specific reaction were maintained.

3.6.3 Sub culturing

To preserve viability and metabolic activity, the bacterial isolates were sub cultured on agar slant of their corresponding media on a regular basis. Agar slants were kept in storage at 4ºC, which promotes growth, shields the cultures from evaporation-related damage, and prevents damage.

3.6.4 Preservation and maintenance

The isolates were kept in duplicates, one serving as a working culture for identification tests and the other as a stock culture from which fresh working cultures could be created as needed.

3.6.5 Bacterial identification

It involves primary and secondary identification.

3.6.5.1 Primary identification
The isolates were first identified based on their cultural traits on agar plates and microscopic inspections. These findings served as the foundation for choosing which biochemical tests would be run (Secondary Identification).

3.6.5.2 Secondary Identification

Based on their biochemical traits, which were detected to help in the identification and categorization of bacteria that were determined to be physically identical, the isolates were secondary identified. Many distinctive enzymatic activities were tested by observing the results by products or the action of enzymes on specific substance supplements on media.

3.7 Detection of the Faecal coliform, i.e. *E. coli*

The faecal coliform *E. coli* is detected using a particular medium that contains two substrates: 4-methylumbelliferyl-β-D-galactopyranoside (MUG) and O-nitrophenyl-β-D-galactopyranoside (DNPG) [19]. A 100 millilitre sample was streaked on sorbitol MacConkey's (SMAC) agar with potassium tellurite after being enriched for the entire night at 37°C in 50 millilitres of triple strength lauryl tryptose broth. MUG was used as the substrate in an enzyme β-D-galacuronidase assay for the sorbitol negative strains (SMAC-).

The test isolate was cultivated in a colony on MUG-impregnated filter paper. After that, it was wet with a saline drop and allowed to incubate at 37°C for 20 minutes. The absence of enzymes was indicated by the lack of fluorescence when exposed to UV light. Coliforms were found in the water samples, and their numbers were determined using the MPN (Multiple Probable Number) test.

3.8 Total Coliforms detection

The MPN (Most Probable Number) assay was utilized to ascertain the quantity of coliforms present in drinking water sample. Most Probable Number was computed using the Mackie and McCartney method [20]. The test consists of three steps that are carried out in sequential order: the finished, confirmed, and presumptive stages. Double-lactose broth (LB 2×) and single-lactose broth (LB 1×) were incubated with different water quantities (10 ml, 1.0 ml, and 0.1 ml) in the assumed test. For a confirmed test, tubes that produced gas were inserted into brilliant green lactose bile broth after being incubated for 24 hours at 35°C. Using the given statistical table [21], the MPN (Most Probable Number) of coliforms in water samples was then calculated.

A test that included inoculating an EMB agar plate, nutrient agar slant, brilliant green lactose broth, and creating a Gram-stain slide from NA slant was done to ascertain whether coliforms were present in the sample.

OBSERVATIONS

The observations are recorded during the present study entitled “Physico-chemical and bacteriological study of drinking water in different areas of Dindori district, Madhya Pradesh” are presented in this chapter under the following headings

A. Physico-chemical analysis

Table 4.1. Showing All variation in different sampling points

S.No.	Sampling points	Area	pH value	Electrical conductivity value in (mmho/cm)	Chloride value in (mg/L)	Sulphate values in (mg/L)	Alkalinity value in (mg/L)
1	C-1	Ajagar	7.21±0.23	0.38±0.15	37±1.20	10.18±0.32	74±1.34
2	C-2	Umardha	7.23±0.45	0.40±0.25	39±0.90	11±0.45	73.90±1.78
3	C-3	Trichhula	7.25±0.12	0.45±0.21	38±0.98	10.90±0.82	73±2.10
4	C-4	Surkhi	7.22±0.18	0.47±0.10	37±1.25	11.15±0.12	73±0.98
5	C-5	Jaitpuri	7.29±0.09	0.36±0.2	39±0.45	12±1.31	74±0.81
6	C-6	Ramhepur	7.28±0.21	0.52±0.12	36±1.38	12.13±0.89	74±.1.76
7	C-7	Mohtara	7.11±0.11	0.46±0.18	38±1.10	11.87±0.72	71.82±1.89
8	C-8	Sarai	7.12±0.15	0.42±0.11	40±0.82	11.91±0.36	72.95±2.03
9	C-9	Lalpur	7.05±0.16	0.40±0.07	38±0.86	11.52±0.88	72±0.45
10	C-10	Kaudiya	7.13±0.08	0.32±0.16	38±0.58	12±0.79	230±2.45
11	C-11	Gorakhpur	7.12±0.28	0.33±0.10	37±1.05	11±0.62	226±1.62
12	C-12	Pondi	7.15±0.24	0.32±0.13	37.73±1.40	10±1.92	224±1.13
13	C-13	Sitalpani	7.20±0.09	0.31±0.08	36±1.35	10±1.30	224±1.26
14	C-14	Kudwari	7.50±0.32	0.34±0.13	37.91±0.88	13±1.20	229±1.88
15	C-15	Banja	7.20±0.18	0.33±0.20	38±1.98	11±1.15	228±2.52
16	C-16	Patkui	7.10±0.45	0.48±0.12	39±0.97	11.50±0.98	73±1.20
17	C-17	Tantar	7.20±0.36	0.45±0.08	38±0.65	11.85±0.82	78±0.93
18	C-18	Bijauri	7.23±0.17	0.46±0.11	39±1.52	11.61±1.18	76±1.38
19	C-19	Madhopur	7.35±0.26	0.48±0.09	32.50±2.49	10.82±0.24	72±1.10
20	C-20	Sunpuri	7.10±0.42	0.39±0.25	35.90±1.68	11.76±0.76	74±1.62

B. Microbiological analysis

Microorganisms ranging from C-1 to C-20 were isolated and identified from study samples. The following headings were used to interpret the observations:

4.2.1 Occurrence of bacterial species in sampling points

4.2.2 Percentage of total isolated microorganisms

4.2.3 The pollution status of drinking water on the basis of *E. coli* contents (WHO 1984)

4.2.4 Incidences of bacteria in water samples.

4.2.5 Major diseases by bacterial species isolated from water samples.

Table 4.2.1 Occurrence of bacterial species in sampling points

Sampling Points	Micro-organisms									
	E. coli	*P. aeruginosa*	*Enterobacter sp.*	*Klebsiella sp.*	*P. vulgaris*	*A. faecalis*	*B. cereus*	*S. aureus*	*M. luteus*	*S. typhi*
C-1	+	-	+	+	-	+	-	+	-	+
C-2	+	-	+	+	+	-	-	-	-	+
C-3	+	-	-	+	-	-	-	+	-	-
C-4	+	+	-	+	-	-	-	+	-	+
C-5	+	-	+	+	-	-	+	-	+	+
C-6	+	-	-	-	+	+	-	+	-	+
C-7	-	+	+	+	-	-	-	-	+	-
C-8	+	-	+	-	+	-	+	-	-	-
C-9	+	+	-	+	+	-	+	-	-	+
C-10	+	-	+	-	-	-	-	-	+	+

C-11	+	-	-	-	+	+	+	-	-	-
C-12	+	-	-	+	-	-	-	+	-	+
C-13	+	+	+	+	-	-	-	-	-	+
C-14	+	-	+	+	+	+	-	-	-	-
C-15	+	-	-	-	+	+	-	+	+	-
C-16	+	-	+	-	+	+	-	+	-	+
C-17	+	+	-	+	+	-	-	+	+	-
C-18	-	-	+	+	+	-	+	-	-	+
C-19	+	+	+	+	+	+	-	+	+	+
C-20	+	-	+	-	+	+	-	-	+	+
Total	18	06	12	13	12	08	05	09	07	13

Table 4.2.2 Percentage of total isolated microorganisms

S. No	Isolates	Percentage
1	*E.coli*	*20%*
2	*Bacillus*	17%
3	*Alcaligenes*	13%
4	*Enterobacter*	11%
5	*Micrococcus*	11%
6	*Pseudomonas*	7%
7	*Staphylococcus*	7%
8	*Klebsiella*	4%
9	*Salmonella*	2%
10	*Proteus*	2%

Table 4.2.3 The pollution status of drinking water on the basis of *E. coli* contents (WHO 1984)

E. coli in per litre	Water pollution status
10,000	Heavily polluted
1000	polluted
100	Slightly polluted
10	Satisfactory
3 or less	Potable

Table 4.2.4 Incidences of bacteria in water samples

S. No.	Sampling point	SPC	TCC	FCC
1	C-1	21.3×10^4	32	+
2	C-2	23.0×10^4	33	+
3	C-3	20.3×10^4	38	+
4	C-4	11.6×10^4	28	+
5	C-5	24.6×10^4	31	+
6	C-6	26.2×10^4	36	+
7	C-7	9.3×10^4	26	-
8	C-8	8.9×10^4	29	+
9	C-9	20.8×10^4	34	+
10	C-10	22.0×10^4	31	+
11	C-11	8.3×10^4	38	+
12	C-12	22.3×10^4	29	+
13	C-13	19.5×10^4	34	+
14	C-14	20.7×10^4	41	+
15	C-15	23.3×10^4	39	+
16	C-16	21.5×10^4	32	+
17	C-17	9.6×10^4	26	+
18	C-18	8.6×10^4	33	-
19	C-19	24.6×10^4	29	+
20	C-20	28.5×10^4	37	+

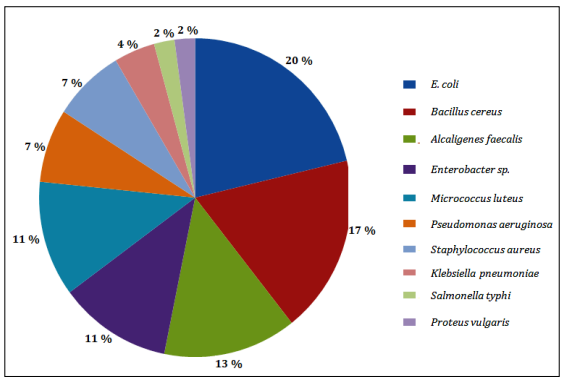
Fecal Coliform Count (FCC); Total Coliform Count (TCC);
(MPN index/100 ml); Standard Plate Count (SPC);

Table 4.2.5 Major diseases by bacterial species isolated from water samples

Name of Bacteria	Major Diseases
Escherichia coli	Urinary tract infection (UTI), enterotoxin, Traveler's diarrhea, foodborne disease, vomiting
Pseudomonas aeruginosa	Opportunistic infection in man, giving rise to inflammations ofmiddle ear, greenish pus
Enterobacter aerogenes	Food spoilage
Klebsiella	Pneumonia
Proteus vulgaris	Urinary tract infection (UTI)
Alcaligenes faecalis	Non-pathogenic
Bacillus cereus	Diarrhea, vomiting
Staphylococcus aureus	Food spoilage, chronic infections, abscesses, wound infection,vomiting
Micrococcus	A common skin flora

luteus	
Salmonella typhimurium	Typhoid fever

Percentage of total isolated micro-organism



RESULTS AND DISCUSSION

In order to explore Physico-chemical and bacteriological study of drinking water in different areas of Dindori district, Madhya Pradesh several experiments were conducted and observed with respect to the analysis of Physico-chemical parameters and microbiological parameters. The present study entitled "Physico-chemical and bacteriological studies on water quality in Dindori district, Madhya Pradesh" was done with two major steps:

5.1 Physico-chemical analysis

5.2 Microbiological analysis

5.1 Physico-chemical analysis

Numerous physico-chemical parameters were examined and discussed in this as well, including pH, electrical conductivity, chloride, alkalinity, sulphate, carbonate, bicarbonate, sodium, calcium, and magnesium as well as residual sodium carbonate, sodium adsorption ratio, dissolved oxygen, and biochemical oxygen demand.

5.1.1 pH determination

According to WHO and BIS specifications, the pH of water exhibits nearly consistent magnitude in all research samples, ranging from 7.05 to 7.50 This range is suitable for living systems. Poisons in water bodies may become more or less harmful depending on variations in the ideal pH ranges [22]. Morana River's pH was likewise in the alkaline range [23]. The water-containing pH values allowed by ISI are appropriate for residential use and irrigation.

5.1.2 EC determination

Rather than pH, electronic conductance reveals sample variability. Samples C-6 and C-13 showed the highest EC (0.52 mmho/cm) and lowest EC (0.31 mmho/cm), respectively. Other compounds become more soluble in water when the EC value is high. According to Ukpong EC (2013), electrical conductivity values from private borehole water samples ranged from 18.13 to 38.62 µs/cm, but public borehole water samples showed values between 89.18 and 103.00 µs/cm. According to Kirlna Jagloo (2002), the usual conductance range is between 2,000 and 4,000 mmho/cm.

Mishra and Bhatt [24] measured the electrical conductivity of borehole water in the Anand district of India and discovered that it ranged from 20.50 to 45.50 µs/cm. Lehloesa and Muyima (2002) reported comparable values of 18.80–60.00 µs/cm of subterranean water in the Victoria district of South Africa.

5.1.3 Chloride determination

Spatial variability chloride showed that study sample C-8 was rich in chloride content (40 mg/L) also its values are higher than Indian specification for drinking water (BIS 1993).

Chlorine must be applied in order to guarantee that drinking water is safe. People detect an odor that is irritating when there is two to three milligrams of chlorine per litre in the water. In consideration of the feeling of most people and the disinfection efficiency of residual dosage, WHO recommends that the residual chlorine in drinking water takes 0.6-1.0 mg/L as standard [25].

In the C-19 research sample, the minimum chloride concentration (32.5 mg/L) was noted. A higher chloride value indicates that the samples contain a lot of salt. One of the main anions present in water and waste water is chloride. Since chloride ions give water a salty flavour, the recommended maximum contaminant level is 250 mg/L. However, if calcium and magnesium ions are present, the chloride ions may not give water a salty taste until above 1000 mg/L. Sources of chloride might include natural geological formations and road salt storage in addition to human and animal waste. According to

ISI, the maximum amount of chloride that can be present in water is 1000 mg/L.

There is a strong correlation between this result and the chloride concentration of the groundwater in the Prakasam district [26]. The elevated chloride content is caused by soil erosion, salt dissolution, and effluent release into water sources. The high salinity may result from the disintegration of organic waste brought on by the release of industrial effluents containing high levels of chlorides.

5.1.4 Sulphate determination

Sulphate content in the water sample demonstrated that the sulphate contents of the various research samples differed significantly. Sample C-14 had the highest sulphate level ever measured, at 13 mg/L. C-12 had the lowest sulphate content (10 mg/L). Drinking water naturally contains sulphate, and because of its laxative properties, health concerns over its amount have been related to diarrhoea [27]. This is especially true when switching from low-sulphate to high-sulphate drinking water. This ion's secondary maximum contaminants level (SMCL) in drinking water is 250 mg/L, a value set as a benchmark for public water systems [28].

Higher sulphate concentrations enhance the overall solid content in water because they have a bivalent charge and a propensity to bind other metallic ions [29]. During the post-rainy season, groundwater samples were taken from ten different places in Ambattur town, yielding a sulphate value of 150–230 mg/L.

5.1.5 Alkalinity determination

Alkalinity in the water sample may not exceed 600 mg/L (ISI).

The dissolution of CO_2 in water causes alkalinity in natural waters. The resulting carbonates and bicarbonates dissociate to produce hydroxyl ions. Total alkalinity in the samples ranged from 71.8 to 229 mg/L; for domestic use, drinking water with an alkalinity of less than 200 mg/L is preferred. When determining the disinfection dosage for defluoridation and water treatment procedures, the alkalinity value is crucial [30]. Alkalinity is major factor for biochemical reaction in living systems. Compared to other samples, samples C-10 through C-15 displayed greater values. The lowest value (71.8 mg/L) was recorded in C-7, while the maximum value (229 mg/L) was achieved in C-14. Aquifer rocks are found to be high in carbonates in ground water scenarios [32].

5.2 Microbiological analysis

In the current study, water samples from 118 different villages in the Dindori district were analyzed for bacterial biodiversity. Of these, more Gram -ve bacteria than Gram +ve bacteria were found.

The standard procedures outlined by APHA [33] and AWWA [34] were followed when conducting bacterial assays. The potability of water is ascertained by bacteriological investigation. 500 colonies per millilitre is the highest amount of bacteria that can be present in drinking water in Canada. A moderate level of bacteria was present in all the water tests, above the permissible limit set by Canada. The proliferation of bacterial colonies may be caused by improper upkeep of water reservoirs and sewage seeping into borewells. 10 MPN/100 ml is the ideal coliform limit in water (ISI).

The mineral water (Aqua natural water) of Bhusawal corporation similarly showed the same total coliform values [31]. The ideal limit was surpassed by the remaining water samples. Both before and after the monsoon, the Umian lake water showed the same results of having a large amount of total coliforms [35]. The discharge of human and animal faces into water bodies was the cause of the high overall amount of coliforms.

It is commonly known that a wide range of infectious diseases are mostly spread by contaminated water supplies that contain human and animal waste, especially feces. Coliform bacteria can be classified as either total or faecal, depending on whether they share a common origin or set of traits. Faecal coliform bacteria, such *Escherichia coli* (E. coli), and other naturally occurring coliform bacteria found in soil are included in the total category. In addition to being present in human and animal intestines, faecal coliform bacteria can also be naturally found in soil and in body waste and animal feces [25]. Because their presence in drinking water may suggest the existence of potentially hazardous, disease-causing organisms, coliform bacteria are utilized as indicators of water quality. Additionally, it is rather easy and affordable to detect them in drinking water (Health Canada 2011).

No faecal coliform should be found in any 100 millilitres of drinking water, according to the WHO. The maximum allowable total coliform in any drinking water is 10 cfu/100 ml, according to the NSDWQ [36], even though faecal coliform should not be found in any 100 ml. based on the findings, it can be said that none of the subterranean water sources' drinking water samples are suitable for human consumption.

The potability of water is ascertained by bacteriological investigation. Indian standard (BIS 1981) states that no sample should have *E. Coli* in 100 ml and that 95% of samples should not include any coliform organisms or be identifiable in 100 ml of any two consecutive samples throughout the year. 10 MPN/100 ml is the ideal coliform limit in water (ISI).

As shown in the result (table 5) total 10 microorganisms from 118 isolates in which *E. coli* (20%), *Bacillus* (17%), *Alcaligenes* (13%), *Enterobacter* (11%), *Micrococcus* (11%) were identified in drinking water samples. The microbial species e.g. *E. coli, Bacillus, Alcaligenes, Enterobacter* and *Micrococcus* showed their presence in most of water samples. Two bacterial species e.g. *E. coli, Bacillus cereus* showed the maximum occurrences followed by *Alcaligenes, Enterobacter, Micrococcus and Pseudomonas.*

This study show that the presence of *E. coli* maximum in samples. Edenberg *et al*., 2000 suggested that *E. coli* can be used as potential indicator of water pollution. According to WHO water can be consumed if it has three or fewer E. Coli bacteria per 100 millilitres. The majority of the sites under study have water that is unsafe to drink, according to the WHO and ICMR. The presence of coliform groups in water may be caused by faecal pollution, which is the discharge of feces into the environment by people and other animals.

According to Klien and Casida [37], coliforms can be used as an indicator of the quality of water; if they are not found in 100 ml, the water can be used as drinkable water. Faecal coliforms (FCC), or *E. coli*, were found in the potable water samples, indicating the contamination of drinking water sources. Constantly consuming such tainted water could be extremely harmful to locals' health, especially for young children (under five years old).

In this investigation, common skin bacteria that cause skin diseases, such as *Micrococcus luteum* and *Streptococcus* lactis, were also found in a number of drinking water samples from various locations. The presence of these bacteria in drinkable water suggests that sewage or bathroom runoff has been mixed in with the water supply. The majority of villagers once bathed their animals and drank at the canal banks. It is most likely the cause of the skin bacteria that contaminated the canal water. Planning commission India's 2002 report [38] states that the following factors increase the risk of water contamination and water-borne illness in rural areas: insufficient water supply, low-quality water at the source, poorly maintained water pipelines and sewage systems, widespread open-air defecation, improper disposal of household, animal, and human waste, and a lack of knowledge about proper sanitation and personal hygiene practices. UTIs (Urinary tract infection) are also caused by *P. vulgaris*.

CONCLUSION

Some physico-chemical parameters in the area were not satisfying the requirements in the World Health Organization. Water quality of surface and ground water should be subjected to analysis regularly.

Study suggests that most of the water collected from ground water and drinking water is severely contaminated with several bacterial strains. The presence of bacterial strains indicates its pollution status. The bacterial strain *E. coli, Bacillus cereus* were commonly distributed micro-organisms in sample while some other strains like *Staphlococcus, Klebsiella, Salmonella* and *Proteus* showed their presence in less amount.

In this study gram -ve bacteria were more frequent in collected water samples. Results suggest that the ground water system in this region is under anthropogenic pressure. Human activities, disposal of industrial effluents and dead animal has polluted the water of system in this region. The presence of several coliform and pollution indicator pathogenic bacteria in collected water strong the above hypothesis. Chlorine showed drastic impact on bacterial growth. Our study suggests that chlorination could be performed before using of ground water for drinking purposes. Since, hygiene awareness must be an integral component of the primary education and a routine action plan for the local self-governments. In this respect it would be ideal to monitor the system in terms of the economic impact of water borne diseases.

The presence of these bacteria in drinkable water suggests that sewage or bathroom runoff has been mixed in with the water supply. The majority of villagers once bathed their cattle in ground water and drank from it. It is most likely the cause of the skin flora pollution of ground water. Overall findings indicated that the presence of coliforms in the ground water is the reason for its low nutritional value.

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