RESEARCH | ARTICLE

Physicochemical and Bacteriological Analysis of Drinking Water Samples from Urban Area of Patna District, Bihar, India

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ABSTRACT- This study is a comparative analysis of physicochemical and bacteriological quality of drinking water intake in the urban area of Patna District, Bihar state. A total of 68 drinking water samples randomly collected from 41 hand pumps, 14 municipal supply tap, 11 boring water and 2 well from 15 different locations of the urban area of Patna District. Samples were collected aseptically in 60 ml sterile plastic container for bacteriological and in 1 liter sterile plastic bottle for physicochemical parameter like pH, Total Hardness, Dissolved Oxygen, Biological Oxygen Demand, etc and compared with BIS (IS-10500). MPN test was applied to detect the presence of coliform in the drinking water samples. The total coliform count was detected in 57 out of 68 water samples. Most of the water samples were shown compromising physicochemical parameters. Total hardness (TH) is above the permissible limits detected in 60 out of 68 samples. Dissolved oxygen (D.O.) was also recorded below the standard for most of the samples. This results indicate that drinking water is highly in jeopardy to bacterial contamination. Construction of septic tanks near with boring and drinking water supply line short distance between water supply network and swage supply line poor constructed well head, cross contamination with waste water, Leakage in the pipe line is the main cause of water contamination.

Key-words- Drinking water, MPN count, Coliforms, Physico-chemical analysis, Bacterial, DO, BOD, pH

INTRODUCTION

Water is the most vital natural resource after oxygen for life of all living organisms from prokaryotes to higher eukaryotes. Demand for fresh water increases rapidly due to rising population and accelerate pace of industrialization [1]. People obtained their drinking water from surface and underground sources. These sources could be contaminated by microbial and chemical pollutants come with domestic waste water, sewage, etc [2]. Increase in urbanization, industrialization and various anthropogenic activities have increased the surface and ground water pollution. Not all bacteria present in water are harmful but it is the kind of specific microorganisms which are pathogenic causes water borne diseases. Their presence in water indicates contamination of water supply with fecal matter [3].

Coliforms are the major microbial indicators for monitoring water quality. These are rod shaped, non-sporing, motile or non motile, gram negative, aerobic and facultative or anaerobic bacteria that ferment lactose with gas formation within 48 hours at 37^0C. They are commonly found in intestinal tract of men and animals and considered as indicator organisms, used all over the world to establish the degree of faecal pollution in water. Faecal polluted materials always contain coliforms [4]. Most Probable Number (MPN) test is a specific test to determine the presence of coliform in a given samples. Coliforms ferment lactose with the production of gas, bacteria other than coliforms do not ferment lactose and they do not produce gas. Faecal contaminate drinking water can spread diseases like hepatitis, cholera, dysentery, typhoid and diarrhea. Diarrhea is considered as most important water borne disease, which affects 40% children under 5 years old.

Dissolved oxygen (D.O.) and Biological Oxygen Demand (B.O.D.) indicates the organic compounds in water. B.O.D. is the volume of oxygen required by the bacteria metabolizing organic compound under aerobic condition. The magnitude of B.O.D. is related to the amount of organic material in wastewater. Total hardness indicates the presence of Mg and Ca salts in water.

MATERIALS AND METHODS

Analytical works were carried out in the laboratory of the Department of Biotechnology, A. N college of Patna during the month of March to May 2017.

Study site

Patna is situated between 24^0 97'–$25^0$57" North latitude and 84^0 44–86^0 49" East longitude at an elevation of about 129 meters above mean sea level. In the national physiographic, its main land is sandwiched between the high Himalayan ranges in the far north and the hilly tracts of Chota Nagpur in the south (now in Jharkhand state). The most significant feature of the city is its linear characters. It is about 20 km long (from east to west) and 4 km width (from north to south). The river Ganga flows all along the north of the city.

Determination of physicochemical parameter of drinking water

Determination of total hardness of water: To determine the total hardness of water samples, 50 ml of the water sample was pipette out in conical flask. One ml of ammonia ammonium chloride buffer solution and 2-3 drops of Eriochrome black T indicator were added in the water sample. The color of the solution turns on wine red. This solution was titrated against previously standardized EDTA solution taken in the burette until the color changes from wine red to sky blue, which indicates the end point. The final reading of the burette was noted and the titration was repeated to get total concordant value. Finally using the analytical calculation, total hardness of water samples was determined in terms of mg/L of $CaCO_3$ [5].

Determination of pH: The pH of the sample was determined by the using digital pH meter (Systronics Model No. 361).

Determination of Dissolved oxygen (D.O.) and Biological oxygen demand (B.O.D.): For the determination of dissolved oxygen, samples were collected in B.O.D. bottle (Borosil 300 ml) and they were fixed at the site and brought immediately to laboratory and were analyzed by Wrinkler's method [6]. D.O. and B.O.D. were analyzed as per the norms of APHA [6]. Total 68 samples from 15 different locations of the Patna urban area were collected in 10 days interval in a routine manner.

Determination of Bacteriological analysis

Bacteriological analysis was carried out for indicator organism i.e. Total and Fecal coliform [7-8].10.3 gm of MacConkey broth was dissolved in 100 ml of distilled water and was autoclaved at 121^0 C for 15 minutes and then cooled in room temperature. Ten ml of this solution were filled in test tubes and a Durham's tube was added in an inverted position in each test tube plugged with non absorbent cotton plug. Again 5.15 gm of MacConkey broth was dissolved in 100 gm of distilled water and was autoclaved at 121^0C for 15 min and then cooled in room temperature, 10 ml of this solution were filled in test tubes and a Durham's tube was added in inverted position in each test tube plugged with non absorbent cotton plug. Fifteen tubes MacConkey broth (Hi media Pvt. Ltd., Mumbai) arranged in three sets of test tubes. First set containing 10 ml of double strength MacConkey broth was inoculated with 10 ml of water sample. Second set containing 10 ml of single strength MacConkey broth was inoculated with 1 ml of water sample. Third set containing 10 ml of single strength MacConkey broth was inoculated with 0.1 ml of water sample, respectively incubated, in an incubator at 37^0C for 48 hours. After incubation, the acid and gas production had occurred in the form of the bubble was counted and the MPN of coliform in 100 ml water sample were estimated [9].

RESULTS AND DISCUSSION

Physicochemical analysis of boring water sample shown pH value maximum 7.66 and minimum 6.10, while the pH of municipal supply water recorded maximum 7.79 and minimum 7.28. The pH value for hand pump-water was recorded 7.48 maximum and 7.30 minimum. Dissolved oxygen in boring water was maximum 5.6 mg/L and minimum 1.6 mg/L whereas municipal water supply shows dissolved oxygen maximum 5.6 mg/L and minimum 1.2 mg/L. Dissolved oxygen for hand pump recorded maximum 5.2 mg/L and minimum 1.6 mg/L and for the two well water samples dissolved oxygen were 5.6 mg/L and 3.0 mg/L.

Biological oxygen demand (B.O.D.) recorded for boring water maximum 1.6 mg/L and minimum 0.2 mg/L whereas for municipal water supply maximum was 1.6 mg/L and minimum 0.2 mg/L. B.O.D. for hand pump water recorded maximum 2.2 mg/L and minimum 0.2 mg/L and for the two well water were 4.0 mg/L and 3.0 mg/L.

Total hardness of boring water recorded was maximum 366 mg/L, and minimum 184 mg/L whereas in municipal water supply maximum total hardness was 368 mg/L, and minimum 188 mg/L. Total Hardness for hand pump was recorded maximum 582 mg/L, and minimum 112 mg/L, and for the two well water samples total hardness was 260 mg/L, and 244 mg/L.

Out of 68 samples, results of MPN test were positive for 57 water samples, which confirm harmful bacterial contamination. All the results obtained from the present study are shown in Table 1 to Table 3.

Table 1: Results of Physicochemical and Bacteriological Analysis of Hand pump water

S. NO	Sample type	MPN	MPN index	D.O.	B.O.D.	T.H	pH
1	HP	5-5-5	>1600	3.2	0.2	290	7.22
2	HP	5-5-3	900	3.2	0.2	346	7.46
3	HP	0	<2	3.6	2.0	206	7.35
4	HP	5-5-5	>1600	3.2	1.2	248	7.36
5	HP	5-5-3	900	2.8	0.8	184	7.21
6	HP	5-5-2	500	4.0	1.0	112	7.48
7	HP	5-5-5	>1600	3.6	0.6	284	7.09
8	HP	5-5-5	>1600	2.8	0.8	278	7.16
9	HP	5-5-5	>1600	2.8	0.8	344	7.20
10	HP	5-5-5	>1600	3.2	0.2	428	7.40
11	HP	0	<2	3.6	0.6	334	7.40
12	HP	5-5-3	900	3.6	0.6	204	7.21
13	HP	5-5-5	>1600	3.2	0.2	298	7.16
14	HP	5-5-5	>1600	3.6	0.6	276	7.33
15	HP	5-5-5	>1600	3.0	0.2	180	7.27
16	HP	0	<2	3.2	1.2	310	7.44
17	HP	5-5-3	900	4.0	1.0	214	7.22
18	HP	5-5-5	>1600	3.2	0.2	560	6.70
19	HP	5-5-5	>1600	3.2	0.2	582	6.70
20	HP	5-5-5	>1600	2.8	0.8	396	6.97
21	HP	5-5-5	>1600	3.2	0.2	304	7.20
22	HP	5-5-5	>1600	2.8	0.8	342	6.80
23	HP	5-5-5	>1600	3.6	1.6	140	7.20
24	HP	5-5-0	240	3.2	0.2	422	6.85
25	HP	0	<2	5.2	1.2	434	6.48
26	HP	5-2-1	70	2.0	0.2	324	7.40
27	HP	5-5-2	500	4.2	1.2	206	7.08
28	HP	0	<2	4.2	1.2	296	7.35
29	HP	0	<2	4.2	1.2	206	7.30
30	HP	5-5-4	1600	4.6	0.6	296	7.35
31	HP	0	<2	5.2	2.2	206	7.20
32	HP	5-5-1	300	3.2	0.2	228	7.00
33	HP	5-5-5	>1600	3.2	0.2	228	6.80
34	HP	5-5-5	>1600	2.0	0.2	210	6.80
35	HP	5-5-5	>1600	2.8	0.8	308	7.46
36	HP	5-5-5	>1600	1.8	0.3	368	7.15
37	HP	5-5-5	>1600	1.6	0.2	224	7.00
38	HP	5-5-4	1600	2.0	0.2	242	7.80
39	HP	5-2-2	500	1.8	0.3	190	7.20
40	HP	0	<2	2.0	0.4	260	7.47
41	HP	0	<2	4.0	1.0	248	7.20

HP- Hand Pump, D.O- Dissolved Oxygen (mg/L) , B.O.D- Biological Oxygen Demand (mg/L) , T.H- Total Hardness (mg/L)

Table 2: Results of Physicochemical and Bacteriological analysis of Municipal supply water

S. No.	Sample type	MPN	MPN index	D.O	B.O.D	T.H	pH
1	M.S.W	5-5-5	>1600	2.8	0.8	222	7.31
2	M.S.W	5-5-3	900	2.8	0.8	208	7.45
3	M.S.W	5-5-0	240	3.2	0.2	206	7.56
4	M.S.W	5-5-0	240	3.2	0.2	200	7.50
5	M.S.W	5-4-0	130	2.2	0.2	244	7.49
6	M.S.W	5-5-1	300	2.4	0.4	194	7.79
7	M.S.W	4-3-1	33	5.6	1.6	368	7.60
8	M.S.W	5-5-5	>1600	2.0	0.2	188	7.47
9	M.S.W	5-5-5	>1600	1.6	0.2	286	7.48
10	M.S.W	3-2-1	17	3.2	0.2	288	7.00
11	M.S.W	5-4-4	350	1.2	0.2	280	7.30
12	M.S.W	5-3-0	80	3.2	0.2	278	7.32
13	M.S.W	0	<2	2.8	0.4	214	7.28
14	M.S.W	5-5-0	240	3.2	0.2	242	7.28

M.S.W- Municipal supply water, D.O- Dissolved Oxygen (mg/L), B.O.D- Biological Oxygen Demand (mg/L), T.H- Total Hardness (mg/L)
Table 3: Results of Physicochemical and Bacteriological analysis of Boring and Well Water

S. No	Sample type	MPN	MPN index	D.O.	B.O.D.	T.H	pH
1	BW	0	<2	1.6	0.2	336	7.00
2	BW	5-3-2	140	2.4	0.4	284	7.44
3	BW	5-3-2	140	3.2	0.2	184	7.46
4	BW	5-3-2	140	2.0	0.2	192	7.42
5	BW	5-5-3	900	3.2	0.2	188	7.45
6	BW	5-4-2	220	2.8	0.8	284	7.47
7	BW	5-3-2	140	2.0	0.4	366	7.40
8	BW	5-5-5	>1600	3.2	0.4	300	6.10
9	BW	5-5-2	500	3.2	0.4	190	7.66
10	BW	5-2-0	50	2.2	0.6	258	7.44
11	BW	5-5-3	900	2.8	0.8	210	7.44
12	WW	5-5-5	>1600	5.6	1.6	244	7.15
13	WW	5-5-5	>1600	3.0	1.0	260	7.30

BW- Boring water, WW- Well water, D.O- Dissolved Oxygen (mg/L), B.O.D- Biological Oxygen Demand (mg/L), T.H- Total Hardness (mg/L)

Graphs were also developed to show the results obtained from the experiment in Fig. 1 & 2.
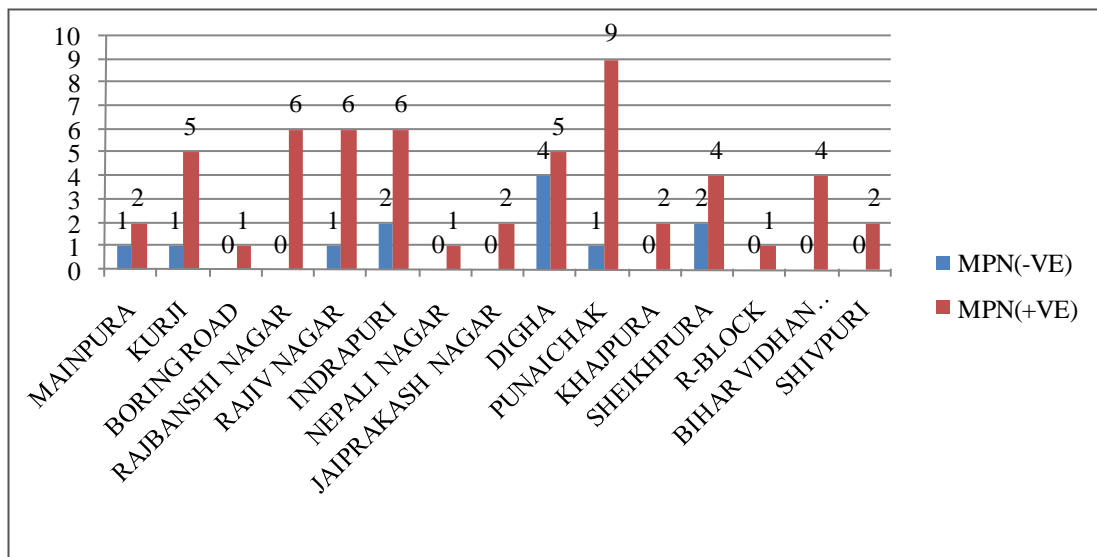

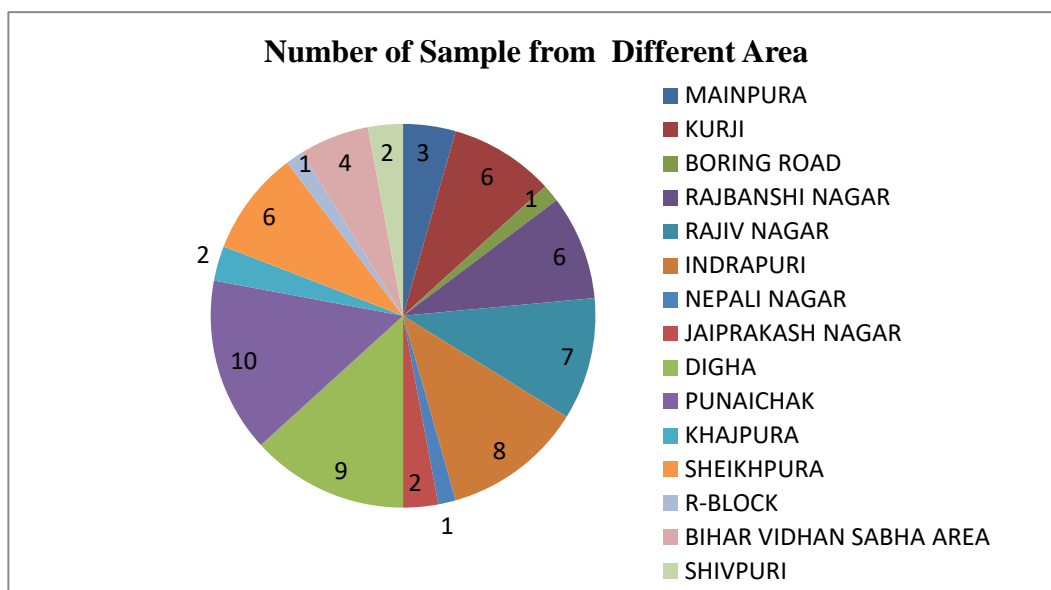**Fig. 1:** MPN results of the samples collected from different area of Patna urban area

Fig. 2: Total number of sample collected from different location of Patna district

From the observation of physicochemical analysis, which is represented in the Table 1 to Table 3. It is shown that the pH value for 67 water samples was found to be under the permissible limit (6.5–8.5) and pH of 1 sample found to be slightly acidic (6.10).

Thirteen out of 41 water samples of hand pump water shows greater Total Hardness value than the permissible limit (300 mg/L). One water sample from each B.W and M.S.W shows increased total hardness.

The B.O.D value for all the water samples were lower than the standard value (2 mg/L) except one hand pump water sample which has higher B.O.D value (2.2 mg/L). The D.O for all the samples was lower than the standard value (6 mg/L).

The MPN values of all the water samples were found out using multiple tube tests and out of 68 water samples tested, 54 water samples exceed the permissible limit (50/100 ml). The permissible limit taken from BIS [10]. Sirajudeen et al. [11], Manjesh et al. [12], and Rajankar et al. [13] also carried out a similar type of work and the parameter was compared with BIS.

CONCLUSIONS

According to the parameters given by APHA, the presence of coliforms in given water samples indicates that the water is polluted and not of potable quality. The presence of coliform in drinking water may cause various diseases like cholera which is highly destructive. The presence of coliform in drinking water supplies may be either due to malfunctioning of treatment plant or to the infiltration of sewage water through cross connection, leakage points and back siphonage. Water sources must be protected from contamination by human and animal waste, which contains hazardous microbes. A regular monitoring of water quality is needed to protect if further polluted.

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