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Quality of Drinking Water in Patna

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Quality of drinking water in Patna with a view to determine the extent of its deterioration has been looked into. Attempts have also been made to find the best source of drinking water available to the people. 15 different sites, 3 from each zone (north, south, central, east & west), were randomly selected for sample collection. Further, from each site 3 types of water samples (municipal supply, surface tube well, deepboring) were collected. The collected samples were analysed on a total of 10 physical, chemical and biological parameters. The degree of deterioration in quality of drinking water of the collected samples was compared with the permissible limits of Bureau of Indian Standard (BIS). The various analysis revealed that physical, chemical and biological parameters were well within the permissible limit of BIS, but turbidity of almost 6 resources of the 5 zones exceeded the permissible limit. This suggested that these samples have high content of clay, silt, organic matter, phytoplankton. The quality of drinking water in three areas of central zone areas of Patna is more deteriorated as compared to other zones. The present study also suggested that deeper aquifers, which commonly are used for drinking water supplies, are relatively free from contamination.

Key words:- *Quality of drinking water; Physical, Chemical and Biological parameters; Coliform test, Turbidity, Deeper aquifers, BIS.*

Introduction : Groundwater is used for domestic, agricultural and industrial purposes in most parts of the world. The major sources of water are rainfall, surface water involving rivers, lakes and groundwater involving wells and bore wells etc. But groundwater is the only alternative option for drinking or cooking purposes even in the urban centres having well-planned, designed and properly executed water supply system. The groundwater potential and its quality level in major cities and urban centres is getting deteriorated due to the population explosion, urbanization, industrialization, failure of the monsoon and improper management of rain water.

The groundwater quality is normally characterized by different physiochemical characteristics. These parameters change widely due to the various types of pollutants. Fertilizers and pesticides from agricultural discharges, highly degradable organic material from detergents, industrial effluents, various viruses and bacteria from sewage, domestic waste are the major pollutants. These pollutants are added to the groundwater through leakage from gasoline storage tanks, improperly designed, located and maintained septic tanks, seepage from municipal wastes etc. Since the groundwater is part of the hydrological cycle, contaminants in other parts of the cycle, such as the atmosphere or bodies of surface water can eventually be transferred into our groundwater supplies (Jain, De1998 Trivedy et.al.1986).

In Patna, seepage from dump garbage into groundwater serves to be the most alarming problem in deteriorating the quality of drinking water.

Materials and Method :

For the present study 15 locations in Patna, 3 from each zone (north, south, central, east, west), and further from each location 3 types of water samples were collected (supply, tube well, deepboring) in month of July making a total of 45 water samples. The water samples from the sampling locations were taken after flushing water for about 10 to 15 minutes. The samples were collected in the pre- cleaned polythene bottles with necessary precautions. The temperature and pH of the samples were noted at their sampling point. The samples were put for examination in the laboratory to determine the physical, chemical and biological parameters. These include

- Physical parameters: Temperature by reversing thermometer method, pH by pH meter, conductivity by conductivity meter, turbidity by turbiditimeter.
- Chemical parameters: Nitrate by phenol disulfonic acid method, iron by Mohr's salt titration method, chloride by argenometric method, total hardness by Ethylene Diamine Tetra acetic Acid (EDTA) method, total alkalinity by titration using methyl orange as an indicator.
- Biological parameter: Total Coliform by presumptive test (Mancy 1971,Talling et.al,1978,Diamant 1974).

Average values of each zone for the 3 types of water samples were estimated and the results were compared to Bureau of Indian Standards.

Different locations selected for collection of water samples in Patna, are as follows:-

1. A.N.College
2. Kurji
3. Rajapur
4. Mahendru
5. Chaudary Tola
6. Gandhi Maidan
7. Bahadurpur
8. Kankarbagh
9. Hanuman Nagar
10. Mithapur
11. Karbigahiya
12. Chandmari Road
13. Sastri Nagar
14. Punaichak
15. Rajbansi Nagar

Results and Discussion :

The increase in temperature of water leads to the speeding up of the chemical reactions in water, reduces the solubility of gases and adversely affects the taste and odour. Temperature of the samples lies between the range of 18.3-21.6ºC which is well within the maximum permissible limit of BIS (30 ºC). Temperature of tube well and supply are almost equal. While deepborings give much lower value in all zones. Among deepborings temperatures of south and central zone are much higher than the other zones. (Table – 1)

pH affects the solubility and thus bioavailability of other substances. Significant changes in pH occur due to disposal of industrial wastes. The collected water samples have pH within the maximum permissible limits of BIS (8.5) i.e. ranging from 6.9- 7.33. pH of tube well resource shows higher value, central Patna having the highest value, compared to other zones. (Table – 2)

Presence of salt and contaminants with waste waters increase the conductivity of the water. Its role mainly lies in determining the suitability of water for irrigation. Conductivity of water samples varied from 3.27- 4.83 µS/cm which is well within the permissible limit of BIS standard (i.e. 1400 µS/cm).Conductivity of all zones of Patna are comparable with slight differences in value but supply water of south zone shows the highest value. (Table – 3)

Turbidity makes water unfit for domestic purposes, food, beverage and many other industrial uses. A reduction in turbidity is associated with reduction in suspended matter and microbial growth. Turbidity in natural waters restricts light penetration for photosynthesis. Turbidity of the samples lies between 8.3 -11 NTU *(Nephelometric Turbidity Units)*. Turbidity of supply water of north zone and tube well of all the zones except south zone exceeds the BIS permissible limit (10 NTU). But of the 5 zones, the eastern zone was far exceeding the permissible limit. This suggests high content of clay, silt, organic matter, phytoplankton and other microscopic organisms (Table – 4) in the water of this zone.

Table 1: Water temperature (in ºC)

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	21.0	21.3	21.6	21.0	21.6
Tube well	20.0	21.0	21.3	20.6	21.3
Deep Boring	18.3	20.0	20.0	19.0	19.0

Table 2: pH of 5 water in zones of Patna

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	7.13	7.16	7.33	6.9	7.16
Tube well	7.12	7.26	7.4	7.12	7.3
Deep Boring	7.16	7.16	7.19	6.9	7.13

Table 3: Conductivity of water (in µS /cm) in 5 zones of Patna

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	3.98	4.83	3.68	3.66	3.69
Tube well	3.79	3.56	3.66	3.67	3.95
Deep Boring	3.41	3.27	3.84	3.68	3.47

Table 4: Water Turbidity of 5 zones of Patna (in NTU)

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	10.6	9.3	9.6	11	10.0
Tubewell	10.3	9.6	10.3	10.6	10.6
Deep Boring	9.0	9.0	9.0	8.3	8.6

Nitrates are of prime concern when the concentration of nitrates exceeds 40 mg/l it leads to blue baby syndrome. In cattles, the high concentration of nitrates is reported to cause more mortality in calves and even abortion in brood animals. High nitrate can reduce body assimilation of Iodine thus causing goitre in humans (Santra 2005). Nitrate content of water sample lies in the range from nil to 37.10 mg/l and does not exceed 100 mg/l proposed as the permissible limit by BIS. Supply samples comparatively showed higher value for nitrate content, but north zone had the highest value for its tubewell sample. (Table – 5)

Iron in excess of 0.3 mg/l causes staining of clothes and utensils. Higher concentration of iron is not suitable for processing of food, beverages, ice, dying, bleaching, and many other uses. Iron in higher concentration causes vomiting. Potatoes turn black on boiling in such types of water(Pinto 2007). High content of heavy metals in water causes kidney damage, bone damage, nervous disorder and cancer. But the heavy metal Iron as analysed in our samples was found in the range nil to 0.34 mg/l, i.e., within the permissible limit as proposed by BIS (1 mg/l). Iron content of tube well sample of central zone was higher than those in other zones. (Table – 6)

The most important source of chlorides in water is the discharge of domestic sewage. It produces a salty taste at 250-500 mg/l level. High chloride content harms growing plants and agricultural crops (Pinto 2007). Chloride content of water sample lies in the range from 120.3- 169 mg/l which does not exceed the permissible limit proposed by BIS (1000 mg/l). Supply sample of central zone contained higher chloride than other resources showing that water of central zones are difficult to be distributed due to their corrosive effect on supply water pipes. (Table-7)

Hardness in water leads to heart disease (Peter, 1974), kidney stone formation etc, and makes water unfit for drinking, washing, cleaning and laundering. However, in certain conditions it forms a thin layer of scale thus preventing corrosion in pipes hence reduces the entry of heavy metals from the pipes to the water(Environmental toxicology). Total Hardness (as $CaCO_3$) of collected samples lies in the range from 233-258.3 mg/l which is within the highest permissible limit of BIS standard (600 mg/l). Total hardness of supply sample of eastern zone was higher as its shows the highest value. (Table – 8)

Total alkalinity is the measure of the water to neutralize a strong acid. The alkalinity value is important in calculating the dose of alum added in supply water, and waste water treatment process. Total Alkalinity (as $CaCO_3$) of water sample is within the range of 220-286.6 mg/l and is within the permissible limit proposed by BIS (600 mg/l). Among the resources deepboring samples were most alkaline. However, as the values of alkalinity of samples are within permissible limit so the taste of water does not change and remains in its natural state. (Table – 9)

Table 5: Nitrate content in mg/l in 5 zones of Patna

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	34.33	00.00	34.33	23.33	12.00
Tube well	37.10	22.00	34.00	23.33	00.00
Deep Boring	19.00	30.66	28.66	0.00	00.00

Table 6: Iron content in 5 zones of Patna (in mg/l)

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	0.31	0.2	0.24	0.00	0.17
Tube well	0.32	0.16	0.34	0.00	0.17
Deep Boring	0.02	0.33	0.22	0.09	0.19

Table 7: Chloride content (in mg/l)

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	165.3	123.3	169	129	125.6
Tube well	165	123.3	167	128.6	121.3
Deep Boring	159.3	120.3	164.6	129	120.3

Table 8: Total hardness in mg/l in 5 zones of Patna

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	245	235.6	253	258.3	233
Tube well	242	235.6	252	251.3	233.6
Deep Boring	224	248.6	258	225.3	234

Table 9: Total alkalinity in mg/l

Sources/Zones	North Patna	South Patna	Central Patna	East Patna	West Patna
Supply	259.6	232.3	231.6	237.3	230.3
Tube well	271.3	236.3	238.6	246	226.6
Deep Boring	266.6	286	286.6	264	220

Coliforms are defined as facultative anaerobic, gram-negative, non- sporing, rod- shaped bacteria that ferment lactose with the production of acid. Coliform make up approximately 10% of the intestinal microorganism in humans and can be used as indicator organisms of faecal contamination. Total Coliforms are completely absent in the collected water samples. But it suggests that the shallow boring generally are at greater risk of contamination. Deeper aquifers, which commonly are used for public drinking water supplies, are relatively free from contamination.

Conclusion :

In the current study on physiochemical parameters of water, it can be concluded that samples collected from different locations in Patna were fit for drinking. But some fluctuations due to seasonal variation may decrease its potability. Water must be boiled, cooled, filtered and then used for drinking purposes. Turbidity of some samples were high suggesting high content of clay, silt, organic matter, phytoplankton and other microscopic organisms but total coliforms are absent. Quality of drinking water in central zone of Patna is more deteriorated as compared to other zones. Therefore water needs to be filtered before drinking in these areas.

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