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Potability of Water Among the Tribals of Vizianagaram Sub-plan Area, Andhra Pradesh: Microbiological and Physico-Chemical Analysis

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ABSTRACT The microbiological and physico-chemical parameters of drinking water samples from two villages of Vizianagaram District were monitored. The microbiological analysis of Janjavathi river water showed very high faecal coliform counts and large number of colony forming units (Cfu) i.e., 540/100ml and 2.18 x 10^8 / ml as determined by MPN test and standard total plate count methods respectively. Borewell water from Sominaiduvalasa village showed 1600 coliforms per 100 ml sample and 4.3 x 10^9 cfu/ml, suggesting that these waters are highly polluted with microbial pathogens and therefore are non-potable. Physico-chemical parameters such as pH, conductivity, Total Solids(TS), Total Dissolved Solids (TDS), total hardness, Calcium hardness, Magnesium hardness, chlorides, flourides, sulphates and Iron were beyond the permissible limits in borewell water indicating that this water is non-potable.

INTRODUCTION

High incidence of water borne diseases viz., gastroenteritis, amoebiasis, bacillary dysentery and occasional cholera among the tribals could be partly due to their unhygienic practices and use of highly contaminated water which possess higher amounts of minerals and other pathogenic microorganisms than the permissible limits. As the quality of drinking water available in Vizianagaram sub-plan area has not been scientifically established so far, it is conceived in this study to collect drinking water samples from various sources like springs, rivers, bore wells and conduct microbiological, physico-chemical tests. Accordingly results obtained from the villages are presented in this paper.

Water samples were collected from Janjavathi river in Banjukuppa village, with a total population of 240, inhabited by Jatapu and Savara tribes, and borewell water from Sominaiduvalasa village, with a total population of 630, inhabited by Jatapu and Konda Dora tribes. Janjavathi river water is used by several other tribal villages as a source of drinking water. These two villages are situated in Komarada Mandal and come under Komarada and K.R.B. Puram P.H.Cs respectively. The results of various parameters tested were compared with standard permissible limits.

MATERIAL AND METHODS

The water samples were collected in sterile containers and immediately stored in the refrigerator until the microbiological analysis was completed. For microbiological analysis, two methods employed were MPN (Most Probable Number) and standard total plate count method. MPN test was performed in order to detect Escherichia coli, the indicator organism, and the presence of which in water sample may be scored as positive for faecal contamination of drinking water. The total plate count reveals the magnitude of bacterial contamination of the sample. Total plate count was done using serial dilutions of water samples. The physical parameters of water samples such as pH, salinity, turbidity, and conductivity were determined, using specific meters. The chemical parameters such as the total solids, total dissolved solids, total suspended solids, total hardness, calcium hardness, magnesium hardness, chlorides, fluorides, nitrates, sulphates, phosphates and iron were analysed in the laboratory as per the standard methods (APHA,1985; SUESS,1982). Various types of hardness and chlorides were estimated using volumetric analysis. The fluorides were estimated by using fluoride meter (Elico-CL 352 model). The nitrates, phosphates, sulphates and iron were estimated by Spectrophotometric methods (systronics). All the concentrations

were expressed in mg/L of water samples.

RESULTS AND DISCUSSION

The results of microbiological and physico-chemical parameters of janjavathi river water from Banjukuppa Village and bore waters from Sominaidu valasa are given in table 1. The permissible limit for Coliform bacteria in drinking water sample is 1/100ml of sample. But in the present study the coliform count was very high, i.e., 540coliforms/100ml sample and 1600 coliforms/100ml in Janjavathi river and borewaters respectively, suggesting that these waters are highly contaminated with faecal matter and are non-potable. The results of the present study correlate well with the data collected from KRB Puram Primary Health Center which showed high incident of fevers, diarrhea, dysentery and gastroenteritis (unpublished data). The MPN test is used to detect the presence of coliform bacteria, especially *Echerichia coli*, the indicator organism in drinking water. *E. coli* is the normal inhabitant of human and animal intestines. Every day millions of *E. coli* are excreted out through human and animal faeces. Presence of coliforms in drinking water is a strong indication for the presence of various pathogenic microorganisms which have been excreted out simultaneously with coliforms. These microbial pathogens may be *Salmonella typhi*, the causative agent of typhoid, *S. paratyphi*, the causative agent of paratyphoid, *Vibrio cholerae*, the causative agent of cholera, *Shigella dysenteriae*, the causative agent of bacillary dysentery, *Entamoeba histolytica* of amebiasis, *Yersinia enterocolitica*, *Y. pseudotuberculosis*, *E. coli* (toxigenic and enteroinvasive strains) that cause diarrhea and gastroenteritis. The viral waterborne diseases may be due to the presence of pathogenic virus in waters such as *Hepatitis-A*, the causative agent of jaundice and *Polio myelitis* Virus which cause polio.

In the present investigation the standard total plate count was 2.1×10^8 and 4.3×10^9 cfu/ml sample in Janjavathi river water and bore waters respectively. These results exceed the permissible limit which should be only <100cfu/1ml. These results suggest high incidence of fevers, diarrhea, dysentery and gastroenteritis among the tribals of Vizianagaram District. The identification of various pathogens of these waters is under progress.

The pH of water is one of the important

Table 1: Microbiological and physico-chemical parameters of drinking water samples from two tribal villages of Vizianagaram District

Parameters tested	*Janjavathi river water from Banjukuppa village*	*Borewell water from Sominaiduvalasa village*	*Permissible limits*
Microbiological Parameters			
1. MPN Test	540 Coliforms/100ml sample	1600 Coliforms/100ml sample	1coliform/100ml sample
2. Total Plate count	2.1×10^8/1ml sample	4.3×10^9 cfu/1ml sample	<100cfu/1ml sample
Physical Parameters			
3. pH	8.7	7.78	6.5-8.5
4. Turbidity	0.8 NTU	0.0 NTU	5.0 NTU
5. Salinity	0.01%	0.0%	0.0%
6. Conductivity	0.6 mMhos	3.4mMhos	<2.5mMhos
Chemical Parameters			
7. Total Solids (TS)	400mg/L	2200mg/L	500-1000mg/L
8. Total Dissolved Solids (TDS)	300mg/L	2200mg/L	500-1000mg/L
9. Total Suspended Solids (TSS)	100mg/L	0.0mg/L	500mg/L
10. Total Hardness	156/L	848mg/L	75-200mg/L
11. Calcium Hardness	96mg/L	112mg/L	50-100mg/l
12. Magnesium Hardness	60mg/L	736mg/L	50-100mg/L
13. Chlorides	464mg/L	1341mg/L	250mg/L
14. Fluorides	0.504ppm/L	1.22ppm/L	1.2-1.5ppm/L
15. Nitrates	3.5mg/L	8.8mg/L	45mg/L
16. Sulphates	200mg/L	500mg/L	250mg/L
17. Phosphates	2.0ug/L	2.5ug/L	250mg/L
18. Iron	0.4mg/L	0.5mg/L	0.2mg/L

physical factors as all biochemical reactions occur at specific pH and are dependent on pH. Usually water sample with a pH of 7 is considered the best but the permissible limit ranges between 6.5-8.5 (ICMR, 1975). In the present study the Janjavathi river water has a pH of 8.71which was beyond the permissible range where as the bore water has a pH of 7.78. If we look in the microbiological perspective, the river water pH favours the growth of Vibrio species, which ultimately cause diarrhea. The salinity of these waters was 0.0% which was within the limits, suggesting that the waters do not taste saltish and are potable.

The conductivity of water is an important parameter which determines the drinking water quality and water used for agricultural purposes. The permissible limit of conductivity for drinking water is <2.5 mMhos. In the present study the conductivity of bore water was 3.4 mMhos which exceeded the normal limit suggesting high concentration of charged ions in the water which eventually qualifies the water as non potable. The turbidity of water is imparted by the total suspended solid particles. The permissible limit for drinking water sample is 5.0 NTU (Nephelo Turbidity Units). In the present investigation the turbidity of tested waters is within the desirable limit suggesting that there was less amount of suspended particles in the waters. The total solids of drinking water should not exceed 500mg/L which may be due to the presence of total suspended solids or total dissolved solids or both. In the present study the total solids of river water was within the limits (400mg/L) but the bore water showed very high value of 2200mg/L indicating that bore water was non-potable. The permissible limit for TDS is 500mg/L, but should never exceed the maximum permissible limit of 1500mg/L (ICMR,1975). In the present investigation the TDS of bore waters from Sominaiduvalasa village is very high i.e., 2200mg/L indicating high degree of dissolved toxic chemicals which were non-filterable and may be carcinogenic. The high TDS results in bad taste, strain on kidney, impact on digestion, blood pressure and other metabolic disturbances. The total suspended solids of river is 100mg/L, where as that of bore water was 0.0mg/L. This result correlates well with that of turbidity where the river water showed little turbidity i.e., 0.08NTU but the bore waters showed 0.0 NTU as it did not contain any suspended solids but possessed only the dissolved solids.

The total hardness of potable water should not exceed the permissible limit of 200mg/L (ICMR,1975) otherwise it may lead to stone formation in kidneys. In the present study borewell water has very high content of total hardness i.e., 848mg/L. the desirable limit for Calcium hardness in drinking water ranges between 75-200mg/L, whereas for Magnesium is 50-100mg/L (ICMR,1975). Calcium and Magnesium sulphates beyond the permissible limit will act as purgatives and may lead to respiratory diseases (Maiti, 1982). In this study the Magnesium hardness of bore water is very high (736mg/L). The chloride content of potable water should not exceed the maximum permissible limit of 250mg/L. But, in the present study river and bore water showed high content of chlorides i.e., 464mg/L and 1341mg/L respectively indicating that there may be sewage or faecal contamination in the river water or the presence of Magnesium chloride rock formation below the ground level indicating that the water is non-potable. The Sulphates of bore water was 500mg/L exceeding the normal limit indicates that the water may act as purgative.

The Fluoride content of drinking water should not exceed the maximum permissible limit of 1.5mg/L (WHO,1971) due to which severe bone diseases called fluorosis may occur. If the fluoride content is <0.2mg/L may lead to dental carries in children. In the present study the bore waters are almost near the maximum permissible limit suggesting the water is non-potable. Recently it has been reported that fluorides in the fluorosis patients have adversely affected various hormonal levels and the development of secondary sexual characters (Deshkar, et al., 1998). The nitrates in drinking water should not exceed the maximum limit of 45mg/L which when exceeds may lead to blue babies (NRC,1972) and methemoglobanemia in humans. This study showed that the nitrate content was within the limits. The phosphate content of the samples tested are within the limits. The iron content of drinking water should not exceed 0.3mg/L but in the present study the water

samples tested exceeded the normal limit., i. e., 0.4mg/L and 0.5mg/L in river and bore waters respectively, suggesting that these waters taste bad and are non-potable.

CONCLUSION

These results clearly indicate that both the river as well as the bore water are highly polluted with pathogenic microorganisms, through fecal contamination as judged by high coliform counts and total plate counts. Regarding the high counts in bore water, there may be open defaecation or dumping yards near the bore well and the coliforms might have leached into the ground waters causing microbiological pollution which ultimately leads to various water borne diseases. The total hardness, Magnesium hardness, Chlorides, total dissolved solids and iron content are very high in bore water than the river water. The people should drink boiled water which may eliminate microbiological and chemical pollution of water to some extent. But the toxic effects caused by heat stable toxins of pathogens can not be removed by drinking boiled water.

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