RESEARCH

Bacteriological and Physicochemical Analysis of Drinking Water in Tokha, Kathmandu, Nepal

Shidiki Amrullah*[1], Bhargava Dipak[1], Gupta Ravi Shankar[1], Ansari Akhtar Alam[2] Pandit Bijay Raj[1]

[1]Department of Microbiology, National Medical College, Birgunj, Parsa, Nepal
[2]Department of Pharmacology, National Medical College, Birgunj, Nepal

ABSTRACT

Background: This study reports the comparative studies and microbial risk assessment of different water samples used for drinking water. The results obtained were compared with WHO and EPA standards for drinking and recreational water.

Methods: Physicochemical and bacteriological analysis of water samples were carried out from source, taps, well and stone spouts used for drinking purpose in Tokha (Saraswati and Chandeswari Village Development Committee). Total viable count was carried out by pour plate technique. Total coliform and fecal coliform were performed by membrane filtration technique. The results obtained were compared with World Health Organization (WHO), National Agency for Food and Drug Administration and Control (NAFDAC) and Nepal Standard of Drinking Water Quality (NSDWQ) standards for drinking water.

Results: The pH, total hardness, chloride, nitrate and arsenic content of samples were found within permissible guideline value however well sample was found to exceed Nepal standard values for calcium hardness and ammonia content. The total viable counts for all the water samples were high exceeding the limit for water (1.0×10^2 cfu/ml). All the water samples were found to contain coliforms and fecal organisms in numbers greater than the required WHO/FAO standards for water. The fecal coliform colonies on M-endo agar plate ranged between 143 and 152 and total coliform from 110 to 248 per 100 ml water also exceed the standard limit for water. The Isolated organisms were identified to be *E.coli*, *Klebsiella* spp. and *Citrobacter* spp.

Keywords: Analysis, Bacteriological, Drinking water, Nepal, Physicochemical

Corresponding Author: Amrullah Shidiki, Department of Microbiology, National Medical College and Teaching Hospital, Birgunj (Parsa), Nepal; **E-mail**: amarullahsidhiqie24@gmail.com

INTRODUCTION

Water of good drinking quality is of basic importance to human physiology.[1] The provision of portable water to the rural and urban population is necessary to prevent health hazards.[2,3] Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is palatable and safe for drinking.[4]

Unfortunately clean, pure and safe water only exists briefly in nature and is immediately polluted by prevailing environmental factors and human activities. Water from most sources is therefore unfit for immediate consumption without some sort of treatment.[5] The consequences of waterborne bacteria and virus infections; polio, hepatitis, cholera, typhoid, diarrhoea, stomach cramps have been well established but nitrate contamination is just as deadly. Contamination of drinking water from any source is of primary importance because of the danger and risk of water borne diseases.[6, 7]

According to WHO estimate, about 80% of the third world diseases are transmitted by polluted water. Due to the lack of safe and protective water supply and sanitation, more than 15 million children below five years die each year.[8] According to public health department of the Government of Nepal (1990), about 443,000 children die every year due to gastroenteritis by drinking contaminated water. The recent example of the epidemic is in the western and mid western region of Nepal where more than 500 deaths have occurred.

In Nepal, Tokha Village Development Committee (VDC) doesn't have proper water supply system. Drinking water is obtained from surface source-river. Such natural water supply is likely to be polluted with domestic and industrial wastes. This work is therefore, in an attempt to examine the different sources of drinking water in this VDC and to compare with standard table water for conformity to microbiological and physicochemical standards for supply water samples as well as to examine the different domestic and industrial effluents/waste water for conformity to standards for effluent discharges.

MATERIALS AND METHODS

The water samples were collected randomly from taps, sources and reservoir from the area of VDC Tokha, Kathmandu. Water was collected in the pre-sterilized biological oxygen demand bottle and clean plastic bottle for microbial and physic-chemical analysis. For tap and source water, bottle was cleaned with alcohol and left water for 2 minutes and finally filled from slow flow of water. For reservoir water, the bottle was placed in the tank at a depth of 15 to 30 cm. After collection, samples were processed at laboratory of National College Kathmandu, Nepal following standard methods with APHA American public health association, 1995.

For microbial analysis, water samples were processed for serial dilution, standard plate count and standard total coliform count by membrane filter procedure. Colonies from M-Endo agar, XLD agar and TCBS agar after 48 hours incubation were sub-cultured onto NA agar for pure culture. Isolated bacteria were identified on the basis of their colonial characteristic, morphological characteristics and biochemical properties according to Bergey's Manual of Determinative Bacteriology, 1994. Physicochemical analysis like temperature, p^H, total hardness, calcium, chloride, nitrate, arsenic and ammonia were identified according to WHO guideline, 1998.

RESULTS

Out of twenty three samples from public taps, wells, stone-spouts and source, pH values of all water samples were found similar in level with Nepal Standard values. From well, the values of calcium hardness and ammonia content were more than Nepal standard. Total hardness content was found same within the standard guide-line values. The nitrate and arsenic content of all samples were same within permissible level. The bacteriological analysis for total coliform and faecal coliformrevealed most frequently *E.coli and Citrobacter*. Water from taps and Inar (T1, T5, T6, T11, T16, T18, T19, and I1 & I2) contained coliforms (>300 cfu/100ml).

DISCUSSION

The temperature of the water was found in the range of 20°C to 22°C. This temperature range of 28^0c – 30^0c of water has been influenced by the intensity of the sunlight as temperature rise from 28^0c -30^0c on relatively hot days.[9] The temperature range of 26^0c- 30^0c is due to the insulating effect of increased nutrient load resulting from industrial discharge.[10] The samples have neutral p^H (7-7·89). The pH of most natural waters ranges from 6.5-8.5 while deviation from the neutral as a result of the CO2/ bicarbonate/carbonate equilibrium.[11]

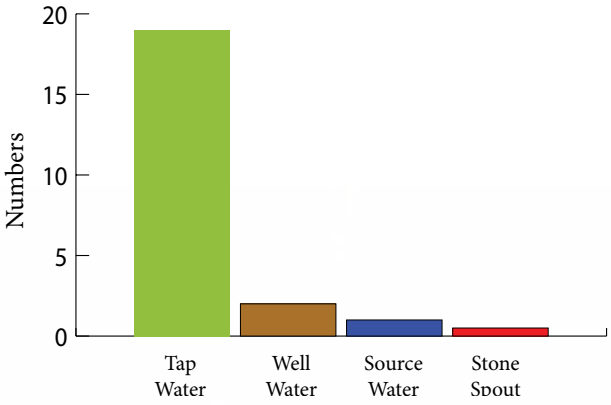

Figure 1: Sample Size

Table 1: Physicochemical parameters of water

Sample	Tem °C	pH 7.0-8.5	Total Hardness 500mg/l	Calcium hardness 200mg/l	Magnesium Hardness mg/l	Nitrate 50mg/l	Arsenic 0.05mg/l	Chloride 250mg/l	Ammonia 1.5mg/l
T1	20	7.5	23	7	16	2	0	12.78	0
T2	20	7.25	14	5	9	2	0	9.23	0.5
T3	21	7.47	9	7	2	2	0	8.52	0
T4	21	7.6	11	26	15	2	0	9.94	0
T5	20	7.19	24	32	8	2	0	7	0
T6	21	7.2	24	10	14	2	0	7.1	0
T7	21	7.67	124	64	60	2	0	46.86	0
T8	21	7.64	140	0	0	0	0	0	0
W1	21	7.89	324.6	242	82.6	8	0	68.16	1
W2	20	7.56	64	378	226	8	0	231.46	**>3**
T9	20	7.45	11	8	3	2	0	9.23	0
T10	20	7.05	10	15	5	2	0	7.81	0
T11	20	7.05	11	8	3	2	0	10.65	0
T12	21	7.52	27	96	69	2	0	7.1	0
T13	21	7.27	23	31	8	2	0	7.1	0
T14	21	7.56	21	34	13	2	0	6.39	0
T15	20	7.57	21	35	14	2	0	7.81	0
T16	21	7.55	24	0	0	0	0	0	0
T17	20	7.57	24	13	11	2	0	8.52	0
T18	20	7.17	26	18	8	≤2	0	9.94	0
T19	20	7.51	24	16	8	≤2	0	7.1	0
S	20	7.56	18	26	8	-	0	-	0
SS	22	7.64	-	55	-	2	0	6.39	0.2

Table 2: Microbiological parameters

SN	Sample	Total bacteria count(CFU/ml)	Total Coliform at 37^0c (per 100ml)	Fecal coliforms at 44^0c (per100ml)
1	T1	141×10^4	TMTC	140
2	T2	67×10^4	113	104
3	T3	241×10^4	228	199
4	T4	100×10^4	128	112
5	T5	8×10^4	TMTC	112
6	T6	10×10^4	TMTC	156
7	T7	101×10^4	144	112
8	T8	150×10^4	144	104
9	T9	134×10^4	240	152
10	T10	TMTC	168	145
11	T11	120×10^4	TMTC	145
12	T12	2×10^4	165	136
13	T13	2×10^4	168	154
14	T14	8×10^4	184	104

SN	Sample	Total bacteria count(CFU/ml)	Total Coliform at 37^{0}c (per 100ml)	Fecal coliforms at 44^{0}c (per100ml)
15	T15	15×10^4	136	60
16	T16	25×10^4	TMTC	222
17	T17	65×10^4	264	172
18	T18	20×10^4	TMTC	145
19	T19	1×10^4	TMTC	250
20	W1	TMTC	TMTC	148
21	W2	TMTC	TMTC	178
22	S	204×10^4	248	152

The fluctuations in pH lead to an increase or decrease in the toxicity of poisons in water bodies.[12] The samples showed hardness within the normal level while one of the sample (I1) showed greater value than normal. The calcium content of the water bodies fluctuates directly with bicarbonates and both of these moves inversely with carbonates and P^H. NH_3 was found within normal range except one sample I2 ($\geq$3) which exceeded WHO guideline value (1.5mg/l). Similar results were found in the ground water samples of Kathmandu valley. Water samples were positive for total coliforms. The quality of water has deterioted due to poor management and no monitoring of water quality. Isolated bacteria were the family of Enterobacteriacea.

The identified organisms include *E.coli*, *Klebsiella* sp*ecies*, *Citrobacter* species. Isolation of *E.coli* was highest among isolates since this organism is abundant in human and animal faeces. The water was faecally contaminated and treatment was ineffective.

CONCLUSION

The pathogenic organic and the indicator organisms present in all the water samples rendered them unfit for human consumption though they can be used for other purposes. Water should meet different quality specifications depending on the particular uses. Thus, potable and domestic water should be harmless for the health of man and should have proper organoleptic properties and should be suitable for domestic use. Water quality should be controlled in order to minimize acute problem of water related diseases, which are endemic to the health of man.

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