STUDY OF UNDERGROUND DRINKING WATER OF SPECIFIC SITE OF KATHMANDU VALLEY

SUBEDI, M,[1*] RAJBHANDARI, GS.[2]
[1]Department of Microbiology, Amrit Science Campus, Kathmandu, Nepal; [2]Department of Botany, Amrit Science Campus, Kathmandu, Nepal.
Email: munalsubedi@yahoo.com
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ABSTRACT : Unsafe water, sanitation, and hygiene are considered to be the most important global risk factors for diarrhoeal illnesses. With an increasing urban population density of the study area, the scarcity and pollution of surface water poses a serious problem for urban drinking water supplies of metropolitan areas. So many people rely on the underground water as an alternative method of safe and reliable drinking water. The present study intends to assess the physicochemical and microbiological quality of drinking water from different sources of underground water in the particular sites of Kathmandu valley. The ground water samples were randomly collected from shallow well, tube well and deep tube wells located at specific places of Kathmandu Valley. The research is primarily focused on the physico-chemical and bacteriological water qualities of underground water. The sampling site is from Sinamangal to Minbhavan. Total sample size was 100, Sample processing was done in Department of Microbiology, Amrit Campus Thamel. Physicochemical parameters, pH, Conductivity, Ammonia, Chloride, Nitrite, Nitrate and Biological parameter (Coliform and Fecal coliform) of each sample were tested. Based on the research work, the observations of the study suggest that the underground water has comparatively high physiochemical and biological parameter (Fecal Coliform) than WHO guideline. Households are using underground drinking water as drinking purposes without or with treatment (sand filter). In summary, the underground water of specific site of Kathmandu Valley is polluted and exceeded the WHO values.

Key words : *fecal coliform,* ground *water, Kathmandu valley, physico-chemical,*

INTRODUCTION:

Groundwater is only the alternative source of safe and reliable drinking water. Water taken from such sources (different types of shallow and deep well) is often of better quality than surface water or other open water sources if the soil is fine-grained and its bedrocks do not have cracks, crevices, and bedding plants, which permit the free passage of polluted water especially within metropolitan zones. However, bacterial as well as chemical pollution of water sources may occur and is mostly derived from watershed corrosion as well as drainage from sewage, swamps, or soil with high humus content or seepage through river. Such suspected water sources cannot be used without caution for human drinking purposes because of the inherent health risks. Prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the ground water to become polluted and created health problems (Raja, Lydia, Princy & Chritopher, 2002).

The unplanned urbanization and industrialization has resulted in over use of environment in particular of water resources (Singh, Pathak & Singh, 2002). The most common and widespread danger associated with drinking water is contamination of water, either directly or indirectly by sewage or other wastes of human and animal origin. Changes in water quality are reflected in its physical, chemical, and biological conditions; and these in turn are influenced by physical and anthropogenic activities Asian Development Bank and International Centre for Integrated Mountain Development, Kathmandu (ADB/ICIMOD2006).

Due to inadequate amount of distributed drinking water (pipe water) by Kathmandu Upatayka Khanipani Limited (KUKL) many denizens in Kathmandu valley are seeking the alternative way to meet their demand. One of the alternative sources of drinking water is the underground water. Meanwhile, underground water of many places of Kathmandu valley is suspected as non potable. Because it is contaminated with various pathogenic as well as opportunistic microflora and toxic chemical compounds by different means, such as improper disposal of garbage, unmanaged sewer system and polluted river.

The major contaminant of underground water might be due to seepage of liquid waste into the underground water. This makes the underground water contamination with different chemicals as well as pathogens. As a result underground water serves as the commonest vehicle of transmission of a number of infectious diseases as well as factor for leaching heavy metals which already garbage contain and it is a tragedy that infants and young children are the innocent victims of the water borne diseases.

The present work is a primary attempt to examine the underground water quality of specific place of Kathmandu valley. In this work, physical, chemical and biological parameters were examined and compared with World Health Organization standard.

MATERIALS AND METHODS :

The location of the study is from Sinamangal to Min-Bhavan site. This is the place where people use hand pump, tube well, deep well for underground drinking water purposes.

This is an experimental based study and was conducted for four months. By systematic sampling method, underground water samples from different households were collected.

About 100 hundred samples were tested. During sampling interview was conducted to know the depth of hand pipe and well and also to find out the exact number of people who have been using groundwater for drinking as well as other purposes. Sample Sinamangal to Min-Bhavan were only included. Drinking water samples was collected and transported by standard methods as mentioned in American Public Health Association (APHA) 1998.

The samples were analyzed on the same day, within 6 hours of collection. When an immediate analysis is not possible, the samples were preserved at 4^0C. Analytical method used for determination of different physicochemical parameters and biological parameters of underground water. The observed various parameters were compared with standard values recommended by World Health Organization (WHO) for drinking purposes.

The laboratory analyses of Samples were done using standard methods (APHA, 1998). To determine coliforms, Most Probable Number was carried out and further test was confirmed by using differential media M-endo agar, and Biochemical Media, Triple Sugar Iron Agar and further confirm was done by Indole, Methyl Red Voges Proskeur and Citrate (IMViC) test.

Physicochemical parameters of water were tested according to standard protocol. For this, following parameters were tested.

S. no	Test parameter	Methods
1	pH	pH meter
2	Conductivity	Conductivity meter
3	Chloride (mg/l)	Iodometric method
5	Ammonia (mg/l)	Phenate method
6	Nitrate (mg/l)	Brucine method
7	Nitrite (mg/l)	UV visible Spectrophotometer method

RESULTS AND DISCUSSION :

Number of house hold used water for solely drinking purpose was comparatively lower, Whereas other purposes such as cooking and bathing were higher (figure 1).

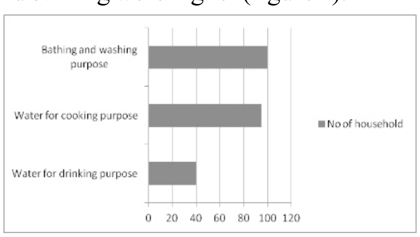


Figure 1. No of Household that uses underground water for different purposes

Only 62% were using conventional sand filter method for the treatment of water rest (38%) other used it without treatment of water (figure 2).

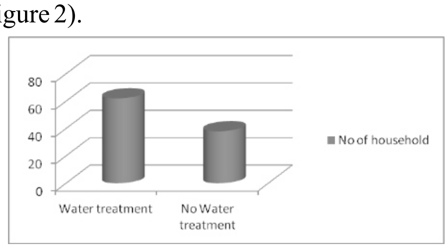


Figure 2. No of Household that uses sand treatment for drinking purposes.

The water quality analysis of different water has been carried out for six physicochemical parameters i.e. pH, conductivity, ammonia, nitrite, nitrate and chloride. In biological parameter, fecal coliforms and total coliforms were observed and identified by selective media and biochemical tests.

The pH of water is important because many biological activities can occur only within a narrow range. Thus, any variation beyond an acceptable range could be fatal to a particular organism. Any alteration in water pH is accompanied by the change in other physic-chemical parameters (Wetzel, 1975).

Present study shows pH is alkaline in most of samples and it ranges from 6.9 -8.4. Similarly in pH value of different studied sample is within the range of prescribed by WHO (6.5-8.5). High value pH may results due to waste discharge, microbial decomposition of organic matter in the water body (Patil, Chonde, Jadhav, & Raut, 2012). The high pH in this case may be attributed to sewage discharge by surrounding human population.

Electrical conductivity is a measure of water capability to transmit electric current and also it is a tool to assess the purity of water. Often, high electrical conductivities correlate to contamination by anthropogenic sources.

Electrical conductivity was found in the range 764-1202 mho/cm. Electrical conductivity is correlated with the presence of salinity of water. One of the reasons of salinity is the high concentration of cation such as sodium, calcium and magnesium where as chloride, phosphate and nitrate as anions (Chan, Zalifah, & Norrakiah, 2007). The higher range of electrical conductivity may be possibility of leaching river water in underground drinking water.

Usually the high concentrations of chloride in combination with nitrate or ammonium show that the water is contaminated by domestic sources (Bhatt, Lacoul, Lekhak, & Jha, 1999). Increase in chloride concentration on discharge of municipal and industrial waste has been reported (Ownby and Kee, 1967). In river Ganga at Varanasi, Chaudhary and Ojha, (1985), it was found that chloride value ranged from 5.9 to 7.9 mg/l. Chloride was found in the range 14.5-70.2 mg/l. It is within the desirable limit prescribed by WHO which is 250 mg/l and 10 mg/l is acceptable. However, this high chloride contents in water makes it taste salty and also promote pipe corrosion. According to Versari, Parpinello, & Galassi, (2002) chloride concentration higher than 200 mg/l is considered to be a risk for human health and may cause unpleasant taste of water.

Ammonia content in water may be harmful to health since it can be converted to nitrate. If only ammonia is present, pollution by sewage must be very recent. The occurrence of NO_2 with ammonia indicates that some time has been lapsed since the pollution has occurred. If all the nitrogen is present in nitrate form, a long time has been passed after pollution because water has purified itself and all nitrogenous matter has been oxidized. The presence of ammonia in ground waters is quite generally a result of natural degradation processes.

Ammonia in higher concentration is toxic to man. The toxicity of ammonia increases with pH because at higher pH most of the ammonia remains in the gaseous form (Goel, 1997).

Ammonia was found in the range 0.5-21.4 mg/l. Many sample has exceed the WHO (2008) guideline for ammonia which is 1.5 mg/l. Although, presence of ammonia does not always mean that it is due to domestic pollution. High ammonia content in deep well can be due to the underlying intercalated layers of peat and lignite. Ammonia of mineral origin is rare in natural water but its presence is quite generally a result of natural degradation processes most inevitably ammonification of organic matter (Pandey, Chapagain, & Kazarna, 2010).

In present study Nitrate and Nitrite was found in the range 0.1-6.2mg/l and 0.1-8.4 mg/l Although these parameters are comparatively more in few, but all are within the range of The WHO. WHO has set maximum contaminant levels for nitrates at 50 mg/l $NO3^-$ and maximum contaminant level for nitrite is 50 mg/L $NO3^-$. Also, there have been recorded cases of "blue-baby" syndrome caused by nitrate concentrations only slightly higher than 10 mg/L $NO3^-$ (Washington State Department of Health, 1999). There is a positive correlation of high nitrate drinking water concentrations to elevated gastric cancer occurrences in Chile and England (Canter, 1997).

The microbiological analysis of water was performed by Most Probable Number. MPN indexing of analyzed water samples were showing wide variation and range from 4 to ≥2400 coliform/100 ml. These shows that 63% (63/100) of underground water samples having presence of coliform that exceeded the WHO standard (table 1).

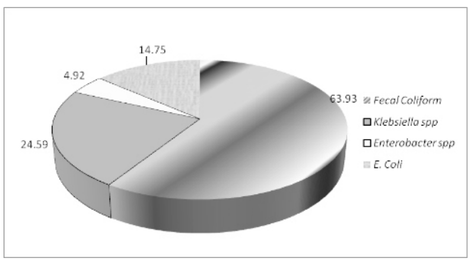
Table 1 WHO guideline for drinking water quality standards. (Results Expressed As mg/L)

S.N.	PARAMETERS	WHO Guideline Value	Acceptable	Allowable
1	pH	6.5-8.5	6.5-8.5	6.5-9.2
2	Turbidity NTU	5	<5.0	10.0
3	Colour TCU	15	<5.0	15.0
4	Taste & Odour	Inoffensive	Palatable	Not offensive
5	Free Residual Chlorine	0.2	0.2	0.5
6	Conductivity □mhos/cm		60.0	250.0
7	Dissolved Oxygen @ 30ºc		7.6	>5.0
8	Iron	0.3	0.3	1.0
9	Manganese	0.1	0.1	0.5
10	Ammonia NH_4-N	1.5	1.5	5.0
11	Orthophosphate PO_4		0.05	1.0
12	Nitrite NO_2-N	50.0		50.0
13	Nitrate NO_3-N	50.0	10.0	50.0
14	Chloride	250.0	10.0	50.0
15	Sodium	200.00	50.0	
16	Total Hardness	500.0	100	150
17	Calcium		75.0	
18	Magnesium		30.0	
19	Total Alkalinity		135.0	185.0
20	Suspended Solids		25.0	50.0
21	Total Dissolved Solids	1000.0	600.0	
22	Silica SiO_2		20.0	40.0
23	Hydrogen Sulfide	ND	ND	0.05
24	Sulphate	250.0	20.0	50.0
25	Aluminum	0.2	0.2	0.2
26	Langelier Saturation Index		-1.3	-4.5
27	Water Quality Index		4.6	7.5
28	Arsenic	0.01	0.01	0.05
29	Fluoride	1.5	1.5	1.5
30	Copper	1.0	1.0	
31	Zinc	3.0	0.1	3.0
32	*Lead*	0.01	0.01	
33	Chromium	0.05	0.05	
34	Cyanide	0.07	0.07	
35	Mercury	0.001	0.001	
36	* Total Coliforms cfu/100ml	Nil	Nil	Nil
37	Faecal Coliforms cfu/100ml *E. coli* MPN/100 ml	Nil	Nil	Nil

Water derived from underground water showed increases in most of the investigated bacteriological parameters. Several sources of contamination could be suggested and could include the possibility contamination from improper management of sewer system (Subedi 2011).

E. coli was found to predominant organism in total coliforms and in most of contaminated drinking water (Subedi and Aryal, 2010; Rai, Ono, Yanagida, Kurokawa, & Rai, 2009; Prasai, Joshi, Lekhak, & Baral, 2007). In our studies fecal *E. coli* was top 92.6% (39/41) of all fecal coliform isolated. Presence of fecal coliform indicates that water is polluted with sewage or from improper management of sewer system (Subedi, 2011). Comparison of coliforms and fecal coliforms is shown figure 3. The principal reason of the bacteriological pollution of drinking water is due to the use of unrepaired old pipeline systems for distribution. All the natural water sources, such as wells and tube wells are neither treated nor protected properly. Thus, deteriorating water quality is the major problem and it has created serious threat to human health and environment.

Figure 3. Comparative analysis of Coliform and Fecal Coliform in underground water.



CONCLUSION :

Based on the research work, the observation of the study suggests that the most of the underground water has comparatively high physiochemical and biological parameter than WHO guidelines. Some households are using this water as drinking purpose without or with treatment (sand filter), which might be one factor for causing water borne disease as this filter does not assure the reduction of chemical and biological parameter according to standard. Thus, water from the underground needs to be treated to reduce the physiochemical parameter and should be disinfected or boiled before consumption to avoid water-borne diseases.

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