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The Study Of Variation In The Various Parameters Of Underground Drinking Water Source As Non-Filtered Manipal Boring Water And Filtered Manipal Boring Water In Pokhara

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Abstract – The chemical analysis of the variation in the various parameters of underground boring water of a source as non-filtered Manipal boring water and filtered manipal boring water. The samples of the drinking water in Pokhara Sub-metropolitan City were carried out. The characters selected for the findings were appearance, turbidity, colour, temperature, pH, electrical conductance, total alkalinity, total hardness, Calcium hardness, Magnesium hardness, total iron, chloride, Ammonia, Arsenic, E. histolytica, Giardia, E.coli which are the major drinking water parameters. The chemical tests were done by photo colorimeter, pH meter, cmparator, Arsenic kit apparatus, the conductivity meter (Electronics) – EC, different titrations and estimation processes. The biological tests for microbes were copleted by the pathological microscope LBM - 100 D. The variation was compared with the permissible limit. The water filter used in the research was the general catadyn ceramic filter with porosity of 0.2 micrometer and the result was displayed. Both samples were fit for drinking purposes.

Keywords: Permissible, Photosynthesis, Instrumentation, Variation, Microbes, Interferential.

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1. INTRODUCTION

Water is an essential substance for all living beings. A molecule of water is made up of two atoms of Hydrogen and one atom of oxygen. It plays vital role in mainly in the photosynthesis process in green plants and the digestive system of all living beings. As our body contains about 70% water and 90% of vertebrates blood contains water we should drink water continuously to maintain the regulation, prevention and circulation of blood in the body.[1,2]

As we know that 2/3rd part of the earth contains water but still there is limited drinking water everywhere because less number of sources of water can supply standard drinking water which have less chemical & microbe parameters within the permissive levels recommended by W.H.O. for drinking. Despite of excessive availability of water, chemical impurities (like high percentage of iron, calcium & magnesium ions, ammonia, nitrate, nitrite, phosphate, manganese and mercury etc. or Microbes like E.coli, Giardia and Entamoeba etc.) are present so the water in the all sources cannot be drinkable. [3,4] Somewhere people are not so conscious about it and they are drinking the impure water from the sources. Our country is the second richest country in the world in water, but the maximum number of water sources cannot be used as drinking water sources because their chemical and microbes parameters are beyond the limitation of quality of drinking water. Many of the water sources contain such the impurities that they cannot be easily and economically purified for drinking purposes. The quantity of water volume from the drinking sources decreases in the winter- season in all areas of Terai, hill and mountain in our country. Comparing to last three decades due to the great variation in global climate, some of the sources of underground water become dry which create serious problem of drinking water for general public.[5,6]

Whether different sources are used as drinking water sources in Pokhara sub-metropolitan city(PSMC) but overall they can categorized as of main two types (i) surface drinking water sources in which people are using drinking water from the rivers, khola, rivulets, and spring water. (ii) Under-ground water in which people are using drinking water from Borings and Wells. Most of the wells are found at the remote area of PSMC while boring water and surface drinking water through water supply corporation office in the central part of the city. When water is not sufficient in dry season then most of the people in PSMC use insufficient water from Boring water i.e. Private drinking water supply.[7] Generally, people of remote areas fulfill their needs of drinking water through sources like wells. Many of the wells are very old and not well maintained. Quantity of water from wells can't meet the need of the growing population due to fluctuation of water quantity.[8] Some wells are far from the PSMC, they use to clean their clothes and take bath and they bring water from there for drinking purpose. Many of the people take their heavy vehicles to the rivers to clean properly which severely contaminates the water in the rivers.[9] In Pokhara, according to the survey of 2012-2013, water demand and supply situation tells that total production during the period as given in the data is in wet season 33.9 ML/d while in dry season is 30.8 ML/d but requirement of total supply of water should be 38 ML/d, but the demand increases in 2014 up to 41 ML/d. Due to lack of perfect and efficient supply system output of total production is not according to the total production capacity. The drinking water is brought from rivers like Mardy khola (river) and Bhotekhola (river). But, as water can not fulfilled according to demand of rapid population growth, many private borings (underground water) supply their water to meet the needs. As there is fluctuation in the parameters of drinking water sources due to heavy rain and complicated geographical situation, drinking water test is necessary.[10,11] As conductance measurement shows the presence of ions present in drinking water it needs to be measured by very reliable method of instrumentation. The parameters should be within the permissive level laid down by WHO and NDWQS (Nepal drinking water quality standard) . If the parameters exceeds the limitation the water should be treated properly for use.[12,13] Proper cares must have taken for sampling the water from the sources because a little impurity affects the test which influences the result. Hence the container was neat and clean physically, chemically and microbiologically.[14]

2. EXPERIMENTAL METHODS

Sample collection:-

Sources selected for drinking water for chemical analysis:-

Samplings were done in the sterilized glass bottles because physical, chemical and microbe tests can be done accurately. The samples as coded here shows variation in different parameters. (Ghosh, B.N.,**2000).** Analysis should be conducted establishing small lab. buying some essential instruments & chemicals or in the chemical laboratory of Cosmos international college GCE A-level or in the settled office, like in the Chem. Lab. of department of chemistry P.N. campus Pokhara or in the central lab. of research and quality control section, water supply corporation, Kirtipur, Kathmandu, Nepal. Pokhara pathological lab. And Fishtail diagnostic lab. Centre was used for the microbe's tests.

Concise technique:-

1. PH-By PH. Meter

   When the electrode is dipped in the sample then the reading of the pH meter shows the pH of the solution.

2. Appearance – By visual method

   Visual test is taken by observing the samples and result is generally given in three codes which are written as a. clear b. slight hazy c. hazy (yellowish)

3. Turbidity – Turbidity meter

   The turbidity meter is first calibrated to zero with standard sample then the test sample is put in the turbidity meter to compare with the standard known sample.

4. Colour – Comparator method Colour is decided by the disc method.

5. Temperature –By thermometer it is taken by using thermometer.

6. Electric conductance –By E.C. meter the electric conductivity meter will give the reading for conductance to find the density of ions present in the sample.

7. Total alkalinity –By titration method 50 ml test sample is added with few drops of MRMB (methyl red methyl blue indicator, colour of the sample becomes green. It is titrated with 0.02N HCl up to colour changes to purple.

Principle:

Under reducing conditions, iron is relatively soluble in natural waters and exists in thee ferrous state. Upon exposure to air, or on addition of chlorine, the iron is oxidized to the ferric state. special conditions to avoid oxidation.

The reaction with ferric ions and thioglycollicacid (Mercaptoacetic Acid) can be represented as follows:

$$Fe^{3+} + 2HSCH_2COO^- + 3OH^- \longrightarrow Fe(OH)(SCH_2COO)_2^{2-} + 2H_2O$$

(red purple colour)

Apparatus:

a. Spectrophotometer for use at 533nm and utilizing a light path f 1cm or longer.

OR

Filter photometer providing a light path of 1cm or longer with a green filter showing Maximum transmittance between 520-540nm

b. 50ml graduated Nessler tubes.

Reagents:

Standard iron(stock) solution.(100mg/L). Dissolve 0.702(+ or -)0.001g of ferrous ammonium sulphate($FeSO_4(NH_4)_2SO_46H_2O$)in 50(+ or -) 0.1ml of hydrochloric acid(5M)

8. Total hardness – EDTA titration method.

Procedure:

With prepared chemicals myself, to certain volume of sample prepared 0.2gm of solo chrome black T indicator is mixed and 2ml ammonia buffer (prepared). Then titration is done with standard E.D.T.A. (prep) solution until last redish tinge disappears.

Total hardness = T $\times$F/V$\times$1000 mg/1 $CaCO_3$ where F is molarity factor of EDTA and V is volume of sample and T is volume of titrant [EDTA]

9. Calcium

To volume of sample (V), 0.2 gm. prepared murexide indicator is added and 2ml of sodium hydroxide buffer. Titration is done by standard EDTA until colour changes from pink to purple. Amount of calcium Ca^{2+} is also estimated by proper calculation from above.

10. Magnesium

From total hardness and calcium hardness by subtraction method magnesium hardness is calculated.

11. Total Iron

To 100ml sample HCl, thioglycolic acid and 4ml ammonia solution are added. The solution is put in Nesseler's tube and absorbance is taken by means of colorimeter.

[Required transmittance 540nm] Iron = Absorbance $\times$ 10mgl^{-1}Fe

12. Silica

To 50ml sample 4ml concentrated H_2SO_4 and 2ml of ammonium molybdate are added and amount of silica is decided by color matching method.

Silica = Reading $\times$20mgl^{-1} SiO_2

13. Total Ammonia

Sample (50ml) + Nesseler's reagent 2ml then by colour matching method reading is taken. Total Ammonia = Reading $\times$ 20 $\times$ 0.02gml^{-1} as N

14. Orthophosphate: By Colorimeter direct reading is taken. Preparation has to be done.

15. Determination of Chlorine as Chloride :

Principle:

In a neutral solution or slightly alkaline solution, potassium dichromate is used to indicate the end point of the silver nitrate titration of chloride. Silver chloride is quantitatively precipitated before silver chromate is formed.(Duggal,K.N.,**2000**).

Microbe Test :

By forming smear:

[First spores are destroyed under pressure 15lbs/(inch)^2 at T = 121^{0}C]. Then preparation for culture test is adopted as done in central laboratory of quality control drinking water corporation, Kirtipur, Kathmandu. For mainly % Entamoeba,E.coli and Coliform are done here(Crady,M.C.,Microbiology, Wiley Publication,NewYork,**1993).**

Underground drinking water source of non-filtered Manipal boring and filtered Manipal boring drinking water sources were selected .The readings was compared with the permissive level of WHO and NDWQS.

3. RESULTS AND DISCUSSION

Comparative data-analysis of non-filtered Manipal boring water with filtered Manipal boring water

Table No.

S.N.	Parameters	Manipal Boring	Manipal Filtered	W.H.O. permissible	N.D.W.Q. permissible
1	Appearance	Clear	Clear	Clear	Clear
2	Turbidity	<5.0	<5.0	5.0	5.0
3	Colour	< 5.0	< 5.0	5.0	5.0
4	Temperature	26°	26°	15-25	------------
5	PH	7.6	7.7	6.5- 8.0	6.5-9.2
6	Electrical conductivity	257.0	250.0		400
7	Total alkalinity	114.0	116.0	200	(50- 500mgl-1)
8	P.P.H. alkalinity	Nil	Nil	----------	-----------
9	Total hardness	120.0	118.0	300	100-500
10	Calcium hardness	80.0	80.0	200	75-200
11	Magnesium hardness	40.0	38.0	150	30-150
12	Calcium	32.0	32.0	75	75
13	Magnesium	9.7	9.1	-----------	---------
14	Total Iron	0.3	0.1	0.3	0.3
15	Chloride	7.6	5.7	250	250
16	Total Ammonia	0.02	0.02	1.5	1.5
17	Arsenic	Not detec.	Not detec.	0.01	0.05
18	E.histolytica	Absent	Absent	0	0
19	Giardia	Absent	Absent	0	0
20	E.coli	Absent	Absent	0	0

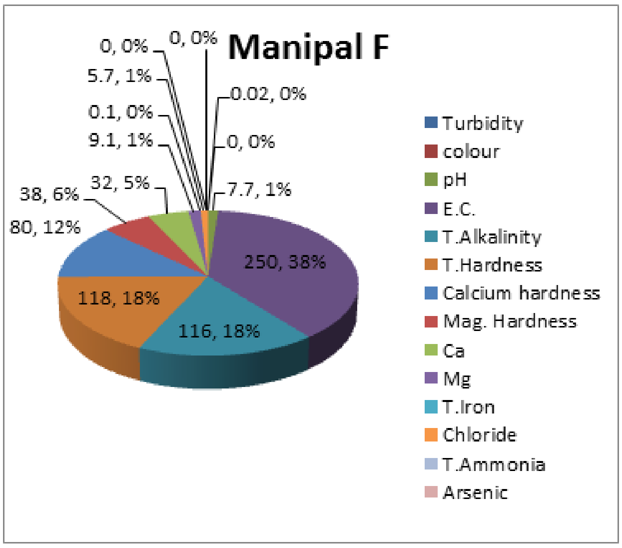

Fig: 1 Comparative and distinct data analysis of filtered Manipal boring water through Pi-chart (calculated data and percentage data)

Sources: Laboratory Report, water quality section KUKL & self-designed pi-chart.

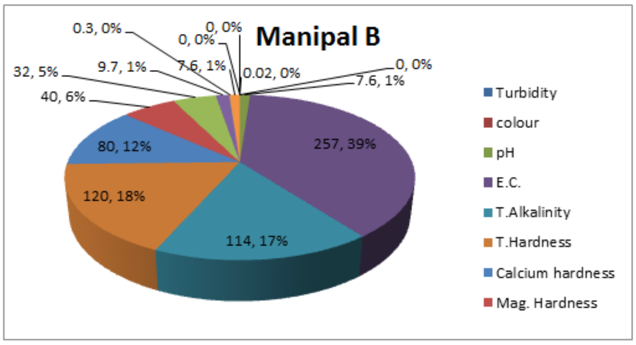

Fig: 2 Comparative and distinct data analysis of non-filtered Manipal boring water through Pi-chart (calculated data and percentage data)

Sources: Laboratory Report, water quality section KUKL & self-designed pi-chart.

Discussion about the Comparative Analysis of calculated data 0f boring waters with the standard values of permissible levels of WHO and NDWQS in drinking water

The appearance of water samples is clear. Turbidity of the sample doesn't exceed 5.0 NTU. Colors of them are within 5.0 TCU. Hence these physical parameters are within the range of drinking water parameters of prescribed by WHO and NDWQS. Physical characteristics may have an effect on or could be associated with other aesthetic parameters. The more Colours, for example, may be related to the presence of iron or manganese. Temperature affects taste and odour perceptions. Corrosion and incrustations, which, in turn, affect colour, taste and odour, can be directly related to pH. The physical characteristics of water colour, odour, taste and temperature are primarily aesthetic parameters but they may have indirect impact on health related parameters. For example, temperature affects the rate of growth of micro-organisms, while some colour-producing and naturally occurring organic parameters are precursors for disinfection by-products such as trihalomethanes. The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process. Water temperature also affect the growth of microorganisms, hence most preferable temperature is 15^{o} c.

The pH of the samples is in between 6.5 and 8.0. pH is a parameter that indicates the acidity of a water sample. The operational guideline recommended in drinking water is to maintain a pH between 6.5 and 8.0. The principal objective in controlling pH is to produce a water that is neither corrosive nor produces incrustation. At pH levels above 8.5, mineral incrustations and bitter tastes can occur. Corrosion is commonly associated with pH levels below 6.5 and elevated levels of certain undesirable chemical parameters may result from corrosion of specific types of pipe. With pH levels above 8.5, there is also a progressive decrease in the efficiency of chlorine disinfection and alum coagulation.

Electrical conductivity

Electrical conductivity parameter in these samples is in between 257-250 µs/cm which is under permissive level of drinking water. This shows the ions present in the water sample. The higher conductance gives the idea that the sample has more ion containing substance and vice versa.

Total alkalinity

The permissive total alkalinity level by NDWQS is 114-116mg/l. The permissive total alkalinity level by Indian Standard, 1991 A.D. is 200mg/l. Hence, the parameter present in all boring water samples is in between 80-180 which does not exceed permissive level. Alkalinity is a measure of the resistance of the water to the effects of acids added to water. The recommended operational range for alkalinity in coagulant-treated drinking water is 30 to 500 mg/L expressed as calcium carbonate. Alkalinity over 30 mg/L assists floc formation during the coagulation process. In some circumstances chemicals must be added to boost alkalinity before addition of a coagulant. Water with low alkalinity may tend to accelerate natural corrosion leading to "red water" problems whereas high alkalinity waters may produce scale incrustations on utensils, service pipes and water heaters. Water treatment processes, which do not use a coagulant generally, do not require alkalinity measurement or adjustment.

Total hardness

It is present in between 120-118 mg/l but permissive level is 500 mg/l, therefore the samples water is fit for drinking purpose. Hardness is caused by dissolved calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. However, certain detergents are largely unaffected by hardness. Conversely, soft water may result in accelerated corrosion of water pipes. Hardness levels between 80 and 100 mg/L as calcium carbonate ($CaCO3$) are considered to provide an acceptable balance between corrosion and incrustation. Water supplies with hardness greater than 200 mg/L are considered poor but tolerable. Hardness in excess of 500 mg/L in drinking water is unacceptable for most domestic purposes.

Ontario Regulation 169/03, Ontario Drinking-Water Quality Standards, made under the Safe Drinking Water Act, **2002**, prescribes drinking-water quality, the operational guideline for hardness in drinking water is set at between 80 and 100 mg/L as calcium carbonate. Because more % of Ca and Mg ions in drinking water will create gastritis problem for persons having poor digestion.

Calcium hardness and Magnesium hardness

They are estimated in the form of their carbonate salts. Their values are calculated from the values of total hardness. The Calcium hardness is determined by titration then it is subtracted from the value of total hardness to find the value of the magnesium hardness present in the samples, hence their values are directly proportional to the value of total hardness obtained. In boring water samples Calcium hardness is from 80-80 mg/l and Magnesium hardness is from 38-40 mg/l. The values are within the permissive level of drinking water up to Magnesium hardness 150 mg/l & Calcium hardness up to 200 mg/l given by both WHO and NDWQS. Ca and Mg in elemental states are calculated from Calcium hardness and Magnesium hardness.

Total iron

Total iron values remains as 0.3 to 0.1 mg/l which does not exceed the acceptable values in drinking water according to WHO and NDWQS. In Nepal, according to WaterAid in Nepal, 2011, Water quality status of sampled shallow groundwater in Terai region contains Total Iron level minimum from Bandipur(Siraha) 0.40 mg/l to maximum Naktiraipur (Saptari) 12.0 mg/l which exceed the range of permissive level and higher in amount with respect to the values in drinking water sources in Pokhara sub-metropolitan city.

Iron may be present in ground water as a result of mineral deposits and chemically reducing underground conditions. It may also be present in surface waters as a result of anaerobic decay in sediments and complex formation. The aesthetic objective for iron, set by appearance effects, in drinking water is 0.3 mg/L. Excessive levels of iron in drinking water supplies may impart a brownish colour to laundered goods, plumbing fixtures and the water itself. It may produce a bitter, astringent taste in water and beverages and the precipitation of iron can also promote the growth of iron bacteria in water mains and service pipes. Iron based coagulants such as ferric sulfate can be highly effective in treatment processes at removing particles from water and leave very little residual iron in the treated water.

Total Chloride

The value in the boring water samples is in between 5.7-7.6 mg/l but its acceptable value is 500mg/l according to WHO and NDWQS. Chloride is a common non-toxic material present in small amounts in drinking water and produces a detectable salty taste at the aesthetic objective level of 250 mg/L. Chloride is widely distributed in nature, generally as the sodium (NaCl), potassium (KCl) and calcium ($CaCl_2$) salts. In Nepal, according to WaterAid in Nepal, 2011, Water quality status of sampled shallow groundwater in Terai region contains chloride level minimum from Panchgachhi (Jhapa) 15.4 mg/l to maximum Bandipur (Siraha) 195.6 mg/l which is whether within the range of permissive level but higher in amount with respect to the values in drinking water sources in Pokhara sub-metropolitan city.

Total Ammonia

In these boring water samples its value is found to be 0.02 mg/l but according to WHO and NDWQS acceptable value is up to 1.5 mg/l hence the value is within the acceptable values for drinking water.

In Nepal, according to WaterAid in Nepal, 2011, Water quality status of sampled shallow groundwater in Terai region contains Total Ammonia level minimum from Bayarban (Morang) 0.5 mg/l to maximum Naktiraipur (Saptari) 1.20 mg/l which is whether within the range of permissive level but higher in amount with respect to the values in drinking water sources in Pokhara sub-metropolitan city.

Arsenic value

Result of the value is not detectable. This shows that arsenic is almost absent in the boring water samples. WHO acceptable value is 0.01 mg/l, NDWQS is 0.05mg/l but Ontario Regulation 169/03, Ontario Drinking-Water Quality Standards, made under the Safe Drinking Water Act, **2002**, prescribes drinking-water quality, the operational guideline for hardness in drinking water is set 0.025 mg/l.The interim maximum acceptable concentration for arsenic in drinking water is 0.025 mg/L. Arsenic is a known carcinogen and must therefore be removed by treatment where present at levels over this concentration. Arsenic is sometimes found at higher levels in ground water in hard rock areas (e.g. Canadian Shield) in Ontario through the natural dissolution of arsenic containing minerals, in some mine drainage waters and in some mine leachates. Arsenic is present at very low concentrations in most surface waters. In Nepal, according to WaterAid in Nepal, 2011, Water quality status of sampled shallow groundwater in Terai region exceeds the permissive level of arsenic.

Microbiological parameters

Boring water donot contain Entamoeba histolytica, Giardia and E.coli hence they are free from Microbes because they cannot reach thousands of feet deep layer of rock.

Therefore boring drinking water sources are fit for drinking purpose.

Analysis of the variations in the different parameters of the non-filtered and filtered Manipal boring water samples.

Due to change in the no. of ions before and after filtration electrical conductance changes from 257 to 250 µs/cm. This shows that if any sample has more conductance by 7 µs/cm with respect to permissive level then we can correct by the filter. The same reasons are for change in the above parameters.

CONCLUSIONS

I) The underground boring water samples are chemically viewing electrical conductance fit for drinking purpose as the chemical parameters are within the permissive levels laid down by WHO and NDWQS.

ii) From the variation in the parameters above we may conclude that the borderline samples can be corrected by the filtration as above.

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