A Study on Some Physicochemical Properties and Trace Metal Concentrations of Tube Well Water from Hinthada University Campus

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Abstract

The present study deals with assessment of some physicochemical properties and trace metal concentrations of tube well water from Hinthada University campus. Studied area is 15 sampling sites of tube well water in Hinthada University campus. As most of the family members of staff living on campus use only this water, they need to know the quality of drinking water and its safety. Thus, the present work is designated to explore the tube well water from various sampling sites in Hinthada University campus. Some physicochemical properties were determined by means of modern techniques. It was found that there is normal pH range between (6.6 ~ 7.9) in tested water samples. Furthermore, turbidity value, ≤ 5 NTU and conductivity measurement range (290~610 μS/cm) were performed in the study. Total dissolved solids; ≤ 500 ppm and chemical oxygen demand; ≤ 10 ppm were observed. By (AAS) method, Cu and Zn were in normal conditions whereas Cd, Pb, Fe and As concentrations in some of the water samples were found to be above the limit of drinking standard (WHO). This paper can contribute to people who apply tube well water from Hinthada University campus by sharing some parameters for quality assurance in their uses.

Keywords: tube well water, 15 sampling sites, Hinthada University campus, some physicochemical properties, trace metal concentrations

INTRODUCTION

Water is a precious natural resource and also essential for a multiplicity of purpose. Water constitutes the major bulk (70% - 90%) of all living cells (Wong and Dixon, 1995). Water is an essential life-supporting factor in every cell, individual organism, ecosystem and cosmos (Biggs, 2000). About 70 % of the earth's surface is covered by water constituting aquatic ecosystems (Anderson and Kim, 2003). Water is an agent of; (i) energy transfer in ecosystem (ii) geological activities that cause weathering rocks to form soil (iii) a nutrient distribution medium as a solvent for soluble salt or a suspending medium for insoluble salt (iv) atmospheric temperature regulation as the water vapors act as an atmospheric blanket and absorb heat radiation, thus regulating the temperature of the earth's upper crust, and (v) an atmospheric scavenger as water vapors absorb gaseous pollutants and particulate matters and wash them down (Kumar and Kakrani, 2000; Bhatt and Jha, 1999; William, 1999). The aim of this work is to investigate and assess the quality of tube well water samples from 15 sampling sites in Hinthada University campus.

In this study, physicochemical properties (pH, total dissolved solids, turbidity, conductivity, chemical oxygen demand) and the trace metal (Cd, Cu, Fe, Pb, As and Zn) concentrations of tube well water samples from 15 sampling sites in Hinthada University campus were determined and the quality of tube well water samples for family members of staff there were assessed. In addition, Hinthada University is situated near the cultivated land in Hinthada. That point becomes to be considered that heavy toxic metals and other factors can contaminate tube well water in campus. Therefore, it is important to study whether tube well water is suitable for drinking purposes or not. Thus, the present work focused on investigating the quality of tube well water as possible as by using available facilities in Department of Chemistry, Hinthada University.

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MATERIALS AND METHODS

Sampling Sites

Tube well water obtained from 15 sources in Hinthada University campus is usually used. The tube well water samples were collected in August, 2020 from 15 sampling sites in Hinthada University campus as follows:

i. Sample (1) - Water Supply Tank (1) of four-storeyed Main Building
ii. Sample (2) - Water Supply Tank (2) beside History Department
iii. Sample (3) - Water Supply Tank (3) near Dhammaryone
iv. Sample (4) - Women's Chummery (1)
v. Sample (5) - Women's Chummery (2)
vi. Sample (6) - Women's Chummery (3)
vii. Sample (7) - Chummery
viii. Sample (8) - Rector's Residence
ix. Sample (9) - Pro-Rector's Residence
x. Sample (10) - Eight- apartment staff housing
xi. Sample (11) - Four-storeyed staff housing
xii. Sample (12) - Building-8
xiii. Sample (13) - Building-9
xiv. Sample (14) - Kyan-khinn & Lay-myat-nhar hostels
xv. Sample (15) - University Stadium.

The water samples were collected by means of a water sampler.

***Chemicals*:** The corresponding reagents measured by Lovibond Spectro Direct Method and atomic absorption spectrophotometer (AAS) were used.

***Apparatus*: C**onical flask (150 mL), beaker (250 mL), volumetric flask (50 mL, 100 mL and 250 mL), glass funnel, graduated pipettes (1 mL, 10 mL and 25 mL), a pH meter (Model EIL-7020, ABB, Kent-Taylar Ltd., England), conductivity meter (Cyberscan-CON 11) and AAS (Shimadzu AA-7000, Japan) and a UV-visible spectrophotometer shown in Figure 1 were used.

Determination of pH

The pH_2 of water samples were measured with a pH meter after adjusting with pH 4.0 and 7.0 buffer solution.

Determination of Turbidity

Turbidity of the water samples was determined by spectrophotometer with the use of Lovibond Spectro Direct Method in Department of Chemistry, Hinthada University. This spectrophotometer is usually applied to water and waste water testing in the absorption range between 500-1100NTU.

Determination of Conductivity

The conductivities in water samples were determined by conductivity/ TDS meter in Department of Chemistry, Hinthada University.

Determination of Total Dissolved Solids

Total dissolved solids of the water samples were determined by conductivity/ TDS meter in Department of Chemistry, Hinthada University.

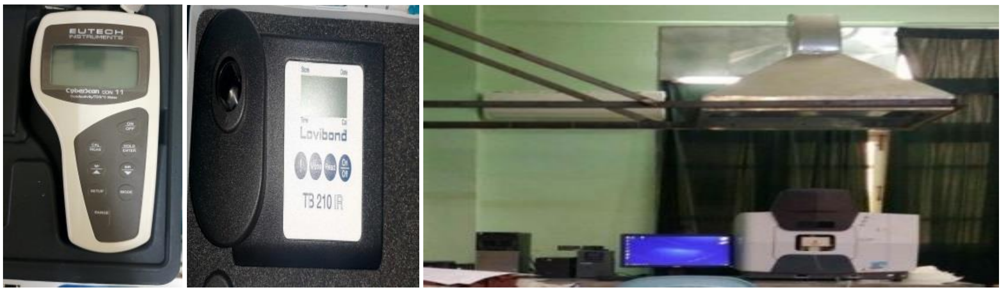
Determination of Chemical Oxygen Demand (COD)

COD concentrations of water samples were measured by COD meter after digesting with thermo-reactor in Department of Chemistry, Hinthada University.

Determination of Trace Elements

Trace element (Cd, Cu, Fe, Pb, As and Zn) concentrations in water samples were determined by atomic absorption spectrophotometer (AAS) in Department of Chemistry, Hinthada University.

Thermo-reactor COD meter Spectrophotometer



Conductivity/ TDS meter Turbidity meter Atomic absorption spectrophotometer

Figure1. Apparatus used in water test

RESULTS AND DISCUSSION

Some Physicochemical Properties of Tube Well Water from 15 Sampling Sites in Hinthada University Campus

***pH*:** The pH of the water measures its hydrogen ion concentration and indicates whether the sample is acidic, neutral or basic. There are three different methods of pH measurement: pH indicator paper, liquid colorimetric indicators and electronic meters. The third method, electrometric pH measurement is accurate and free from interferences. One or more buffer solutions are necessary for standardization.

In this study, the pH of the water was measured by electronic pH meter. The pH of tube well water samples from 15 sampling sites in Hinthada University campus are in the range between 6.6 ~ 7.9 and the detail results in each sampling site are described in Table 1. It is an acceptable level that all the tested tube well water samples can be compared with drinking standard (WHO).

***Turbidity*:** Turbidity is a measure of light transmission and indicates the presence of suspended material such as clay, silt, finely divided organic material, plankton and other inorganic materials. If turbidity is high, be aware of possible bacterial contamination. They may be harmful or cause undesirable tastes and odors.

In this study, the turbidity of water samples was found to be ≤ 5 NTU (Nephelometric Turbidity Unit) and acceptable level of drinking water standard (WHO) shown in Table 2. It can be remarked that water samples are normal.

Conductivity**:** Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Pure water is not a good conductor of electricity.

In this research, the conductivity of water samples: Water Supply Tank (2) beside History Department, Water Supply Tank (3) near Dhammaryone, Women's Chummery (1), Women's Chummery (2), Rector's Residence, Pro-Rector's Residence, Eight- apartment staff housing, Building-8, Building-9, Kyan-khinn & Lay-myat-nhar hostels, and University Stadium was found to be above the acceptable level (≤ 400 μS/cm) of drinking standard (WHO) shown in Table 3. Thus, it could be remarked that high conductivity of water samples may be affected by the presence of dissolved substances in the water, including salts and heavy metals. Some of these substances may cause the harmful effect to aquatic life and to humans, especially at high concentrations.

Total dissolved solids**:** The substance remaining after evaporation and drying of water samples is termed as the "residue". The residue is approximately equivalent to the total content of the dissolved and suspended matter in the water sample. Non-filterable residue corresponds to the total suspended solids and the filterable residue is the total dissolved solids (TDS).

In this research, the determination of total dissolved solids (TDS) was done by conductivity/ TDS meter. A total dissolved solid depends on various factors such as geological character of watershed, rainfall and amount of surface runoff and gives an indication of the degree of dissolved substances such as metal ions in the water. All of the observed TDS values of water samples were comparatively lower than the drinking level of WHO and effluent standard in Myanmar Emission Guideline, 2015. Thus, the tested water samples can be taken as the normal conditions (Table 4).

Chemical Oxygen Demand (COD)**:** Chemical oxygen demand (COD) is the total measurement of all chemicals (organic and inorganic matters) in the water sample. Higher COD levels mean a greater amount of oxidized organic material in the sample, which will reduce in DO can lead to anaerobic conditions which is deleterious to higher aquatic life forms.

In the current study, COD of all the tested water samples were found to be normal conditions as it was lower than the WHO standards (Table 5).

Trace Metal Concentrations of Tube Well Water in Hinthada University Campus

Atomic absorption spectrophotometer is commonly used in many analytic laboratories for determination of trace elements in water sample. Trace metals have been referred to as common pollutants, which are widely distributed in the environment with sources mainly from the weathering of minerals and soils. However, the level of these metals in the environment has increased tremendously in the past decades as a result of human inputs and activities. The presence of toxic metals such as Cd, Pb and As in the environment has been a source of worry to environmentalists, government agencies and health practitioners. This is mainly due to their health implications since they are non-essential metals of no benefit to humans. Sources of cadmium (Cd) include waters from Cd based batteries, incinerators and runoff from agricultural soils where phosphate fertilizers are used since Cd is a common impurity in phosphate fertilizers.

Lead (Pb) is still widely used as an additive in petroleum for automobiles and is emitted to the atmosphere in their exhaust gases, thereby entering the hydrological crude. Arsenic (As) is one of the heavy toxic metals that occurs naturally in rocks and soil and is used for a variety of purposes within industry and agriculture. Arsenic can enter the water supply from natural deposits in the earth or from industrial and agricultural pollution. Arsenic is removed from the air by rain, snow, and gradual settling. Once on the ground or in surface water, arsenic can slowly enter groundwater. High arsenic levels in private wells may come from certain arsenic containing fertilizers used in the past or industrial waste (Prater, 1975).The assessment of metal pollution is an important aspect of most water quality assessment programs. The Global Environment Monitoring System (GEMS) Program GEMS/WATER includes ten metals: Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Mn and Zn. The United States Environmental Protection Agency (USEPA) considers eight trace elements as high priority: As, Cd, Cu, Cr, Pb, Hg, Ni and Zn.

In the present work, Cd, Cu, Fe, Pb, As and Zn were determined by atomic absorption spectrophotometer and results of trace metals analyses in tube well water at Hinthada University campus are presented in Tables 6, 7, 8, 9, 10 and 11, respectively. In this study, the trace metal levels of copper (Cu) and zinc (Zn) were below the WHO permissible level. The trace metal concentrations of cadmium (Cd) were found to be lower than the WHO permissible level except the water sample collected from Kyan-khinn and Lay-myat-nhar hostels. As the Iron (Fe), water samples from Water Supply Tank (1) of four-storeyed Main Building, Women’s Chummery (1), Women’s Chummery (3), Four-storeyed staff housing, Building-8, Building-9 and University Stadium were observed that Fe concentrations were higher than the WHO permissible level and effluent standard whereas the other tested water samples were normal. Symptoms, signs and diseases such as chronic fatigues, heart failure, liver cancer, joint pain, abdominal pain and skin color changes resulted by too much iron will be caused. In the determination of lead (Pb), most of the water samples in Hinthada University campus were the lower limit of detection (0.1 ppm) whereas water samples from Kyan-khinn& Lay-myat-nhar hostels and University Stadium were found to be higher than the WHO permissible level and effluent standard. Lead is a toxic heavy metal. Even low level of lead exposure can damage central nervous system (CNS) and also can cause impaired formation and function of blood cells. The long term exposure of lead can mainly attack the cardiovascular system. Out of the collected water samples, arsenic (As) concentrations in the sampling sites of Women’s Chummery (1) and Four-storied staff housing were the highest in comparison with WHO permissible level although these were below the effluent standard (50 ppb). Arsenic is also toxic heavy metal. Heating or boiling water will not remove arsenic. Because some of the water evaporates during the boiling process, the arsenic concentrations can actually increase slightly as the water is boiled. It can cause skin changes, cancer, stomach-related symptoms such as vomiting and nervous system damage, reduction in blood cell production, liver enlargement, loss of sensation in the limbs and brain damage. High blood pressure, heart attacks and other similar conditions related to the circulatory system are the most significant among them. Arsenic exposure can be fatal in high doses and the cause of major, long-term health risks in lower doses (WHO, 2010).

Table1. pH of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	pH	Drinking Standard (WHO)	Effluent Standard*	Remark
1	Sample (1)	7.3			
2	Sample (2)	6.6			
3	Sample (3)	7.7			
4	Sample (4)	7.8			
5	Sample (5)	7.7			
6	Sample (6)	6.7	6.5 – 8.5	6.0 – 9.0	Normal
7	Sample (7)	6.6			
8	Sample (8)	7.9			
9	Sample (9)	7.8			
10	Sample (10)	7.7			
11	Sample (11)	7.7			
12	Sample (12)	7.1			
13	Sample (13)	7.1			
14	Sample (14)	7.3			
15	Sample (15)	7.5			

*Myanmar Emission Guide Line, 2015

Table 2. Turbidity of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Turbidity (NTU)	Drinking Standard (WHO), (NTU)	Effluent Standard	Remark(s)
1	Sample (1)	0.82			
2	Sample (2)	0.17			
3	Sample (3)	0.70			
4	Sample (4)	1.36			
5	Sample (5)	0.45			
6	Sample (6)	1.00	≤ 5	NG	Normal
7	Sample (7)	0.87			
8	Sample (8)	0.42			
9	Sample (9)	0.45			
10	Sample (10)	0.32			
11	Sample (11)	0.61			
12	Sample (12)	1.37			
13	Sample (13)	0.62			
14	Sample (14)	0.61			
15	Sample (15)	0.40			

NG = No Guide Line

Table 3. Conductivity of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Observed Conductivity (µS/cm)	Drinking Standard (WHO)(µS/cm)	Effluent Standard	Remark(s)
1	Sample (1)	290			Normal
2	Sample (2)	484			Above normal
3	Sample (3)	557			
4	Sample (4)	610			
5	Sample (5)	545			
6	Sample (6)	308			Normal
7	Sample (7)	311	≤ 400	NG	
8	Sample (8)	604			Above normal
9	Sample (9)	584			
10	Sample (10)	493			
11	Sample (11)	333			
12	Sample (12)	530			Above normal
13	Sample (13)	464			
14	Sample (14)	524			
15	Sample (15)	568			

NG = No Guide Line

Table 4. Total Dissolved Solids of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Total Dissolved Solids (ppm)	Drinking Standard (WHO) (ppm)	Effluent Standard (ppm)*	Remark(s)
1	Sample (1)	181			
2	Sample (2)	235			
3	Sample (3)	290			
4	Sample (4)	301			
5	Sample (5)	261	≤ 500	≤ 2000	Normal
6	Sample (6)	224			
7	Sample (7)	250			
8	Sample (8)	305			
9	Sample (9)	289			
10	Sample (10)	245			
11	Sample (11)	168			
12	Sample (12)	270			
13	Sample (13)	235			
14	Sample (14)	267			
15	Sample (15)	281			

*Myanmar Emission Guide Line, 2015

Table 5. Chemical Oxygen Demand (COD) of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	(COD) (ppm)	Drinking Standard (WHO) (ppm)	Effluent Standard	Remark(s)
1	Sample (1)	low			
2	Sample (2)	low			
3	Sample (3)	low			
4	Sample (4)	low			
5	Sample (5)	low			
6	Sample (6)	5	10	NG	Normal
7	Sample (7)	low			
8	Sample (8)	low			
9	Sample (9)	8			
10	Sample (10)	low			
11	Sample (11)	26			
12	Sample (12)	9			
13	Sample (13)	low			
14	Sample (14)	7			
15	Sample (15)	low			

NG = No Guide Line

Table 6. Cadmium (Cd) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Cadmium (Cd) Concentrations (ppm)	Drinking Standard (WHO)/ (ppm)	Effluent Standard/ (ppm)*	Remark(s)
1	Sample (1)	0.0048			
2	Sample (2)	0.0042			
3	Sample (3)	0.0050			
4	Sample (4)	0.0046			
5	Sample (5)	0.0026			Normal
6	Sample (6)	0.0024			
7	Sample (7)	0.0038			(except
8	Sample (8)	0.0028	≤ 0.005	≤ 0.1	Sample
9	Sample (9)	0.0022			(14) ,
10	Sample (10)	0.0038			above DW
11	Sample (11)	0.0028			limit)
12	Sample (12)	0.0030			
13	Sample (13)	0.0018			
14	Sample (14)	0.0080			
15	Sample (15)	0.0036			

*Myanmar Emission Guide Line, 2015

Table 7. Copper (Cu) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Copper (Cu) Concentrations (ppm)	Drinking Standard (WHO)/ (ppm)	Effluent Standard/ (ppm)*	Remark(s)
1	Sample (1)	0.0017			
2	Sample (2)	0.0033			
3	Sample (3)	0.0022			
4	Sample (4)	0.0017			
5	Sample (5)	0.0033			
6	Sample (6)	0.0022			
7	Sample (7)	0.0028	≤ 0.05	≤ 0.5	Lower limit of detection (0.01 ppm)
8	Sample (8)	0.0022			
9	Sample (9)	0.0022			
10	Sample (10)	0.0044			
11	Sample (11)	0.0050			
12	Sample (12)	0.0050			
13	Sample (13)	0.0055			
14	Sample (14)	0.0066			
15	Sample (15)	0.0044			

*Myanmar Emission Guide Line, 2015

Table 8. Iron (Fe) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Iron (Fe)Concentrations (ppm)	Drinking Standard (WHO)/ (ppm)	Effluent Standard/ (ppm)*	Remark(s)
1	Sample (1)	16.3854			
2	Sample (2)	ND			
3	Sample (3)	ND			
4	Sample (4)	2.5208			
5	Sample (5)	ND			
6	Sample (6)	7.5625	≤ 0.2	≤ 3.5	Higher detection Above DW limit
7	Sample (7)	ND			
8	Sample (8)	ND			
9	Sample (9)	ND			
10	Sample (10)	ND			
11	Sample (11)	7.5625			
12	Sample (12)	6.3021			
13	Sample (13)	10.0833			
14	Sample (14)	ND			
15	Sample (15)	11.3438			

*Myanmar Emission Guide Line, 2015 ND = Not Detected

Table 9. Lead (Pb) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Lead (Pb)Concentrations (ppm)	Drinking Standard (WHO)/ (ppm)	Effluent Standard/ (ppm)*	Remark(s)
1	Sample (1)	ND	≤ 0.01	≤ 0.1	Lower limit of detection (0.1 ppm), except Sample (14) and (15)
2	Sample (2)	ND			
3	Sample (3)	ND			
4	Sample (4)	ND			
5	Sample (5)	ND			
6	Sample (6)	ND			
7	Sample (7)	ND			
8	Sample (8)	ND			
9	Sample (9)	0.0751			
10	Sample (10)	0.0601			
11	Sample (11)	0.0977			
12	Sample (12)	ND			
13	Sample (13)	ND			
14	Sample (14)	0.2254			
15	Sample (15)	1.2625			

*Myanmar Emission Guide Line, 2015 ND = Not Detected

Table 10. Arsenic (As) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Arsenic (As)Concentrations (ppb)	Drinking Standard (WHO)/ (ppb)	Effluent Standard/ (ppb)*	Remark(s)
1	Sample (1)	ND	≤10	≤50	Normal DW limit, except Sample (4) and (11)
2	Sample (2)	ND			
3	Sample (3)	ND			
4	Sample (4)	14.8481			
5	Sample (5)	ND			
6	Sample (6)	ND			
7	Sample (7)	ND			
8	Sample (8)	ND			
9	Sample (9)	4.6869			
10	Sample (10)	ND			
11	Sample (11)	12.1729			
12	Sample (12)	9.5894			
13	Sample (13)	5.2369			
14	Sample (14)	ND			
15	Sample (15)	ND			

*Myanmar Emission Guide Line, 2015 ND = Not Detected

Table 11. Zinc (Zn) Concentrations of Water Samples from 15 Sampling Sites in Hinthada University Campus

No.	Sampling sites	Zinc (Zn)Concentrations (ppm)	Drinking Standard (WHO)/ (ppm)	Effluent Standard/ (ppm)*	Remark(s)
1	Sample (1)	0.1898	-	≤ 2	Normal
2	Sample (2)	0.0949			
3	Sample (3)	0.0380			
4	Sample (4)	ND			
5	Sample (5)	ND			
6	Sample (6)	ND			
7	Sample (7)	ND			
8	Sample (8)	ND			
9	Sample (9)	ND			
10	Sample (10)	ND			
11	Sample (11)	0.1139			
12	Sample (12)	ND			
13	Sample (13)	ND			
14	Sample (14)	ND			
15	Sample (15)	ND			

*Myanmar Emission Guide Line, 2015 ND = Not Detected

CONCLUSION

The present study is to assess the water quality with a view and to find out some clues for tube well water samples in Hinthada University campus. During the study period, the physicochemical characteristics and trace metal concentrations of water quality can be concluded as follows: pH value, turbidity, TDS, COD and the trace metal concentrations of Zn and Cu of all the tested water samples were found to be reliable normal conditions. Out of the water samples, Women's Chummery (1), Kyan-khinn & Lay-myat-nhar hostels and University Stadium sampling sites could be denoted that these were high in conductivity, Fe, Cd and Pb concentrations. In addition, the arsenic concentrations in the sampling sites of Women's Chummery (1) and Four-storied staff housing were detected that these water samples were higher than WHO permissible level whereas these were below the effluent standard.

Therefore, according to the results obtained from the current study, it could be suggested that the contaminated concentrations of Cd, Pb, Fe and As including conductivity should be managed to be reliable resources of tube well water.

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