Microbiological and Physico-Chemical Quality of Deep well water in Selected Public Elementary Schools

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Abstract - *Contaminated deep well water results in problems of gastro-enteritis and other water-borne diseases. Groundwater which is the main source of drinking water should be periodically monitored. This study focuses on the microbiological and physico-chemical quality of deep well water in four barangay public elementary schools of Bayambang, Pangasinan during the month of September, 2013. Physical Characteristics of the water samples were also determined. It employed the use of standard laboratory procedures to analyze the water quality parameters and the results compared with the Philippine National Standards for Drinking Water (PNSDW, 2007). In the microbiological parameters, the total bacterial count and total coliform of the four water samples did not pass the standard values while for the fecal coliform only Buenlag elementary school water sample passed the permissible limit. The test for E. coli.is negative to the four water samples. In the physico-chemicalquality, all water samples passed the standard values on salinity, pH, nitrite and pesticide residues, while for total dissolved solids, one sample passed the PNSDW standard values. Water samples are odourless, two slightly fishy in taste, and two yellowish in color. Based on the microbiological and physico-chemical findings, deep well water in the four elementary schools must be boiled first and filtred before drinking. Deep well water should be tested every six months for microbiological and every three years for physico-chemical.*

Keywords: *Microbiological, Physico-chemical, quality, deep well*

INTRODUCTION

The United Nations has proclaimed Water for Life Decade for the period 2005 – 2015 and highlights water as a focal point of the UN – Decade of Education for Sustainable Development. With water resources getting scarce, it has become imperative to teach and guide young children for a sustainable future through water education [1]. According to the UN Environment Programme, 5 million to 10 million deaths occur each year from water-related diseases. The report quoting WHO said that more people in fact would die of consuming unsafe drinking water and unsanitary conditions by the year 2020 than from AIDS if steps to improve water quality were not taken as war footing [2].

In the Philippines, people living in the rural and areas are dependent on groundwater as their source of water. The water is widely utilized for various rural and urban domestic purposes such as drinking, cooking, washing, bathing, and in agriculture and industry. It is sad to know that at present, 15.73 million Filipinos live in 212 waterless barangays in Metro Manila and in 432 waterless municipalities in the rest of the country without access to safe water supply [3]. Access to safe drinking water is not only essential for the promotion and protection of public health but is a basic human right. Provision of safe water supply prevents the transmission of waterborne pathogens and reduces the exposure of individuals to chemical and physical hazards that could be ingested through contaminated drinking water. Diarrhea and other waterborne diseases still rank among the leading causes of illnesses in the country. Setting standards for drinking water establishes threshold limits for different impurities found in drinking water. These limits are intended to minimize risk and therefore prevent deleterious health repercussions that result from lifelong exposure to these impurities through consumption of water [4].

There is now a growing awareness on the use of safe water for consumption in schools around Pangasinan. Some residents use disinfection methods such as boiling or chlorination of water which comes from wells for drinking purposes. Others drink purified or commercial mineral water. However, there are still residents who drink water directly obtained from different groundwater sources and is presumed to be safe. In poor and remote barangays especially in their own schools, this is one of major problems faced everyday. Barangay schools which provide the basic level of education, must be given priority in all aspects, especially drinking water and that the quality of groundwater should be periodically monitored. This is also in consonance with the DepEd Education Manual [5] mandating the provision of water, sanitation, and hygiene facilities that every school shall have a standard water system and its regular inspection and maintenance is important and necessary.

OBJECTIVES OF THE STUDY

This study is undertaken to determine the quality of deep well water of four barangay public elementary schools in Bayambang, Pangasinan. Specifically, the study aimed a) to determine the physical characteristics of the water samples as to color, odor and taste. b) to analyse microbiological quality in terms of total bacterial counts, total coliform, fecal coliform and *E. coli*. c) to analyse physico-chemical quality in terms of salinity, pH, total suspended solids, nitrite and pesticide residues.

METHODS

Research Design

This study made use of the descriptive research design. The research took place in a natural setting employing a combination of observations and questionnaire. Four(4) public elementary schools in Bayambang, Pangasinan were chosen using the four cardinal directions, namely the North, South, West and East in the town's map. Buenlag elementary school from the North, Warding elementary school from the South, Maigpa elementary from the West and A.P. Guevarra elementary school from the East.Before the start of actual water sampling, ocular survey of deep well in the selected four public elementary schools in the town was accomplished. A questionnaire on the physical characteristics of deep well water as to color, odor and taste was prepared. Thirty respondents in the different elementary schools were chosen in random to answer the questionnaire.

The study also employed the use of standard laboratory procedures to analyse the water quality parameters. All values were compared with the standard values set by PNSDW [4].

Materials and Procedure

For microbiological analyses, four empty catsup bottles with a capacity of 350 mL were cleaned thoroughly and sterilized for thirty minutes. Bottles were dried ready for collection of water samples. For physico-chemical analyses, four 1-liter capacity of freshly emptied PET distilled water bottles with caps were used for collection of water samples.

In each pump well where water samples were collected, the outlet or mouth of the mechanical water hand pump was wiped to remove any adhering dirt using a clean cloth or tissue. Pumping for two minutes was done to ensure that the water sample represents the quality of groundwater that feeds the deep well. The mouth of the pump was sterilized for a minute with the flame from an ignited cotton wool swab soaked in an alcohol held by forceps. Pumping was done again to discard water for 1-2 minutes while an assistant opened the sterilized bottle and fill it with the water sample. A small air space was left in the water sample bottles to facilitate shaking at the time of inoculation prior to analysis. Sampling bottles were capped then placed inside an ice chest (filled with ice) immediately after collecting the sample at low temperature so that bacterial action is reduced. Collected water samples were immediately transported to the laboratory. The samples were analysed with the use of standard methods of analyses and laboratory apparatus at BFAR-NIFTDC Microbiology and Limnological Laboratories at Bonuan Binloc, Dagupan City for the microbiological and physico-chemical analyses. Pesticide residues was analysed at the analytical laboratory of Bureau of Plant Industry, Baguio City.

Physical characteristics of water samples was evaluated using average weighted mean. All numerical values obtained from laboratory analyses of water parameters were compared with the values set by PNSDW[4]. This is to find out whether the quality of deep well water samples passed or failed the national standard.

RESULTS AND DISCUSSION

Table 1. Physical Characteristics of Water Samples

School	Color AWM	Description	Odor AWM	Description	Taste AWM	Description
A.P. Guevarra	2.75	Colorless	2.74	odorless	2.50	Slightly fishy
Warding	2.34	Yellowish	3.00	odorless	2.85	Tasteless
Maigpa	3.00	Colorless	3.00	odorless	3.00	Tasteless
Buenlag	2.26	Yellowish	2.60	odorless	2.45	Slightly fishy
Average	2.59	Colorless	2.84	odorless	2.70	Tasteless

AWM: average weighted mean

Table 1 shows the physical characteristics of water samples in the four public elementary schools of Bayambang, Pangasinan. It can be gleaned from the table that the general odor description is odourless among the study sites. Warding and Buenlag elementary schools water samples are yellowish in color while the taste of deep well water in A.P. Guevarra and Buenlag is slightly fishy. Yellow color in water is usually caused by iron rust from galvanized iron, steel or cast iron pipes. While unpleasant and potentially damaging to clothes and fixtures, iron in drinking water is not a human health concern [8].

Fishy taste is usually from organic matter such as plants, animals, or bacteria that are naturally present during certain time of the year. Although harmless, this material can affect the taste and smell of drinking water at low concentration. Based from the Central Customs Laboratory [9], pure water has no color, odor, or smell because there are no minerals or trace elements. The data imply that in terms of physical characteristics, all the water samples from the four selected deep wells passed the test as perceived by the consumers.

Table 2 reveals the data on total bacterial counts, total coliform, fecal coliform and *E. coli* of the deep well water samples. It shows that the total bacterial counts and total coliform of deep well water samples in the four study sites did not pass the standard for drinking water as per standard methods of detection and values for microbiological quality [4]. In the fecal coliform parameter, only Buenlag elementary school water sample passed the standard value for safe drinking water. *E. coli* is not detected to all deep well water samples. The PNSDW standard value for total bacterial count is <500 CFU/mL, for total coliform is <1.1 MPN/100 mL, fecal coliform is 0 MPN/100 mL and *E. coli*is <1.1 MPN/100 mL. According to A.L. Smith (1971), the presence of coliform bacteria warns of the potential presence of disease causing organisms and should alert the person responsible for the water to take precautionary actions. No detection of *E. coli* is evident in all areas because *E. coli* have relatively short life span. These bacteria survive for about 4-12 weeks in water containing a moderate amount of microflora at a temperature of 15^o – 18^o[6]. The findings of Town [10] as cited by Ishaku et al, [7], contradicts with the result of the study. Town (2001) reported a strong positive correlation between fecal coliform and *E. coli* bacteria. When concentrations of fecal coliform are elevated, concentrations of *E. coli* are elevated too. But as explained above, *E. coli* is considered to be the most sensitive to environmental stresses, so its survival is short live.

Table 2.Microbiological Analyses of Deep Well Water Samples

School	Total Bacterial Counts (cfu/mL)	Total Coliform MPM level/100 mL	Fecal Coliform MPM level/100 mL	Test for *E. coli*
A.P Guevarra	20,000	1,100	290	-
Warding	8,000	43	23	-
Maigpa	900	1,100	1,100	-
Buenlag	900	3	0	-

Table 3.Physico-chemical Analyses of Deep Well Water Samples

School	Salinity (ppt)	pH	TSS (mg/mL)	Nitrite	Pesticide Residue (mg/kg)
A.P. Guevarra	1.0	8.28	4.80	0	< LOQ
Warding	1.0	6.89	1.00	0.024	< LOQ
Maigpa	1.0	6.78	3.00	0	< LOQ
Buenlag	2.0	8.13	1.02	0	< LOQ

ppt: parts per thousand *pH: power of hydrogen* *TSS: total suspended solids*

Table 3 presents the results obtained from the physico-chemical analyses of the four deep well water samples. It can be gleaned in the table that the salinity of the four deep well water samples is high compared with the allowable limit of 0 -0.5 ppt. The possible sources of salinity in groundwater are from agriculture and natural sources. Evaporation of irrigation water will remove water and leave salts behind. More salt can be dissolved from soil as irrigation water percolates downward. Plants can naturally increase soil salinity as they uptake water and exclude salts. Groundwater contains naturally-occuring salts from dissolving rocks and organic materials. Some rocks dissolve very easily; groundwater in these areas can naturally be very high in salinity [11]. The pH of the four water samples passed the standard value for safe drinking water. The table reflects that only warding elementary school water sample passed the allowable limit of 1 mg/L of total suspended solids. According to Taiwo [12], high total suspended solids in drinking water could harbour microbiological pollutant during and after rainfall, citing in particular the groundwater in Abeokuta which becomes turbid and laden with suspended solids. In terms of nitrite and pesticide residue, all water samples are safe for drinking. Farming around the sites of the deep wells is not as intensive as the researcher had thought. The farmers in the different sites are practicing crop rotation.

SUMMARY OF FINDINGS

The following are the significant findings of the study: All deep well water samples are odourless, but two (Warding and Buenlag) are yellowish in color , and two (A.P.Guevarra and Buenlag) are with slightly fishy taste. For the microbiological qualities of the water samples, in terms of total bacterial counts, A.P Guevarra has the highest (20,000 cfu/mL) while Maigpa and Buenlag are the lowest (900 cfu/mL). Total coliform of A.P. Guevarra and Maigpa water samples are both the highest (1100 MPM level/100mL) and Buenlag the least which is 3 MPM level/100 mL.Maigpa water sample is the highest in fecal coliform (1100 MPM level/100 mL while Buenlaghas zero Fecal Coliform. *E. coli* is negative to all water samples. For the physico-chemical analyses, in terms of salinity, Buenlag elementary school has the highest, while A.P Guevarra, Warding and Maigpa are the same. The pH ranges from 6.78 – 8.28 among the four water samples. In terms of total suspended solids , A.P. Guevara is the highest which is 4.80 mg/mL while Warding is the lowest (1.00 mg/mL). Nitrite and pesticide residue are below the standard values which are 3 mg/mL and less than the limit of quantification which is 0.01 mg/kg respectively.

CONCLUSION

The deep well water samples were generally colorless, odourless and tasteless. Based on the laboratory analyses, all samples except Buenlag (fecal coliform) did not pass the standard for drinking water as per standardmethods of detection and values for microbiological quality. Water samples from the four deep well sites passed the permissible limit for pH, nitrite and pesticide residue. Salinity values did not pass the standard for drinking water. Only Warding passed the total suspended solids.

RECOMMENDATION

Constant monitoring in the microbiological and physico-chemical qualities of deep well water in all barangay elementary schools is suggested. Drinking water should be tested every six months for microbiological and every three years for physico-chemical. The inclusion for test of metals is recommended in researches related to the quality of water in deep wells. The conduct of training programs for teachers and LGUs in the construction of instructional materials and in the formulation of guidelines, and policies that will sustain deep well water potability is also suggested to be concerned of health, care and sanitation.

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