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Potability of ground water supply in Sulu, Philippines

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Abstract

Annoor Village in Indanan, and Sahaya Village in Patikul, are municipalities in the Sulu province known to have utilized untreated ground water for household use. The residents use this water for drinking, cooking and washing. The need to study the potability of the ground water in these areas is necessary. Physical, chemical and bacteriological parameters were used. The study showed that for the physical properties, samples A and B coming from Anoor Village and sample C coming from Sahaya Village are within the permissible level set by the Philippine National Standard for drinking water(PNSDW). For the chemical properties, samples A, B and C are within the permissible level for total acidity, total hardness, total suspended solids and total dissolved solids, except for sample B where the total alkalinity value is slightly higher than the standard. For the Dissolved Oxygen (DO), all the samples have values less than 5mg/L, therefore, are not within the permissible level. For the Biological Oxygen Demand (BOD), sample B is within the permissible level (3.33 mg/L), samples A and C are above the permissible level (7.0 mg/L and 15.33 mg/) respectively. For the bacteriological properties all the samples A, B and C have total coliform count higher that the standard value for Drinking Water which should be less than 1.8 MPN/100mL for both total coliform and E.Coli. For the E.Coli count only sample C was within the standard value which was less than 1.8 MPN/100mL for the three consecutive sampling periods. The study concludes that samples A and B from Annoor Village is not potable due to the presence of Total Coliform and E.Coli , whereas sample C from Sahaya Village can be recommended for drinking since the E.Coli count was within the permissible level of less than 1.8 MPN/100mL.

Keywords: Potability; Ground Water

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1. Introduction

Water is one of the most important resources to sustain living organism on earth. In fact, according to Cheremisinoff (1993) the three vital factors of life in order of importance are air, water and food. Water is the element of life which is needed by almost all organisms for survival. Humans can survive for several weeks without food but for only a few days without water. However, water may also lead to the destruction of life if ingested without undergoing proper treatment. That is if not chemically and bacteriologically safe for human consumption.

Cheremisinof (1993) stated that aside from rainfall which is the ultimate source of all fresh water, water supply is usually directly acquired from surface water such as lakes, streams and rivers or from ground water such as springs and wells. He defined ground water as simply the water beneath the earth's surface often between saturated soil and rock that supplies wells and springs. Ground water is among the nation's most important natural resources, it is a valuable resource that is withdrawn in all parts of countries for a variety of uses. In addition it is one of the sources for public water supply it provides drinking water for the rural population who do not have access to a public water supply system. Moreover, it may be the only economically viable source for many communities.

Although ground water has been considered generally safe for human consumption even without treatment, ground water can still become polluted or contaminated as stressed by Plummer (1999). In fact pure water does not exist all naturally fresh regardless of the source, it is likely to contain some dissolved gases and minerals as well as microorganisms.

Since water is a basic necessity of life, then people must be careful and selective in the use of this resource. What usually happens is that some people take this thing for granted. They keep on using water without considering the quality/purity and its depletion from the source. As a consequence to such negligence, scarce water resource is usually experienced and outbreaks of water born diseases in several parts of the Philippines happen. These usually occur in the rural areas where sources of water are coming from ground water such as wells without certification from the Department of Environment and Natural Resources (DENR) as safe for drinking. Most of the household users of these wells are observed to have dug it near septic tanks. Studies showed that very rare outbreak of water born diseases occur in communities near the city proper because the source of water is usually treated before it reaches the houses. However, there are still isolated cases that occur due to the presence of microbiological contaminants.

Sulu is one of the provinces in Mindanao with 18 municipalities where Jolo is the town proper. All the barangays in Jolo have water connections coming from the Jolo mainland water district. The water supplied by the mainland water district undergoes water treatment. The Jolo mainland water district is the only government water utility system that supplies drinking water in Jolo, Sulu. This system is under the subsidy of the national water utility system. However, not all municipalities in Sulu are distributed with water by the mainland water district. Since, the connection is expensive the government cannot afford to provide the necessary water service throughout the island.

A study on the potability of drinking water for a majority of barangays in Jolo coming from the Jolo mainland water district was conducted by Fronda, (2004). Her study showed that the water from the households in some barangays were not potable. The study was carried out due to an increased number of cases of typhoid fever in Jolo in the year 2003. In 2005, Jalani a medical doctor and master in public health made a similar study on the risk factors of drinking water contamination in Jolo. His study focused on various factors contributing to contaminated drinking water.

Since the potability of drinking water in the town proper of Sulu was already studied, the researcher finds it interesting to study the condition of the water used in other municipalities of Sulu where the water source(s) is not coming from the Jolo mainland water district but from other nearby sources. Annoor village in Indanan Sulu and Sahaya village in Patikul Sulu are places in the Sulu province known to have utilized ground water as the main source of water supply for the residents. This is being used by the community members for drinking, cooking, washing, and for other related purposes.

In this connection, it is imperative to determine if the ground water located at Annoor and Sahaya villages respectively is safe for human consumption. Sahaya is a community (a housing project) populated majority by Tausug professionals who are mostly government employees while the rest of the populace are engaged in business ventures. Annoor village has two sources of ground water, one ground water system supplies water to the residences occupying the housing project such as the Sahaya village, while the other ground water system operated in the same village supplies water to the nearby village where houses are situated in privately owned (non housing project) lots. In Annoor village, based on the number of pipes connected to the tank, there are 80 families using ground water coming from one source (sample A) and there are 65 families in the other source(sample B). In Sahaya village there are 117 families using the groundwater (sample C). Considering the number of families availing water from these sources, prompted the researcher to come up with the study on the potability of ground water supply in these villages.

2. Methodology

The study made use of the descriptive quantitative design. The collection of the ground water samples were done between 3:00 to 5:00 in the afternoon in order to comply with the time requirement for transport from the source in Jolo, Sulu to the AdZU Laboratory in Zamboanga City. The samples were gathered from a huge tank through a pipe connected to the tank. The water sampling was done weekly every Tuesday for 3 consecutive weeks. Clean and dry polyethylene bottles were used as containers for physical and chemical properties, while sterilized glass containers were used for the bacteriological properties.

For every sample one liter water was collected for physical properties determination, seven liters for chemical properties determination and three hundred seventy five mL for bacteriological properties. The ground water samples collected were kept in an ice cooler from the time it was collected in Sulu until it reached the laboratory in Zamboanga City.

The physical properties(color, odor, taste, Temperature and pH) were done onsite while chemical properties (total acidity, total alkalinity, total hardness, total suspended solid and total dissolved solid) was

done in the Ateneo de Zamboanga University laboratory however, for BOD, analysis was done at Department of Science and Technology IX laboratory, Zamboanga branch. The Dissolved Oxygen was carried-out onsite using a DO probe meter.

The bacteriological properties such as total coliform and E.Coli were done at the DOST laboratory, Zamboanga Branch. Total coliform count was done thru multiple tube fermentation and E. coli count was done thru MPN, FDA-BAM.

2.1. Study Area

The study was conducted in Annor Village, barangay Butan, Indanan and Sahaya Village of barangay Godinez Patikul, Sulu. The ground water analyzed in the study is located in these villages respectively. Annor village is 4.0 km away north of the town of Jolo. There are two ground water systems operated in this village which are 500 m away from each other.

Sahaya village is 3.5 km away, east of the town of Jolo. In this village there is also one ground water system. In both villages the ground water passes from the source to a huge holding tank and connected to the different household through smaller rubber pipes.

3. Results and discussion

The results show that the ground water samples (A, B and C) for all three sampling periods are colorless, odorless, and tasteless which conform to the standard value set by the Philippine National Standard for Drinking Water. The results show that all of the three physical parameters for potable water are met as seen on Table 1 below.

The results also show that the water samples have an average pH of 8.38 for sample A, 8.4 for sample B, and 8.26 for sample C respectively. The Philippine National Standard for drinking Water has set an acceptable pH value with the range of 6.5 to 8.5. Using the standard value of PNSDW, all the samples in this study are within the acceptable value. The results also show that the water samples have an average pH of 8.38 for sample A, 8.4 for sample B, and 8.26 for sample C respectively. The Philippine National Standard for drinking Water has set an acceptable pH value with the range of 6.5 to 8.5. Using the standard value of PNSDW, all the samples in this study are within the acceptable value.

Table 1. Results of Physical Properties

Result (Water Samples)													
Parameter	May 18, 2011			May 25, 2011			May 31, 2011			Average			Standard Value
	A	B	C	A	B	C	A	B	C	A	B	C	

Color	Color less	Color less	Color less	Color less	Color less	Color less	Color less	Color less	Color less	Color less	Color less	Color less	N/A
Odor	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Odor less	Unobjectionable
Taste	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Taste less	Flat
PH	8.38	8.4	8.26	8.38	8.4	8.26	8.38	8.39	8.27	8.38	8.4	8.26	6.5 – 8.5
Ambient Temp.^{o}C	30	30	31	29	29	29	31	31	31	30	30	30.3	30 ^{o}C
Temp. of Water sample ^{o}C	29	28	30	28	28	29	30	30	30	29	28.7	29.7	

Legend: samples A and B from Annoor village; Sample C comes from Sahaya village

The Philippine National Standard for drinking Water has set an acceptable pH value with the range of 6.5 to 8.5. Using the standard value of PNSDW, all the samples in this study are within the acceptable value. Temperature is very important in the detection of water potability because it plays a role in the solubility of oxygen. When the temperature is high tendency of oxygen to be dissolved is low as compared when the temperature is low. When the temperature of the water elevates the tendency of oxygen is to liberate itself to gaseous form. This is the reason why temperature plays a role in the determination of the DO and BOD levels of the water samples. In this study the results show that the average temperature of the water samples for sample A is 29 degree Celcius, sample B is 28.7 degree Celcius, and sample C is 29.7 degree Celcius respectively. In this study all the samples A, B, and C were taken when ambient temperature was approximately 30 ^{O}C or even higher, hence the average temperature of the water samples was 30.3 ^{O}C. This could have affected the amount of dissolved oxygen (DO) available in the water samples aside from other factors which could have contributed to the low DO level as seen on Table 2.

Table 2. Results of the Chemical Properties

Parameter	May 18, 2011			May 25, 2011			May 31, 2011			Average			Standard Value
	A	B	C	A	B	C	A	B	C	A	B	C	
DO	2.7	2.78	2.23	2.68	2.81	2.26	2.72	2.78	2.21	2.7	2.79	2.23	5mg/L
BOD	6	3	25	8	2	1	7	5	20	7	3.33	15.33	**5mg/L**

Total Acidity	10.9	5.19	9.0	10.9	5.2	8.37	10.27	5.19	9.0	10.69	5.193	8.79	50mg/L
Total Alkalinity	115.38	213.47	141	116.18	212.67	140.6	115.78	212.67	141.4	115.78	212.94	141	50-200 mg/L
Total Hardness	20.47	32.18	59.50	20.19	32.18	58.64	20.47	32.18	59.50	20.38	32.18	59.21	300 mg/L
Total Suspended solid	11.93	0.7	1.97	12.2	0.73	2.1	11.7	0.7	1.97	11.94	0.7	2.01	50 mg/L
Total dissolved solid	8.7	225.33	43.33	8	229.33	4.6	9.33	228	42.7	8.68	227.55	44.01	1000mg/L

Legend: samples A and B from Annoor village; Sample C from Sahaya village

Table 2 above shows the results of the chemical analysis of the water samples. Dissolved oxygen refers to the amount of oxygen dissolved or contained in water.

The study shows that the water samples for all three sampling periods have an average DO of 2.7 for sample A, 2.79 for sample B, and 2.23 for sample C. The results show that all the samples for the three sampling periods have values for dissolved oxygen less than the standard value. It should be recalled however, that high DO level in a community water supply is good because it makes drinking water taste better. The review of literature reveals that when Oxygen is present in water it is consumed not only by living organisms (for respiration) but also by organic molecules present in the water system. Organic molecules need oxygen for their oxidation and chemical transformation. The water samples in this study might have living organisms/organic matter causing the depletion of dissolved oxygen.

BOD relates to the demand made on the available oxygen in the water by bacteria including aerobic and anaerobic forms and any organic matter in the water. All of which use oxygen as their sustenance for life. The higher the BOD level the less oxygen is available for aquatic and plant life and under normal conditions, an increase in BOD means less availability of dissolved oxygen. Five milligram per liter (5mg/L) is the standard value set by the PNSDW for both DO and BOD and that BOD should not be greater than 5 and DO should not be lesser than 5. The results for BOD show that the water sample have an average of 7 for sample A 3.33 for sample B and 15.33 for sample C. Based from the results of the study only sample B is within the permissible level for BOD which is lower than 5mg/L, where as samples A and C have BOD higher than 5 mg/L which is not within the permissible level. In fact as revealed by the results of the DO level, all the samples A, B, and C have low DO and all are below 5 mg/L,an indication that it is not within the acceptable level for standard water quality.

It can be further be explained that the low DO level of all the three samples is supported by the results of the total coliform count in which all the samples are above the acceptable value, this means that more bacteria is present in the samples resulting to the depletion of dissolved oxygen in the water.

It can be seen from the table that the TSS is low this is because the water samples were gathered from the holding tank in which suspended matter might have been settled at the bottom of the tank.

Table 3. Results of Bacteriological Properties

Parameter	May 18, 2011			May 25, 2011			May 31, 2011			Average			Standard Value
	A	B	C	A	B	C	A	B	C	A	B	C	
Total coli form Count (MPN/100mL)	490	1,300	13	5,400	9,200	17	790	790	490	2,226.66	3,763.33	173.33	<1.8 MPN/100 mL
E. Coli Count (MPN/100mL)	<1.8	14	<1.8	12	<1.8	<1.8	<1.8	2.0	<1.8				<1.8 MPN/100 mL

Legend: samples A and B from Annoor village; Sample C from Sahaya village

Table 3 above shows the results of the analysis on the bacteriological properties of the water samples. The detection of coliform organism and E. Coli in water is usually done to evaluate the quality of drinking water. Total coliform count gives a general information of the sanitary condition of the water. The E. Coli is the indicator organism for fecal contamination in water. Drinking water and those especially for household use should not contain the indicator organism otherwise; the presence of these bacteria in drinking water especially if it is above the acceptable value is detrimental to the health of the consumers. E-coli in particular, if present in amounts exceeding the allowable standard value, is a cause for alarm in the community because it can become the source of an epidemic.

As shown on Table 3, the total coliform count per 100 mL of the water samples for all the three sampling periods have an average of 2,226.66 MPN for sample A, 3,763.33 MPN for sample B, and 173.33 MPN for sample C respectively. For the E.coli count, only sample C has less than 1.8 MPN/100mL for the three consecutive sampling periods. Sample A recorded less than 1.8 for the first and third sampling period and 14 for the second sampling. In sample B only the second sampling has less than 1.8 MPN/100mL, the first and third sampling recorded 14 and 2 respectively.

Based from the results of the study, the total coliform count of the three water samples for all three sampling periods were not within the acceptable value. For the E.Coli count, only sample C conform to the acceptable value of less than 1.8 MPN/100mL.

There are some factors observed by the researcher which might account for the presence of total coliform and E. Coli in the water samples. One factor is the way the ground water source was built and maintained as well as the huge tank where it is stored. The source of the ground water (deep well) for samples A and B

consumed by the residents of Annoor Village is not deep and are not covered. So the tendency of animal wastes to enter and contaminate the source of the ground water is possible. Suspended materials in the air brought about by the wind may enter to the source and the huge tank as well. It was also observed that there are stray animals within the vicinity of the source of the ground water.

Literature states that animal feedlots and slaughter houses may contain bacteria, viruses and parasites that can contaminate ground water. This is one source of ground water contamination identified by Plummer (1999). Therefore, the presence of many animals (like cows, dogs and others) in Annoor Village may be one reason why E.coli is present in samples A and B. The presence of E. Coli is an indication of fecal contamination either from human or animal waste.

In this study, it is possible that fecal contamination is brought about by the animal waste that entered into the body of water and those of the residences of the village. For sample C, collected from the water source in Sahaya village, since E. Coli is with-in the acceptable value, therefore fecal contamination is not alarming and detrimental to human health. This is because in this village one can rarely find a stray animals in the vicinity as compared to Annoor Village. As seen on Table 3 the total coliform count is 173.33 MPN/100mL. The presence of total coliform in this sample is an indication that less pollutants enter via soil contamination, or possibly a warning to the residences that more serious pollution could follow if they will not maintain cleanliness in the vicinity of the ground water source.

4. Conclusion

The study on the potability of ground water supply in selected municipalities in Sulu revealed that samples A and B taken from the water sources in Annoor Village Indanan, Sulu are not potable for drinking based on the bacteriological results, since drinking water for human consumption should not contain indicator organism like E.Coli. Water from sources A and B are not recommended especially for drinking since the E. Coli count is way above the acceptable value of less than 1.8MPN/100mL as prescribed by the PNSDW.

However, sample C has lesser contamination as compared with samples A and B therefore can be recommended for drinking since the E. Coli count was within the permissible level.

The results of the study requires that the water supplied to the residences of Annoor Village, Indanan, Sulu and Sahaya Village and Patikul, Sulu should undergo regular chemical and Microbiological treatment before it is distributed to the community to protect the health of the members of the community and to prevent the outbreak of intestinal diseases/epidemic.

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