Analysis of Nitrate Concentration of Shallow Tube Wells of Selected Corn Producing Barangays in Bautista

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Abstract - *Too much concentration of nitrates in drinking water is hazardous to health, several studies claimed that it causes methemoglobinemia or blue baby syndrome to pregnant women. This study analyzed the nitrate concentration of shallow-tube wells of corn-producing barangays in Bautista. Water samples were subjected into two nitrate-testing schedules for November 2013 and January 2014. The results were compared to the water quality standards sets by the Environmental Protection Agency. Water samples from Vacante are high and above the nitrate standards while Artacho shows irregular nitrate concentrations. Water samples collected in Nibaliw and Sinabaan are significantly normal in their nitrate concentrations. All of the nitrate concentrations obtained from the shallow tube wells are similar in the sampling periods of November and January. It is suggested that the residents in the sampling area to avoid drinking the water from their shallow-tube wells. This to prevent possible nitrate related contaminations. It is recommended that future researchers should delimit the month of nitrate testing to a longer time interval, this is to determine any significant differences and to establish which particular month/s shows high or low nitrate level concentration.*

Keywords:*nitrate concentration, shallow-tube wells, corn producing barangays*

INTRODUCTION

Over the years, there has been a wide range of development in agronomic practices in the Philippines with the urgent efforts to increase food production. The perceived increased of production from agricultural land has been directed by the overused and misused of inorganic fertilizers. Nitrogen being one of most important nutrient because it is mainly absorb by plants, is essential in ensuring healthy plants for production and consumption. Nitrogen plays an important role in the formation of proteins that makes up the tissues of most living organisms, however excessive application of nitrogen in forms of fertilizer, has negative effects both on soil and water table.

The overuse and misuse of fertilizers has become a common agricultural practice in many countries." In the Philippines, it is also considered as a cultural practice, farmers aim at yielding more to suffice the cost of agricultural use. Their widespread use often leads to new problems including poisonings, insect resistance to chemicals, the loss of the pests' natural enemies and even water table contamination [1]. 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. Diarrheas and other waterborne diseases still rank among the leading causes of illnesses in the country. It is apparent that continuous development or refinement of policies and programs geared towards minimizing the risk of contracting waterborne diseases should be supported to provide optimal health service for the population. 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 [2]. Our water table is greatly affected by nitrate contaminations, these contaminations are primarily caused by run-off from agricultural wastes, fertilizers and pesticides applications and other topographic conditions.

The Minnesota Department of Health has established a Health Risk Limit (HRL) of 10 milligrams per liter (parts per million, or ppm) of nitrate nitrogen in ground water. An HRL is the concentration of a contaminant in ground water that is safe to ingest daily over a lifetime. The primary concern for ingesting ground water high in nitrates is with infants under six months old. The toxic effects of nitrates in infants occur when bacteria in the stomach convert nitrate to more toxic nitrite, which reduces the capability of the blood to carry oxygen to the tissues, resulting in "blue baby syndrome" (methemoglobinemia). Most children over six months old and adults have enough stomach acid to inhibit growth of the bacteria which can cause the disease [3]. Some studies claimed that too much nitrates in drinking water causes cancer; [5] Drinking water contaminated with nitrates has a potential role in developing cancers of the digestive tract, and has also been associated with other types of cancer such as non-Hodgkin's lymphoma, bladder and ovarian cancers (Ward et al. 2005).

The town of Bautista is known the home of the Philippine National Anthem or the LupangHinirang, also recognized as the Walis Tambo Capital of Pangasinan". Despite of its small land area of 8,213 hectares or 59.19 square kilometers, it is also known as one of the major corn producing towns of Pangasinan. The town of Bautista is geographically a low-lying town along the Agno River, with this consideration it is being selected as the site for nitrate testing. Some studies focused on low lying areas to determine the topographic effect on the seepage of nitrate concentrations in the water table.

Several studies both foreign and local revealed that the increasing use of artificial fertilizers, the disposal of wastes (particularly from animal farming) and changes in land use are the main factors responsible for the progressive increase in nitrate levels in groundwater supplies over the last 20 years [4]. In the Philippines, the results show examples of groundwater pollution with nitrates in the two provinces sampled, Benguet and Bulacan, and this pollution seems related to intensive farming areas where nitrogen fertilizers (and other agrochemicals) are applied in excess [5]. In 5 out of the 18 artesian wells tested, nitrates levels were above the World Health Organization (WHO) drinking water safety limit of 50 mg/l NO3, this water pollution could have serious health implications for the local population, especially for children. Surface waters generally showed lower nitrate levels than groundwater sources, pointing to the rapid cycling of nitrate in surface waters in tropical climates. For both surface and ground waters, the high input of nitrogen into the aquatic ecosystem could have negative environmental effects on the local and regional level, from eutrophication in lakes to harmful algal blooms in coastal waters [5].

METHODOLOGY

This study made use of the experimental and laboratory methods of research. The experimental method of research was used to establish the significance of the difference between the two sampling schedules implemented for the month November and January. Laboratory method of research sought to determine the level of concentration of nitrates of the water samples collected from the four corn-producing barangays Bautista. Water samples collected from these two sampling schedules, were subjected to first and second nitrate testing by the Bureau of Soils and Water Management (BSWM). The parameters being used in the laboratory is in terms of Nitrate-N and the unit used is in parts per million (ppm) or milligrams per liter (mg/L).

Subjects of the Study

The four corn-producing barangays in Bautista were selected based on purposive sampling. The following corn-producing barangays are Vacante, Artacho, Nibaliw, and Sinabaan. The shallow-tube wells depth ranges from 20-40 feet or 64-128 meters. These tube wells were sourced from irrigation and sometimes used by human consumption in the area.

Procedure

For the laboratory analysis method, all water samples were collected, in the morning using a sterilized bottle/vial. Once water samples are collected, samples are placed immediately in the ice box / refrigerator to prevent the nitrate from evaporating from the water sample. The water samples were collected from 8:00 to 10:00 in the morning of November 19, 2013 (First sampling schedule) and November 26, 2013 (Second sampling schedule) to represent the Sampling period for November. After the first sampling period, the water samples were immediately tested in the laboratory of the Bureau of Soils and Water Management (Quezon City). Water samples for the month of January were collected also from 8:00 to 10:00 in the morning of January 17, 2014 (First sampling schedule) and January 24, 2014 (Second sampling schedule). In addition, after the second sampling period the water samples were immediately tested in the laboratory of the Bureau of Soils and Water Management for nitrate concentration analysis.

Data Analysis

To determine the nitrate concentration, water samples were analyzed by the Bureau of Soils and Water Management. The concentrations of nitrates obtained from collected water samples were expressed in terms of parts per million (ppm). The average of the nitrate concentration (ppm) for November and January was computed and categorized as High, Normal, and Low. The results of the analysis were compared using Paired Sampled t-test to establish differences and similarity between the levels of nitrate concentration in shallow-tube wells for two-sampling; and level of standards set by Environmental Protection Agency (EPA).

RESULTS AND DISCUSSION

Data in Table 1 shows that the nitrate concentrations obtained from Vacante in the first and second testing during the month of November was 94 ppm and 81 ppm respectively. The average of these two concentrations is 87.5 ppm and is described as High (H) in its nitrate concentration. In addition, Vacante was still high in its nitrate concentration during the month of January, (90 ppm) concentration in the first and second testing respectively. The average of these two concentrations was 90 ppm and is described as High (H) in its nitrate concentration. The sample water obtained from Vacante was consistently high in nitrate concentration for two sampling periods, which is above the nitrate standards set by the Environmental Protection Agency (EPA). According to the EPA (2003), nitrate concentration ranging from 10 ppm and above is unsafe for human consumption.

The sampled shallow tube wells of Artacho reveals 1 and 70 ppm for the first and second testing in November. The average of these two concentrations is 35.5 ppm and is described as High (H) in nitrate concentration. Water at this nitrate concentration range is unsafe to drink. However, during the sampling period of January it revealed 5 and 1 ppm for the first and second nitrate testing. The average of these concentrations is 3 ppm and is described as Normal (N) in nitrate concentration.

Table 1.Level of Nitrate Concentration of Shallow-Tube Wells of Corn-Producing Barangays in Bautista for Two-Sampling Periods during November (2013) and January (2014)

	TESTING PERIOD							
	NOVEMBER				JANUARY			
BARANGAYS	FNT_N (ppm)	SNT_N (ppm)	Average (ppm)	DR	FNT_J (ppm)	SNT_J (ppm)	Average (ppm)	DR
Vacante	94	81	87.5	**H**	90	90	90	**H**
Artacho	1	70	35.5	**H**	5	1	3	**N**
Nibaliw	1	3	2	**N**	2	2	2	**N**
Sinabaan	5	5	5	**N**	2	2	2	**N**

Legend:

H	-	*High in nitrate concentration* ***(above 10 ppm)***
N	-	*Normal in nitrate concentration* ***(1ppm – 10 ppm)***
L	-	*Low in nitrate concentration* ***(below 1 ppm)***
FNT_N	-	*First Nitrate Testing (November)*
SNT_N	-	*Second Nitrate Testing (November)*
FNT_J	-	*First Nitrate Testing (January)*
SNT_J	-	*Second Nitrate Testing (January)*
Average	-	*Average concentration of first and second nitrate testing*
DR	-	*Descriptive Rating*

This shows an irregular nitrate concentration of Artacho during the months of November and January. The sudden decrease in the nitrate level concentration may be caused by the topographic condition of Artacho, which makes leaching of nitrates faster into water table. In addition, the type of soil (paddy) and amount of rainfall might have affected the nitrate concentration of Artacho.

During the month of November, Nibaliw had a nitrate concentration of 1 ppm and 3 ppm on the first and second testing. The computed average of these two concentrations is 2 ppm and is described as Normal (N) in nitrate concentration. In the month of January, the concentration obtained was 2 ppm for two testing schedule respectively. These concentrations had an average value of 2 ppm, which is described as Normal (N) in nitrate concentration. This means that the concentration of the sampled shallow tube wells in Nibaliw was at the normal tolerable range of nitrate concentration.

Water samples from Sinabaan, were consistent to have 5 ppm for the sampling periods in January. The average of these two nitrate concentrations is 5 ppm and is described as Normal (N). For the month of January, water samples from Sinabaan were still low of nitrate concentration with 2 ppm nitrate concentration respectively. The computed average was also 2 ppm and is described as Normal (N) in nitrate concentration. This means that water at this nitrate concentration range is tolerable and safe for drinking. Based on the Environmental Protection Agency (EPA 2003), using the nitrate level standard for drinking water. Water having above 10-ppm nitrate concentration is considered "High". Water at this level is unsafe to drink. Environmental Protection Agency (EPA) added, that drinking water ranges from 1-10 ppm concentrations are considered "Normal" in nitrates and is safe for drinking; while below 1 ppm concentration is also considered "Low" in nitrates and is also safe for drinking.

Data in table 2 shows that the mean of the nitrate level concentrations during the sampling periods for the months of November and January were 32.5 and 24.25 respectively. The average mean for the sampling period in November was higher than the month of January with a mean difference of 8.25. The computed t-value is equal to 0.94 with a corresponding p- value of 0.38, which is considered **Not Significant (NS)**. The hypothesis of no significant difference is therefore accepted, which means that the nitrate concentration for two sampling periods in the month of November and January is comparable. This means that the nitrate concentration of the shallow tube wells did not show significant increase or decrease during the testing period.

This negates in the findings of Hanson (2002) "In shallow, unconfined groundwater that is not diluted by recharge from surface water, nitrate nitrogen concentrations commonly fluctuate on a seasonal cycle, with higher concentrations in winter and spring and lower concentrations in autumn. The magnitude of these fluctuations is typically on the order of 2-6 mg/L over a single year, but there is substantial variation in both the magnitude and the timing of the fluctuations, largely owing to variations in rainfall and groundwater recharge [7].

Table 2.Difference between the Levels of Nitrate Concentration ofShallow-Tube Wells of Corn-Producing Barangays for Two Sampling Periods. (November And January) (N = 8)

Sampling Periods	Mean	Mean Difference	t-value	p-value/ Sig. (2-tailed)	DR
November	32.5	8.25	**0.94**	**0.38**	**NS**
January	24.25				

Legend:

Mean	–	*mean of paired sample statistics for each sampling period*
Mean Difference	–	*mean difference for November and January sampling period*
N	–	*Number of nitrate testing*
t-value	–	*Computed t-value of paired differences for November and January sampling period*
DR	-	*Descriptive Rating*
S	-	*Significant*
NS	-	*Not Significant*

Data in Table 3 shows that the average mean values for the levels of nitrate concentration for November and January and the levels of nitrate standard set by Environmental Protection Agency (EPA) are 28.37 and 6.37 respectively. The average mean for the levels of nitrate concentration of shallow tube wells is considerably higher than the level of nitrate standards set by the EPA. The computed mean difference is 22.0. This means that there is significant difference in the level of nitrate concentration of shallow tube wells and level of nitrate standards set by EPA. This implies significant variations in the obtained nitrate concentrations in the shallow tube wells as compared to the set nitrate standards. The EPA has set 10 mg/L or ppm for nitrate concentrations on drinking water, above this standards are considered potential hazards to health.

Table 3. Levels of Nitrate Concentration of Shallow-Tube Wells during November and January Sampling Periods and the Levels of Nitrate Standard set by Environmental Protection Agency (EPA) (N = 16)

Paired Samples	Mean		Average Mean	Mean Difference	t- value	p-value/ Sig. (2-tailed)	DR
	November	January					
*Level of Nitrate Concentration of Shallow-tube wells: (NOVEMBER and JANUARY)	32.5	24.25	**28.37**	**22**	**2.406**	**0.029**	**S**
*Level of Nitrate Standards	6.437	6.312	**6.37**				

CONCLUSION

Water from the shallow tube wells of Vacante has high nitrate concentration for two sampling periods. The high nitrate concentration in Vacante was due to geographic/topographic condition and other environmental factors. Water from the shallow tube wells of Artacho has irregular nitrate concentration for the two sampling periods. The irregular nitrate concentration of Artacho might be caused by the amount of rainfalls that occured during the sampling stages in the area. Water from the shallow tube wells of Nibaliw and Sinabaan had normal nitrate concentration and therefore safe for human consumption. The levels of nitrate concentrations of the barangays are comparable. The level of nitrate concentration of shallow-tube wells is significantly different compared to the levels of nitrate standard set by Environmental Protection Agency (EPA). Other environmental factors like amount of rainfall, topographic/geographic conditions, and nitrogen cycle might have affected the level of nitrate concentrations in the shallow tube wells.

RECOMMENDATION

There should be a potable water system in Vacante where high nitrate concentrations were observed. This could be done by a joint effort of the community and the local government. This to prevent possible nitrate related contaminations, since the nitrate concentrations of shallow tube wells were above the nitrate standards set by Environmental Protection Agency (EPA). There should be a regular monitoring in the shallow tube wells of Artacho on the possible sources of its irregular nitrate concentrations. The local government and the Department of Agriculture could conduct regular nitrate analysis in the areas of Artacho. They should establish a stable nitrate range, so that possible solutions on irregular nitrate concentration can be done, like putting up a potable water system or water treatment facilities. Although normal nitrate range was observed in the shallow tube wells of Barangays Nibaliw and Sinabaan, there should still be a regular monitoring of the nitrate concentration in the area. Future researchers and water analysis experts should delimit the month of nitrate testing to a longer time interval. Significant differences in the nitrate concentrations of certain wells takes at least 2 to 3 years from time of testing period to show increase, decrease and stable nitrate level concentrations. This is to determine any significant differences and to establish which particular month/s shows high or low nitrate level concentration. Future researchers should look into other possible sources of the increase or decrease of nitrate level concentration of a certain area. They should also look into topographic condition, climate, and other environmental factors. The choice of sampling sites for nitrate testing, should be categorized according to its potentiality of accumulating sources of nitrates, researchers may consider the topography and the type of soil in the area. Residents in areas showing high nitrate level concentration should not drink the water from their shallow-tube wells. Information dissemination on the possible adverse health effects of high nitrate concentration should be conducted by agencies like the Department of Health and Department of Agriculture. While, the Bureau of Soils and Water Management and other concern agencies should conduct wider nitrate studies and researches.

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