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# Microbiological Analysis, Physical-Chemical Analysis, and Acceptability of Deep Well Water of NEUST-SIC Tabon

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**Abstract:** ***In a school setting, water quality is of vital importance to sustain the day to day activities of students as well as the usage of it by its faculty, staff, and administration. Proper monitoring ensures that water is of quality fit for use. This study focuses on the microbiological analysis, Physical-Chemical Analysis, and Acceptability of deep well water of NEUST San Isidro Tabon Campus. Physical Characteristics of the water samples were also determined. It employed the use of standard laboratory procedures to analyze the water quality parameters. For the microbiological parameters, the fecal/thermotolerant coliform, the deepwell water of NEUST SIC Tabon "Passed" the permissible limit. For Physical and Chemical Analysis, the deepwell water "Passed" the following parameters; turbidity, Color, Total Dissolved Solids, Nitrates, and Arsenic. However, it registered a pH level of 6.15 which is below the standard pH level of water and therefore considered as "Acidic". As for its Acceptability, it was determined in terms of Color, Odor, and Taste. Most of the respondents deemed the water "Completely Acceptable" for its color and odor, while "Barely Acceptable" in terms of the taste. Follow-up and constant monitoring in the microbiological qualities of deep well water in all the campuses of NEUST is suggested every six months. Likewise, physico-chemical analysis every three years should also be made to further determine the chemical content of deep well water if the water source is located in agricultural area. The inclusion for test for the presence of insecticides is also recommended since the place is identified as an agricultural area.***

**Keywords:** Microbiological Analysis, Physico-chemical Analysis, Acceptability, Deepwell Water, Permissible Limit

## 1. Introduction

The Philippines obtains its water supply from different sources. These include: rainfall, surface water resources, i.e. rivers, lakes, reservoirs, and groundwater resources. In terms of ground water, the country has an extensive groundwater reservoir with an aggregate area of about 50,000 sq. km. Data from the Mines and Geosciences Bureau (MGB) show that several groundwater basins are under laid by about 100,000 square kilometer (sq.km) of various rock formation and one of these resources are found in Central Luzon (Water in PH Green Peace, 2007). According to World Health Association (WHO), the amount of fresh water on Earth is limited, and its quality is under constant pressure. Preserving the quality of fresh water is important for the drinking-water supply, food production, and recreational water use.

Water Quality can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards. In a report of water.org, out of 101 million Filipinos, nine million rely on unimproved, unsafe, and unsustainable water sources. The Philippine Clean Water Act of 2004 measures water quality in terms of physical, chemical, biological, bacteriological, or radiological characteristics by which acceptability of water is evaluated (Water in PH Green Peace, 2007).

In a report by Environmental Management Bureau (EMB 2006), four regions were found to have an unsatisfactory rating for the water quality criteria. These include National Capital Region (NCR), Southern Tagalog Region (Region IV), Central Luzon (Region III), and Central Visayas (Region VII). Based from various Feasibility Studies of water districts with the Local Water Utilities Administration (LWUA) for the period 1990-1997 and data from Philippines Environment Monitor (PEM), 58 percent (%) of ground water sampled are found to be contaminated with coliform bacteria, thus, needs treatment. A more updated data, though limited in number of samples, was the result of the 2005 Tapwatch Monitoring Program by the EMB. From the 88 wells monitored in depressed areas in the country, the project found 21 sites with potable groundwater, while 27 sites were found to be contaminated with fecal coliform (Water in PH Green Peace, 2007).

## 2. Methodology

### 2.1 Research Design

This study made use of the laboratory analyses and descriptive research design. The research took place in a natural setting employing a combination of collection, observations and questionnaire. Deepwell water from Nueva Ecija University of Science and Technology in San Isidro Tabon Extension was used. Before the start of actual water sampling, a survey was done on the deep well. The study employed the use of standard laboratory procedures to analyze the physical characteristics and microbiological water quality parameters. After the investigation of Microbiological and Physical-Chemical Analysis of Water, a questionnaire on the acceptability of the physical characteristics of deep well water was prepared wherein thirty respondents from the students and teachers of NEUST-SIC Tabon participated.

### 2.2 Questionnaire on the Acceptability of Water

The questionnaire on the Acceptability of Water was developed using a modified 4-point acceptability scale that best reflect the condition of the water based on previous observations of the residents of NEUST SIC Tabon. The questionnaire was utilized to retrieved data and evaluated with the following scores and their descriptions: 4 – Completely Acceptable, 3 – Barely Acceptable, 2 – Barely Unacceptable, and 1 – Completely Unacceptable. These scores were assigned for the evaluation of the water as to its color, odor, and taste.

**Parameter on the Acceptability of Water**

| | Completely Unacceptable | Barely Unacceptable | Barely Acceptable | Completely Acceptable |
|---|---|---|---|---|
| Color | Color is cloudy with impurities that is visible to be identified | Color is little cloudy with bits of impurities. | Color is clear with negligible impurities | Color is Clear with no impurities |
| Taste | Taste is somewhat not good and hard to identify that leaves an unpleasant feeling. | Taste is hard that leaves a metallic and salty consistency to the tongue. | Little hard for the tongue but does not leave any undesirable taste. | Taste is not hard and does not leave any undesirable taste. |
| Smell | Strong unpleasant odor that is a mixture of different materials. | Exhibits a rusty metallic odor. With somewhat fishy or organic smell. | Does exhibit a bit metallic odor but no indication of any fishy or organic smell. | No indication of any unpleasant odor. |

### 2.3 Procedure

The thirty (30) participants made use of disinfected spoon to have a bit of taste of the collected water sample. Observations were done in assessing the water color and odor. After the acceptability evaluation, the score sheets were gathered, recorded, tallied, summarized and prepared for computation. Percentage and Mean was used in determining the level of acceptability in terms of color, odor, and taste. The following scale and descriptions were used:

1.00 – 1.75 Completely Unacceptable
1. 76 – 2.50 Barely Unacceptable
2.51 – 3.25 Barely Acceptable
3.25 – 4.00 Completely Acceptable

### 2.4 Materials and Procedure for Water Analysis

For Water Collection, one bottle with a capacity of 150 mL was cleaned thoroughly and sterilized for thirty minutes. It is then dried ready for collection. In the pump well where water sample was collected, the outlet or mouth of the mechanical water hand pump was wiped to remove any adhering dirt using a clean cloth. Pumping for five 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 bottle to facilitate shaking at the time of inoculation prior to analysis. Sampling bottle was capped then placed inside an ice chest (filled with ice) immediately after collecting the sample at low temperature so that bacterial action is reduced (De Vera, 2015).

For Physical Characteristics and Microbiological Analysis, collected water sample was immediately transported to the laboratory. The sample was analyzed with the use of standard methods of analyses and laboratory apparatus at Cabanatuan City Water District – Water Testing Laboratory for the microbiological analysis using the Multiple Fermentation Technique. This is to find out whether the quality of deep well water of NEUST SIC Tabon Extension sample passed or failed the national standard for Fecal/Thermotolerant Coliform.

For Physical – Chemical Analysis, collected water sample was immediately transported to Angeles City Water District. Analysis was divided in three different parameters; Physical Analysis, Chemical Analysis, and Heavy Metal analysis. For Physical Analysis, Nephelometry was administered to measure turbidity and Spectrophotometry for Color. For Chemical Analysis, Electrometry, Gravimetry, and Nitrate Electrode were employed to find out the pH, Total Dissolved Solids, and Nitrates respectively. And for Heavy Metal Analysis, Atomic Absorption Spectroscopy was employed to determine the presence of Arsenic.

## 3. Results

**Table 1:** Microbiological Analysis of Deep Well Water

| Sampling Point | Date and Time of Sampling | Total Coliform (MPN/100ml) | Fecal/ Thermotolerant Coliform | Remarks |
|---|---|---|---|---|
| NEUST TABON (SIC) | 22-May-19 11:45 AM | <1.1 | <1.1 | Passed |
| PNSDW Limits AO 2017 -0010 | | * | <1.1 | |

Table 1 reveals the data on the fecal coliform/thermotolerant coliform of the deep well water sample from NEUST SIC Tabon. It shows that the fecal/thermotolerant coliform of deep well water sample **"PASSED"** as per standard methods of detection and values for microbiological quality.

**Table 2:** Physical Analysis of Deep Well Water

| Parameters | Concentration | Unit | 2017 PNSDW Limit | Method | Remarks |
|---|---|---|---|---|---|
| pH | 6.15 | pH units | pH 6.5 - 8.5/5.0-7.0* | Electrometry | Failed |
| Total Dissolved Solids | 286 | mg/L | 600 mg/L / 10 mg/L** | Gravimetry | Passed |
| Nitrates | 0.4 | mg/L | 50 mg/L | Nitrate | Passed |

| | | | | | |
|---|---|---|---|---|---|
| (NO3) | | | | Electrode | |

Table 2 shows the data on the Physical Analysis which include the pH, Total Dissolved Solids and presence of Nitrates. It reveals that the deep well water of NEUST SIC Tabon "Passed" the parameters on Total Dissolved Solids and Presence of Nitrate with a concentration of 286 mg/L and 0.4 mg/L which is below the standard level of 600 mg/L/10 mg/L and 50 mg/L respectively. However, it "Failed" on the pH level which registered at 6.15 that is lower than the standard range of 6.5 to 8.5.

**Table 3:** Chemical Analysis of Deep Well Water

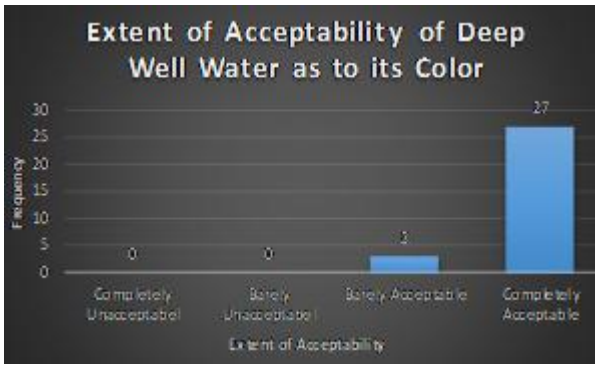
| Parameters | Conce-ntration | Unit | 2017 PNSDW Limit | Method | Remarks |
|---|---|---|---|---|---|
| Turbidity | 0.515 | NTU | 5 NTU | Nephelometry | Passed |
| Color | 8 | ACU | 10 ACU | Spectrophotometry | Passed |

Chemical Analysis shown in table 3 reveals that the turbidity and color "Passed" the standard level. It registered a concentration of 0.515 NTU and 8 ACU which is below the standard value of 5 NTU and 10 ACU for Turbidity and Color respectively.

**Table 4:** Heavy Metal Analysis of Deep Well Water

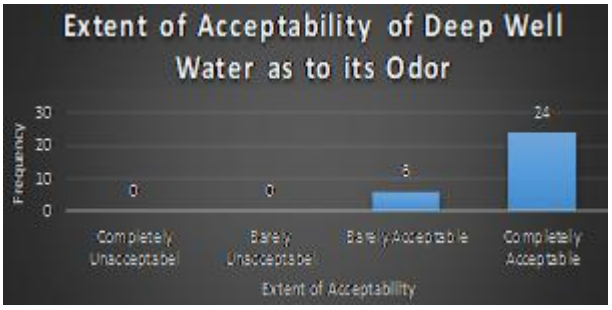
| Parameters | Concentration | Unit | 2017 PNSDW Limit | Method | Remarks |
|---|---|---|---|---|---|
| Arsenic, As | <MDL (MDL = 0.002) | mg/L | 0.01 mg/L | Atomic Absorption Spectroscopy | Passed |

Table 4 reveals the heavy metal analysis of Deep Well Water of NEUST SIC Tabon in terms of Arsenic content. It shows that the level of arsenic is 0.002 which is an indicative that it "Passed" the 2017 PNSDW Limit of 0.01 mg/L.



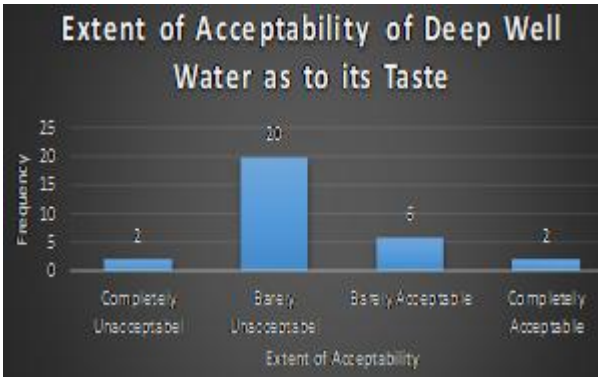

**Graph # 1:** Extent of Acceptability as to its Color

The graph shows the extent of acceptability of the deep well water of NEUST-SIC Tabon as to its color. It can be observed from the graph that ninety percent or 27 out of 30 participants or 90 % of the respondents responded "Completely Acceptable". While the other 10 % percent or 3 respondents marked the color of the deep well water "Barely Acceptable".




**Graph # 2:** Extent of Acceptability as to its Odor

The graph shows the extent of acceptability of the deep well water of NEUST SIC Tabon as to its odor. It can be observed from the graph that 80 % or 24 out of 30 participants responded "Completely Acceptable". While the other 6 participants marked its odor "Barely Acceptable". It implies that in terms of odor, the deep well water of NEUST SIC Tabon is perceived as "Completely Acceptable". In addition, most of the respondents commented that the water is odorless and does not exhibit any unpleasant smell.




**Graph # 3:** Extent of Acceptability as to its Taste

The Graph shows the extent of acceptability of the deep well water of NEUST SIC Tabon as to its taste. It can be gleaned that 66.67 % or the majority of the respondents or 20 out of 30 deemed "Barely Unacceptable" when it comes to the taste of deep well water, while 20 % or 6 participants has a verdict of "Barely Acceptable". Only 2 out of 30 respondents deemed the water "Completely Acceptable" to the taste

**Table 5:** Mean Ratings and Interpretation on the Extent of Acceptability of Deep Well Water of NEUST-SIC

| Parameters | Mean | Interpretation |
|---|---|---|
| Color | 3.9 | Completely Acceptable |
| Odor | 3.8 | Completely Acceptable |
| Taste | 2.27 | Barely Unacceptable |
| Grand Mean | 3.32 | Completely Acceptable |

Table 5 shows that the Grand Mean for the different parameters on the extent of Acceptability of Deep Well Water of NEUST SIC Tabon is 3.32. This indicates that the residents of NEUST SIC Tabon Extension find the Deep Well Water "Completely Acceptable".

## 4. Discussions

The Philippine National Standards for Drinking Water

(PNSDW) standard value for fecal coliform is <1.1 Most Probable Number (MPN) per 100 milliliters. We must remember that the presence of coliform bacteria is an indication of the potential presence of disease causing organisms and should alert the person responsible for the water to take precautionary measures. The result of the analysis is a good indication that the collected water is free from residues (Clay and Silts) that can make the water cloudy (turbid). We can also infer that the groundwater from NEUST-SIC Tabon Extension contains layer consisting of sands which makes the water clear (not turbid).

Deep well water of NEUST SIC Tabon has a pH level of 6.15. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters. Careful attention to pH control is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection. Lower-pH water (approximately pH 7 or less) is more likely to be corrosive (WHO, 2017). If the pH of water is too high or too low, the aquatic organisms living within it will die. pH can also affect the solubility and toxicity of chemicals and heavy metals in the water [12]. The majority of aquatic creatures prefer a pH range of 6.5-9.0, though some can live in water with pH levels outside of this range. There are many factors that can affect pH in water, both natural and man-made. Most natural changes occur due to interactions with surrounding rock (particularly carbonate forms) and other materials. pH can also fluctuate with precipitation (especially acid rain) and wastewater or mining discharges [13]. In addition, CO2 concentrations can influence pH levels (Fondriest Environmental, 2014).

The deep well water of NEUST SIC Tabon also registered "Passed" in Total Dissolved Solids, Nitrates, Turbidity, Color, and Arsenic. Total dissolved solids test is used as an indicator test to determine the general quality of the water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water. High total dissolved solids may affect the aesthetic quality of the water, interfere with washing clothes and corroding plumbing fixtures (Oram, 2014).

The presence of normal levels of nitrates usually does not have a direct effect on aquatic insects or fish. However, excess levels of nitrates in water can create conditions that make it difficult for aquatic insects or fish to survive (Partnership for Environmental Education and Rural Health, 2019).

Turbidity is an optical determination of water clarity [1]. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Suspended solids and dissolved colored material reduce water clarity by creating an opaque, hazy or muddy appearance. Turbidity measurements are often used as an indicator of water quality based on clarity and estimated total suspended solids in water (Fondriest Environmental, 2014).

The amount of arsenic in ground water supplies like wells is usually higher than in surface water supplies such as lakes, streams and rivers. Arsenic can get into drinking water from natural deposits or runoff from agriculture, mining and industrial processes. If not monitored, exposure to very high levels of arsenic in drinking water can lead to arsenic poisoning. Symptoms of exposure to high levels of arsenic include stomach pain, vomiting, diarrhea, and impaired nerve function, which may result in 'pins and needles' sensation or numbness and burning in hands and feet. Arsenic can also cause skin changes, which include darkening, and wart-like or corn-like growths. These are mostly found on the palms of the hands or bottoms of the feet. Other symptoms can include skin flushing and rashes (Water Stewardship Information Series, 2007).

The color and odor of the deep well water of NEUST-SIC Tabon is perceived as "Completely Acceptable" by its residents. Majority of the respondents also mentioned that the deep well water is very clear which is a good indication that there is no impurity or any kind of residue found. Color may be due to the cloudiness, particulate matter and visible organisms may also be noticed by the respondents and may create concerns about the quality and acceptability of water supply (WHO, 2017). Whereas, odor can originate from natural inorganic and organic chemical contaminants and biological sources or processes (e.g. aquatic microorganisms), from contamination by synthetic chemicals, from corrosion or as a result of problems with water treatment (e.g. chlorination). Odor may also develop during storage and distribution as a result of microbial activity. Odor in water may be indicative of some form of pollution or of a malfunction during distribution. It may therefore be an indication of the presence of potentially harmful substances (WHO, 2017).

In terms of taste, the respondents lamented that the taste is somewhat hard as compared to the taste of bottled water. This kind taste may be attributed to the presence of iron in the water. Also, two participants mentioned that the taste of the water is slightly fishy although not totally recognizable. Thus, they marked it poor. According to the research of De Vera, 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 can have an effect on the taste of water at low concentration.

Overall, the residents of NEUST SIC Tabon Extension found the water fit for use such as for washing, cleaning, watering plants and also for raising fish (Tilapia). However, they still doubt the quality of the Deep Well Water to be used for drinking purposes (Potability).Accordingly, they find the taste of the water hard and with a trace of fishy taste for the two participants.

## 5. Conclusions

Based on the laboratory analysis, the sample "Passed" the standard as per method of detection and values for microbiological quality and also "Passed" the Physical-Chemical Analysis in terms of Total Dissolved Solids, Nitrates, Turbidity, and Color. However, it fails on the pH

level. Making the Deep Well Water of NEUST SIC Tabon "Acidic". The deep well water sample from NEUST SIC Tabon was colorless, odorless and with fishy taste that is not totally recognizable.

## 6. Recommendations

Follow-up and constant monitoring in the microbiological qualities of deep well water in all the campuses of NEUST is suggested every six months. Likewise, physico-chemical analysis every three years should also be made to further determine the chemical content of deep well water if the water source is located in agricultural area. Since deep well water in NEUST SIC Tabon is below the pH range which registered 6.15 or "Acidic", the inclusion for test for the presence of insecticides is also recommended.

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