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A Comparative Analyses of Physicochemical and Microbial Content of Water from the Tank Source and Water Fountain Quality and Filtration Effectivity in Liceo De Cagayan University – Main Campus

Hershean P. Senapilo, Gerard Vincent B. Almonia, Kiercy O. Dolosa, May Ann C. Gelbolingo, Abigail Jim G. Lapinid, Dennicy D. Perez, Jas Felicisimo A. Cane*, Naihma Mae E. Casicas

Liceo de Cagayan University, Rodolfo N. Pelaez Boulevard, Brgy Kauswagan, 9000, Cagayan de Oro, Mindanao, Philippines
*Corresponding author: jcane@liceo.edu.ph

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Abstract: Monitoring water quality in educational institutions such as schools and universities are critical to ensuring the health and well-being of students and faculty who rely on potable water for hydration and sanitation. This study examined the physicochemical and microbial properties of water from a tank source and its corresponding water fountain at an educational institution. Temperature, turbidity, pH, Total dissolved solids, Lead levels, and *E. coli* are among the tests performed. The mean values of all parameters have met the standard specified by the Philippine National requirements for Drinking Water, the United States Environmental Protection Agency, and the World Health Organization, indicating that effective filtration processes exist. However, ongoing monitoring for additional indicators is recommended in order to maintain water quality standards. This emphasizes the significance of regular assessments and attention in protecting the water supply in educational settings, resulting in a healthy and safe learning environment for everybody.

Keywords: *water quality monitoring, physicochemical and microbial parameters, drinking water safety*

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1. Introduction

Monitoring and maintaining the quality of water sources should be important, particularly in institutional factors such as schools and universities. Educational institutions, such as the Liceo de Cagayan University - Main Campus, serve as centers of intellectual and social activity, with a diversified population reliant on clean water for hydration and sanitation. Waterborne contaminants, pollutants, and microbiological agents that can create health risks to individuals who drink or come into contact with such water have raised concerns about the safety of water in public places, especially water fountains on university campuses. The Cagayan de Oro Water District (COWD) serves as the local drinking water source. In addition, the tank source of the water fountain is chlorinated every 6 months.

Access to safe and clean drinking water is a fundamental human right and a crucial aspect in safeguarding individuals' and communities' health and well-being. The United Nations adopted Resolution 64/292 in 2010, which explicitly recognizes the human right to water and sanitation, recognizes that clean drinking water and sanitation are necessary for the realization of all human rights, and seeks to protect water as a national resource and the people who need it the most [1].

In addition, [2] stated that, waterborne infections are becoming more common in Davao de Oro. As of December 2021, a notifiable number of cases of Typhoid, Diarrhea, Cholera, and Hepatitis A have emerged. There were 2 Typhoid, 1238 Diarrhea, 11 Cholera, and 16 Hepatitis A cases, respectively. Hence, a study conducted by [3], shows that there are insufficient hygienic and sanitary conditions and that there is need for regular water quality testing. Thus, it is advised to continue the study with periodic monitoring of water obtained from drinking fountains using similar analyses to those related in that study as well as of other parameters provided for in the current legislation, in order to detect potential physical, chemical, and/or biological changes early. Therefore, the significance of the study addresses the necessity of testing clean drinking water for the consumption of individuals at Liceo de Cagayan University Main-Campus. Additionally, it aids in preventing any major health risks for the consumers that will drink from the water fountains. By doing so, the researchers can help not only the school but also the individuals who will drink from the fountain.

2. Methods

2.1. Research Design

This study's non-experimental research design fits into the category of Cross-sectional research. A one kind of observational study design is the cross-sectional study design, in which the researcher simultaneously measures the study sample's exposures and outcomes [4].

2.2. Research Setting

The samples were collected from the Riverside Canteen's water fountain and Tank source in Liceo de Cagayan University – Main Campus at Rodolfo N. Pelaez Boulevard, Cagayan de Oro City. Samples were tested at the Department of Science and Technology (DOST) located at Jesus V. Seriña St., Carmen and The First Analytical Services and Technical Cooperative (FAST) facilities located at Casiño Building, C.M. Recto Avenue, corner Camp Alagar Road, Brgy., Lapasan both in the same city of Cagayan de Oro. In addition, the tank source of water fountains in Liceo de Cagayan University Main-Campus is routinely chlorinated every 6 months.

2.3. Data Gathering Process

2.3.1. Sample Collection

In the process of collecting water samples (Figure 1), thorough preparation and careful execution are essential. Prior to sampling, a meticulous check of the system is conducted to remove any potential contaminants. The water fountain shall then be turned on at maximum rate, and the system is sterilized for one minute using a flame ignited from alcohol-soaked cotton wool. Afterward, the water flows for two minutes at a medium rate. The sampling bottle is prepared by removing covers, and while holding it under the mouth of the water fountain, approximately 250 mL for microbial and 1L for physicochemical of the water sample will be collected, leaving ample space in the bottle. The cap will be securely placed back on the bottle, and the protective cover is fixed with a rubber band. The entire sampling bottle shall be immediately placed inside an ice chest filled with ice for preservation. This careful procedure ensures the integrity of the water sample, crucial for accurate testing in the laboratory, especially when specific cooling requirements are mandated by the laboratory for water samples.

2.3.2. Data Gathering Procedure

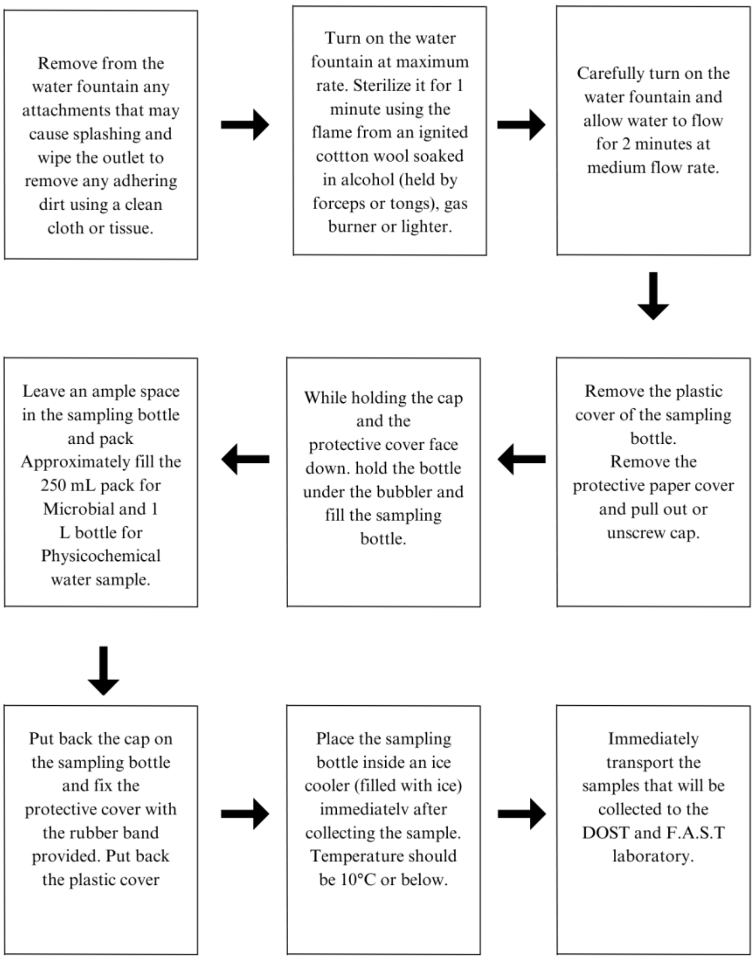

Figure 1. Flowchart for Water Collecting Procedures of DOST and F.A.S.T

2.3.3. Physicochemical Analyses

A sample's pH is determined electrometrically while following the Method 4500-H+, SMEWW 23rd Edition. While Total Dissolved Solids (TDS) is determined by the method 2540C SMEWW 23rd Edition, temperature (°C) is assessed using Infrared water thermometer. A photometer and turbidity guidelines are needed for the Photometric method of turbidity assessment used in the DOST laboratory. Furthermore, laboratory personnel at F.A.S.T used advanced analytical techniques such as the Lead Test Method (3030 E. Nitric Acid Digestion) and Direct Air-Acetylene Flame Atomic Absorption Spectrophotometry (311 B. Direct Air-Acetylene Flame AAS) to assess lead contamination and accurately quantify lead levels in water samples.

2.4. Microbial Analysis

In order to identify *E. Coli*, it is fermented using the Multiple Tube Fermentation Technique. The multiple-tube fermentation technique consists of three stages, and the results are statistically reported as the Most Probable Number (MPN). These stages—the presumptive stage, confirmed stage, and completed test.

2.5. Data Analysis

Table 1. Accuracy and Normal Values of the Parameters

Parameters	Normal Values (WHO, US EPA, and PNSDW standards)
Temperature	10-32 degrees Celsius
Turbidity	< 5 Nephelometric Turbidity Unit (NTU)
pH level	6.5-8.5
Total Dissolved Solids	< 500 mg/L or ppm
Heavy Metal (Lead)	0.01 mg/L
E. coli	Zero count of *E. coli* per 100 ml

In this study, the quality of water in Liceo de Cagayan University's Riverside Canteen water fountain were systematically evaluated to address potential health and safety concerns. Physicochemical parameters, including Temperature, Turbidity, pH level, and Total Dissolved Solids (TDS) (Table 1) were measured independently for each source. Descriptive statistics, specifically mean, had provided a central tendency for each parameter within the Riverside water fountain and its tank source. Microbial parameter, specifically *E. coli* levels, was also assessed separately, and descriptive statistic was used to present counts of microbial contamination in each cluster. Data normalization will be performed to account for variations in measurement scales to be implemented during sample collection and analyses. The interpretation of the findings will be conducted within the context of established water quality standards, guiding the formulation of cluster specific recommendations to address identified issues and improve or maintain water quality in The Tank Source and Riverside Water fountain.

2.6. Statistical Treatment of Data

In the treatment of the data, measures were taken to ensure the reliability of the findings for River side canteen water fountain and its tank source at Liceo de Cagayan University – Main Campus. To address variations in measurement scales, data normalization was performed independently for physico-chemical parameters (pH Level, Turbidity, Total Dissolved Solids, and Temperature) and microbial parameter *(E. coli* levels) within each cluster. Strict quality control measures were implemented during both sample collection and laboratory analyses to safeguard against potential biases and ensure the accuracy of the results. Consistent units were established for all measured parameters and outliers in the data set was detected and corrected. The normalized data will be then interpreted within the context of established water quality standards, guiding the formulation of cluster-specific recommendations to address identified issues and enhance or maintain water quality of The Tank Source and Riverside Water fountain.

3. Results and Discussions

3.1. Data Presentation, Analysis and Findings

Table 2. Normal Values compared to the Mean of Tank Source and Riverside Water Fountain

Parameters	Normal Values (WHO, US EPA, and PNSDW standards)	Mean of Tank Source	Mean of Riverside Water Fountain
Temperature (° C)	10-32 degrees Celsius	31.3	10.17
Turbidity	< 5 Nephelometric Turbidity Unit (NTU)	< 1 NTU	< 1 NTU
pH level	6.5-8.5	7.70	7.83
Total Dissolved Solids (mg/L)	< 500	174.0	159.8
Lead (mg/L)	0.01 mg/L	< 0.01	< 0.01
E. coli	Zero count of *E. coli* per 100 ml	< 1.1 MPN	< 1.1 MPN

The average temperature of the tank source, which stands at 31.3 degrees Celsius, and the water fountain, which is at 10.17 degrees Celsius, indicates that they are likely located in separate environments or settings. According to [5], the temperature of drinking water can change significantly as it is distributed from the source to the consumer. The weather, the depth at which distribution and transit pipes are installed, the kind of soil, groundwater levels, the existence of man-made heat sources, and hydraulic residence times all have a significant impact on this alteration. These unique conditions often result in varying average temperatures between different sources. It is therefore not unusual for two sources to show contrasting mean temperatures due to the diverse variables present in their respective environments.

The tank source and water fountain have been tested for turbidity levels, both showing readings of below 1 NTU. Turbidity is a measure of the cloudiness of water. It is used to show the efficacy of the filtering process and the quality of the water (e.g., whether disease-causing organisms are present). Increased turbidity levels are frequently linked to increased concentrations of pathogenic microorganisms, including some bacteria, viruses, and parasites. The World Health Organization [6], establishes that the turbidity of drinking water shouldn't be more than 5 NTU, and should ideally be below 1 NTU. This indicates that the water is clear and of high clarity, meeting regulatory standards for cleanliness and suitability for drinking purposes. The transparency of the water confirms that it is safe for consumption.

The pH level in the tank source is measured to be 7.70, whereas the water fountain shows a higher pH level of 7.83. The water's pH can be used as a reference to determine the possibility that an issue may exist, but it is not a precise indicator of the water's acidic (low pH) or basic (high pH). According to [7], pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. pH values that are too high or too low may not be good for using water. High pH results in an unpleasant taste, deposits build up in water pipes and appliances that consume water, and it reduces the efficacy of chlorine disinfection, necessitating the use of additional chlorine. Metals and other materials will corrode or dissolve in low pH water. It is possible that this discrepancy in pH levels is attributed to variations in water treatment techniques employed, including the introduction of alkaline substances in the water fountain or the inherent differences in mineral composition of the water originating from different sources. Since compounds in the water can change pH, pH is a useful indicator of chemical changes in the water.

The difference in Total Dissolved Solids (TDS) levels between the tank water (174.0 mg/L) and the water fountain (159.8 mg/L) at Liceo de Cagayan University shows how different water sources and cleaning practices affect water quality. This signifies that the TDS of the water from the Water Fountain is consistent with international and national drinkable water requirements. A lot of factors can explain the differences in TDS levels between the two sources. The material of the water tank, which varies between the Tank source and the Water Fountain, might affect TDS levels since different tank materials can leach minerals into the water over time [8].

Both the tank source and water fountain results are <0.01 mg/L, meeting international standards for safe drinking water. It means that the amount of lead in your drinking water is well below the regulation action limits, which is quite low. Stated by United States Environmental Protection Agency [9] a reading of 0.01 mg/L is regarded as low and presents very little risk to human health. In terms of water quality and safety, it indicates that there is very little to no lead pollution in your water supply. This suggests effective control measures in place to prevent lead contamination, irrespective of the source differences because lead is a hazardous metal that can be damaging to human health even at low exposure levels.

E. Coli bacteria, which are often found in the intestines of healthy humans and animals [10]. The microbiological analysis of the Water Fountain, presented in Table 2, consistently reveals *E. Coli* levels decrease below the 1.1 MPN threshold. This significant conformance to WHO, US EPA, and PNSDW microbiological criteria highlights the Water Fountain's water's safety and quality. Furthermore, the World Health Organization states that a zero count of *E. coli* per 100 mL of water is deemed acceptable for consumption [11].

The results from Table 3 revealed several important insights into the physicochemical parameters of water from the tank source and river side water fountain at Liceo de Cagayan University-Main Campus, with a particular focus on evaluating the effectiveness of the filtration system.

The findings of the paired t-tests indicated significant differences in temperature between the tank source and water fountain ($t(2) = 158.500$, $p < .001$). Specifically, the river side water fountain exhibited a significantly lower temperature compared to the tank source, with a mean difference of 21.133°C. This finding aligns with expectations for water filtration systems, which often include components for cooling the water [12]. The cooler water dispensed from the fountain may be more appealing to users [13].

However, it's evident that there were no statistically significant differences observed in turbidity between the tank source and river side water fountain. Laboratory results indicated that both sources displayed turbidity levels less than 1 FAU, which adheres to World Health Organization (WHO) guidelines [14]. The absence of variation in turbidity between the two sources further supports the notion that the river side water fountain is directly supplied from the tank source, indicating consistency in water quality. Similarly, laboratory results revealed lead concentrations below 0.01 mg/L for both sources. This uniformity suggests the filtration system effectively removes lead, a contaminant of concern in drinking water [15].

Table 3. Comparative Analysis of Physicochemical Parameters Between Tank Source and River Side Water Fountain at Liceo de Cagayan University-Main Campus Evaluating Filtration Effectiveness

Measure 1		Measure 2	t-value	df	p-value	Mean difference	Remarks
Tank Source (Temperature (°C)	vs	Water Fountain (Temperature (°C)	158.500	2	< .001	21.133	Significant
Tank Source (Turbidity (NTU)	vs	Water Fountain (Turbidity (NTU)	NaN[a]	NaN[a]	NaN[a]	NaN[a]	Not Significant
Tank Source (pH Level)	vs	Water Fountain (pH Level)	-1.787	2	0.216	-0.098	Not Significant
Tank Source (Total Dissolved Solids (mg/L)	vs	Water Fountain (Total Dissolved Solids (mg/L)	4.068	2	0.055	14.250	Not Significant
Tank Source (Lead (mg/L)	vs	Water Fountain (Lead (mg/L)	NaN[b]	NaN[b]	NaN[b]	NaN[b]	Not Significant

Test at α=0.05 level of significance

Note: [a] The variance in Turbidity (NTU) is equal to 0 after grouping on Source and [b] the variance in Lead (mg/L) is equal to 0 after grouping on Source

Table 4. Comparative Analysis of Microbial Parameters Between Tank Source and River Side Water Fountain at Liceo at Liceo de Cagayan University-Main Campus Evaluating Filtration Effectiveness

Measure 1		Measure 2	t-value	df	p-value	Mean difference	Remarks
Tank Source (E. coli)	vs	Water Fountain (E. coli)	NaN[a]	NaN[a]	NaN[a]	NaN[a]	Not Significant

Test at α=0.05 level of significance
Note: [a] The variance in E.coli is equal to 0 after grouping on Source

These results suggest that the filtration system may be effectively maintaining the physicochemical quality of water within acceptable standards. The consistent levels of turbidity and lead concentration between the tank source and water fountain imply efficient removal of contaminants by the filtration system.

The results presented in Table 2 offer valuable insights into the microbial quality of water obtained from the tank source and the riverside water fountain at Liceo de Cagayan University – Main Campus indicate a consistent pattern of E. coli levels below the threshold of 1.1 MPN per 100 ml for both sources. This finding, as observed in Table 4 of the research paper, underscores the effectiveness of the filtration system in maintaining microbial water quality within acceptable standards. This analysis focused on Escherichia coli (E. coli) levels to assess the effectiveness of the filtration system.

A paired t-test revealed no significant difference in E. coli levels between the tank source and the riverside water fountain ($t(2)$ = NaN[a], $p > .05$). This finding, however, should be interpreted with caution due to the "NaN" result, potentially indicating insufficient data points for a statistically robust analysis. Regardless, the fact that both sources displayed E. coli levels below the standard of 1.1 MPN per 100 mL [14] suggests effective filtration and consistent microbial water quality throughout the system.

Furthermore, the observation that the variance in E. coli levels became zero after grouping by source highlights the apparent uniformity between the tank source and riverside water fountain. This consistency strengthens the notion that the filtration system effectively removes E. coli bacteria, maintaining water quality within acceptable limits [13].

In conclusion, the consistent E. coli levels below the threshold of 1.1 MPN per 100 ml in both the tank source and riverside water fountain highlight the effectiveness of the filtration system in ensuring microbial water quality at Liceo de Cagayan University – Main Campus.

4. Conclusions

This study provides a detailed assessment of the physicochemical and microbiological content of water from the Tank source and Water Fountain at Liceo de Cagayan University's Main Campus. Across many trials, this study consistently showed that both water sources met major international and national drinkable water quality standards. With continuously low turbidity levels, pH values in the permissible range, acceptable total dissolved solids (TDS) concentrations, low lead content, and negligible amounts of *E. coli*, the water from both the Tank source and the Water Fountain is considered safe and potable. These findings reassure the university community about the dependability and safety of the water supplied by campus fountains, promoting a positive environment for students, teachers, and staff.

Furthermore, these findings provide a foundation for utilizing appropriate maintenance and monitoring techniques. In addition, it is necessary to come up with regular monitoring and maintenance procedures in order to preserve the observed high-quality standards. This ensures that the LDCU community continues to have access to clean and potable water, which benefits everyone's health and well-being on campus access to clean and potable water, benefiting the health and well-being of everyone on campus. These findings also debunked the theory that the water coming from the water fountain is sourced and unfiltered from the river.

Overall, the results correspond with the drinking water safety requirements established by the Philippine National Standards for Drinking Water (PNSDW) 2017, the US Environmental Protection Agency (US EPA), and the World Health Organization (WHO).

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