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Preliminary study of the trace elements, physico-chemical properties and utilization of the salty water spring from Sungkilaw Falls in the Philippines

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Abstract

This study aimed to investigate the physico-chemical and bacteriological properties of the salty water spring at Sungkilaw falls, Brgy. Diwan, Dipolog City, Philippines after a long, rainless and warm period to determine its groundwater chemistry. A single sampling technique was employed to collect water samples, which were analyzed for various parameters such as pH, turbidity, temperature, electrical conductivity, hydrogen sulfide, bicarbonates, sulphates, chlorides, salinity, nitrates, nitrites, fluoride, and phosphates. Trace elements were determined using AAS/ICP-OES method, while coliforms were detected using Multiple Tube Fermentation Technique. Results revealed that the analyzed spring water was slightly acidic with an average temperature and electrical conductivity. It met the maximum permissible limit set by PNSDW for nitrates, nitrites, sulfate, and alkalinity ($CaCO_3$). The water was found to be rich in Fe, Na, Zn, F-, SO_4, Pb, Hg, H_2S, Ba, and $CaCO_3$. However, the presence of coliforms suggests that the water needs to be treated. Further studies are needed to confirm the possibility of utilizing salty spring water for bath spa projects, considering its enhanced concentration of hydrogen gas. Overall, this study provides valuable information on the quality of the salty water spring in Dipolog City, Philippines which can serve as a basis for future research and water resource management and possible tourism initiatives.

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Introduction

Water quality is crucial for human health and well-being and is a significant factor in the success of tourism destinations. The issue of water quality is a global concern, and it has been highlighted by various studies and reports. The United Nations (UN) Sustainable Development Goal 6 aims to ensure access to clean water and sanitation for all, as poor water quality can lead to health problems, environmental degradation, and economic losses (UN, 2021). The World Health Organization (WHO) estimates that 2.2 billion people lack access to safe drinking water, which can lead to waterborne diseases such as cholera, typhoid fever, and hepatitis A (WHO, 2021). In addition, the UN also recognizes the importance of sustainable tourism and encourages the development of responsible tourism practices that protect natural and cultural heritage while promoting economic growth and poverty reduction (UNWTO, 2021).

In Asia, the issue of water quality is a major concern due to population growth, urbanization, and industrialization. The Asian Development Bank (ADB) estimates that around 1.7 billion people in Asia lack access to basic sanitation, and 700 million people do not have access to safe drinking water (ADB, 2021). The ADB also highlights the impact of poor water quality on the tourism industry, as tourists are increasingly concerned about the environmental impact of their travels and the health risks associated with poor water quality (ADB, 2021).

In the Philippines, the issue of water quality is also a major concern, as access to clean water and sanitation remains a challenge in many parts of the country. The Philippine Statistics Authority (PSA) reports that in 2020, around 17.3% of the population or 14.7 million Filipinos did not have access to basic sanitation facilities, while 5.5% or 4.7 million Filipinos did not have access to safe drinking water (PSA, 2020). In addition, the Department of Environment and Natural Resources (DENR) reports that only 5% of the country's water resources are classified as "Class A," which means that they are suitable for drinking, while 52% are classified as "Class C," which means that they are only suitable for agriculture, fishing, and industrial purposes (DENR, 2021). Therefore, the study of the water quality of tourist destinations in the Philippines, such as Sungkilaw Falls, is crucial in promoting sustainable tourism and protecting public health.

Factors Affecting Water Quality

Water quality is a vital aspect of public health and ecosystem management. Previous studies have shown that several factors can affect water quality, such as surface runoff, dissolved carbon dioxide, and the presence of dissolved salts (Caedo & Argüelles, 2019; Swenson, n.d.). The flavor of water can also vary depending on its source, with different minerals and compounds contributing to distinct tastes (Richardson, 2003). Mineral content can also influence water taste, with calcium making water taste milky and smooth, magnesium making it bitter, and sodium making it salty (Richardson, 2003). Moreover, several recent studies have highlighted the importance of water quality for human health and the environment (Kumar & Kumari, 2018; Singh *et al.*, 2020; Wang *et al.*, 2021). The chemical composition of spring water has been linked to its therapeutic properties, which can be attributed to therapeutic mineral and thermal waters present in areas with carbonate bedrock (Dobrzyñski & Rossi, 2017).

Status of Salty Water Spring in the Philippines

Studies suggest that salty water springs in the Philippines are widespread, and their physicochemical properties can vary depending on their location and geological composition. The results also highlight the need for proper monitoring and management of these water resources to ensure their safety and sustainability. The status of salty water springs in the Philippines has been the subject of several studies. According to Delos Reyes *et al.* (2018), the presence of salty water springs in the country is mainly due to its geological composition. The researchers noted that the country is located in the "Pacific Ring of Fire," an area characterized by volcanic activities and tectonic plate movements that lead to the formation of various types of rocks and minerals, including those that contain high levels of salt. Furthermore, Tengco *et al.* (2018) conducted a study on the physico-chemical properties of groundwater in two salty water springs in the Philippines, namely Alaminos and Sta. Maria Springs in Laguna. The study revealed that the springs' water had high salinity levels, with chloride as the dominant anion and sodium as the dominant cation. The researchers also found that the groundwater had alkaline pH and high electrical conductivity levels, which are typical characteristics of saline water. Meanwhile, a study by de Guzman *et al.* (2019) focused on the microbial and physicochemical quality of a saline spring in Quezon province. The researchers noted that the saline water had high levels of total dissolved solids, with chloride and sodium as the dominant ions. The study also revealed that the water had a slightly alkaline pH and low levels of dissolved oxygen, which can affect the water's suitability for human consumption.

Medicinal Properties of Spring Water

The medicinal properties of spring water have been linked to its chemical composition, as discussed by Dobrzyñski and Rossi (2017). The researchers found that therapeutic mineral and thermal waters are present in areas with carbonate bedrock, and the healing properties of spring water can be attributed to its chemical composition. However, despite the apparent therapeutic benefits of Sungkilaw Falls, there is a lack of scientific studies on the chemical composition and water quality of the area. The study is essential in providing a comprehensive analysis of the Sungkilaw Falls' water quality and the community's consumption practices. The findings of this study can serve as a basis for future monitoring studies on river water quality in Dipolog, particularly in the context of tourism development. Overall, this study will contribute to the existing body of knowledge on water quality and its impact on human health and well-being, particularly in tourism destinations.

The Sungkilaw Falls in the Philippines is a popular tourist destination known for its salty water spring, which is believed to have medicinal effects due to its high mineral content. However, there is limited information on the physico-chemical properties and trace elements present in the water, as well as its bacteriological characteristics. This study aims to address this knowledge gap by determining the water's physico-chemical properties, trace elements, and bacteriological characteristics, including total coliform, fecal coliform, and heterotrophic plate count analysis. Additionally, the study seeks to determine the community's utilization of the water. The results of this study will provide valuable information to various stakeholders, including the community, local government units, Department of Environment and Natural Resources, Department of Tourism, and future researchers. The findings can be used as a basis for formulating policies and programs for water quality monitoring and evaluation, as well as serve as a starting point for future research on water quality in the area.

In recent years, there has been growing concern over the water quality of Sungkilaw Falls in Dipolog City, Philippines (Acedera, 2018). Previous studies have reported high levels of total coliform and fecal coliform bacteria in the water, indicating possible contamination (Cajoles, 2015). Additionally, the presence of high levels of dissolved salts and minerals in the water can have both positive and negative effects on human health (DOH, 2017).

To address these concerns, this study aims to investigate the trace elements and physico-chemical properties of the salty water in Sungkilaw Falls, as well as its bacteriological characteristics through total coliform, fecal coliform, and heterotrophic plate count analysis. The study also seeks to determine the utilization of the water by the community.

The findings of this study can be used by local government units, the Department of Environment and Natural Resources, and the Department of Tourism to formulate policies and programs for monitoring and improving the water quality of Sungkilaw Falls. Moreover, the study can contribute to the body of knowledge on water quality and health in the Philippines.

The study being conducted on the water quality of Sungkilaw Falls in Dipolog City, Philippines, is expected to provide valuable information to various stakeholders. The community will benefit from the data and information on the water's physico-chemical properties and mineral concentration, which is believed to have medicinal effects. Local government units can use the study's findings as a basis for formulating policies and programs for water quality monitoring and evaluation. The Department of Environment and Natural Resources (DENR) will benefit from the data on the water characterization of salty water in the falls, while the Department of Tourism can use the study to determine the water quality of a popular tourist destination. Lastly, the study can serve as a starting point for future researchers who want to delve deeper into water quality in the area.

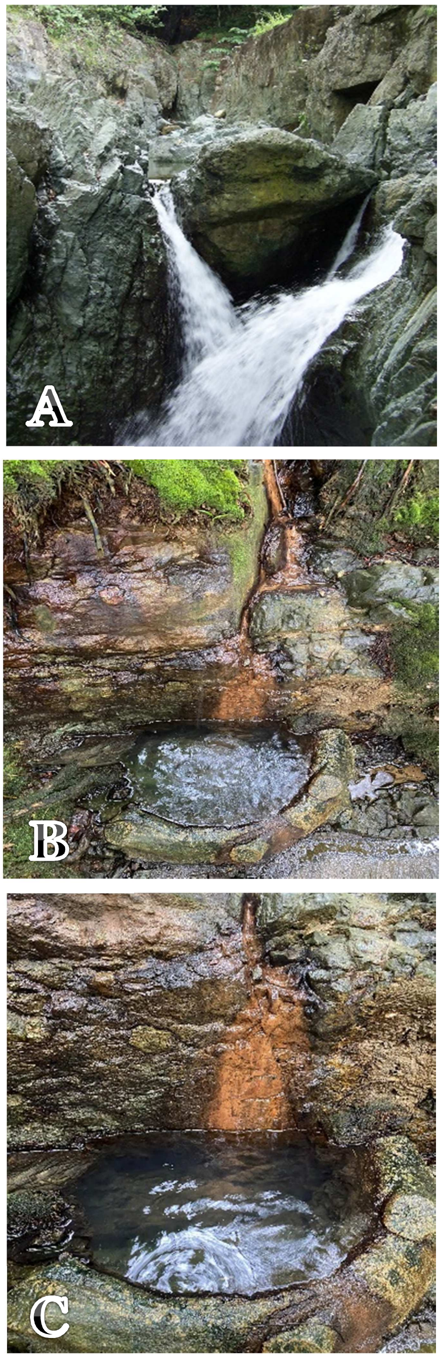
Objectives of the Study

This study aims to investigate the pattern of trace elements, physico-chemical properties, and community consumption of the miraculous salty water in Sungkilaw Falls, Dipolog City, Philippines. Specifically, the objectives are to determine the physico-chemical characteristics of the water, including pH, turbidity, temperature, electrical conductivity, hydrogen sulfide, bicarbonates, S04, chlorides/salinity, nitrates, nitrite, fluoride, and phosphates. The study also seeks to determine the trace elements present in the water, such as iron, sodium, zinc, lead, barium, and germanium, as well as its bacteriological characteristics, including total coliform, fecal coliform, and heterotrophic plate count analysis. Lastly, the study aims to determine the utilization of the miraculous salty water by the community.

Materials and methods

Description of the Study Area

The study area, situated in Sitio Virginia, Barangay Diwan, Dipolog City, Philippines, is a 42.5 feet high waterfall known as Sungkilaw Falls (Latitudes 8^{0}21` 14.78846‶; Longitude 123$^{0}$ 21`37.4860‶) (Fig. 1). The natural wonder is located in the middle of a dense jungle, surrounded by a rich diversity of flora and fauna. To access the study site, one must traverse approximately 400 descending steps, which meander through a lush canopy of green trees, vines, and other vegetation. The coordinates of the study site were identified using the total station NTS 332R model, ensuring the accuracy and precision of the geographical location of the sampling area. The unique location of the study area, nestled in a dense jungle, provides an excellent opportunity to study the physico-chemical characteristics of the water and trace elements present in a pristine natural environment.



Drinking the salty water sample known as the "Miraculous Water" near the middle stream

Fig. 1. Description of the sampling area.

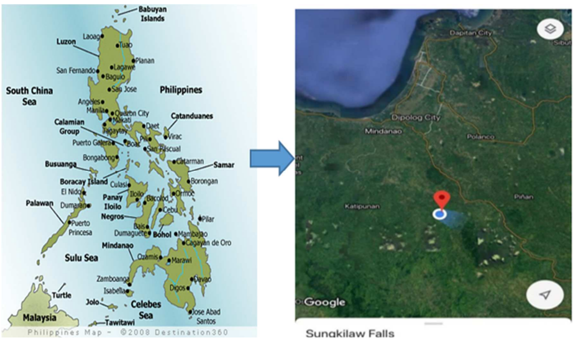


Fig. 2. Map of the Phillippines showing Brgy Diwan Dipolog City Phillippines.

Data gathering procedure

Sampling technique

In conducting this study, a grab sampling technique was employed on May 15, 2022. To ensure the scientific integrity of the sampling process, the researcher followed a set of steps in handling the water samples. Sterilized bottled containers were used to collect the water samples, which were then maintained at a consistent temperature to prevent any contamination. Before sample collection, the containers were washed three times with the river water to ensure the samples were as pure as possible.

The surface spring waters were taken from sampling stations located one meter above the ground. To ensure the accuracy and validity of the results, the samples were transported to a testing center for water analysis. Overall, the sampling technique used in this study was carefully designed and executed to ensure the reliability of the data obtained.

Determination of the physico-chemical analyses of the salty spring was carried out by comprised field, laboratory measurements and determinations of (pH, turbidity, temperature, EH, EC, H_2S, bicarbonates, sulfates, chlorides, nitrate, nitrite, fluorides, phosphates) and trace elements.

Determination of pH

The pH of the samples was determined against pH 4 and pH 7 in an Oakton pH700 pH meter equipped with an automatic temperature compensation probe, respectively in three replications.

Turbidity

Water Turbidity was determined nephelometrically with a Merck Turbiquant 1500T in three replications.

Temperature

Water temperature was measured by a water thermometer.

Electrical conductivity (EC)

Electrical conductivity was measured by conductivity meter.

Hydrogen sulfide (H_2S)

Hydrogen sulfide was measured by Iodometric titration.

Bicarbonates

Alkalinity as bicarbonates was measured by titration.

Sulfates

Sulfates were measured by Turbidimetric method.

Chlorides

Sample was titrated with AgNO3 using sodium chromate as indicator (Mohr method).

Nitrates

The concentration of nitrates in surface water samples, a standardized scientific protocol was followed in this study. First, clean bottles were used to collect the water samples from the surface and then they were immediately placed in an icebox to preserve their integrity during transportation to the laboratory. Upon arrival, six 10-mL aliquots were pipetted into separate canisters, and three of them were spiked with 0.2mL of 1.0535 ppm NO_3-N. Next, 10mL of ammonium chloride buffer was added to both the spiked and unspiked samples. The mixture was poured into a reductor to reduce the nitrates to nitrites, and the last 10mL of the reduced sample was collected after rinsing. Then, 0.4mL of sulfanilamide and 0.4mL of N-1-naphthylenediamine hydrochloride were added to the reduced sample to form an azo dye, which was allowed to develop for about 15 minutes. Finally, the absorbance of the sample was measured within one hour at a wavelength of 540nm to determine the concentration of nitrates present in the water samples. This rigorous sampling and analysis process was employed to ensure the accuracy and reliability of the results obtained in this study.

Nitrite

Nitrite nitrogen content was determined by UV-Vis Spectrophotometry.

Flouride

Determined by photometric-flouride spectroquant kit 14500.

Phosphates

The analysis of phosphates in water samples, and aimed to ensure the accuracy and reliability of the results. To achieve this, careful and precise steps were taken throughout the sampling and testing process. Water samples were collected in triplicate from three different sampling sites and were immediately stored in glass bottles and placed in a styropore box with ice to maintain sample integrity during transportation to the laboratory for analysis. Prior to testing, stock solutions of sulfuric acid, ascorbic acid, and mixed reagent were meticulously prepared to ensure their accuracy and consistency. The sulfuric acid was diluted with water and stored in a plastic bottle, while ascorbic acid was dissolved in a glass bottle with water and sulfuric acid and refrigerated for storage. The mixed reagent was prepared by dissolving specific amounts of $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ and potassium antimony tartrate (with or without ½ H_2O) in water.

To conduct the phosphate analysis, 10mL of filtered sample and 0.2mL of ascorbic acid mixed reagent were added to a test tube or scintillation vial, and the absorbance at 880 nm was measured between 5 to 30 minutes. By following these meticulous steps, the study aimed to ensure the accuracy and reliability of the results of the phosphate analysis. The study design and testing procedures utilized in this research demonstrate a high degree of precision and care in order to produce reliable and valid results. This attention to detail is critical in any scientific investigation, and provides a strong foundation for further research and understanding of the phosphate content in water samples.

Determination of Trace elements of salty water spring

Presence of Iron *(Fe),* Sodium *(Na),* Zinc *(Zn),* Lead *(Pb),* Barium *(Ba)* and Germanium *(Ge)* were determined by AAS/ICP-OES method.

Bacteriological Determination of salty water spring

Total Coliforms/Fecal Coliforms Analysis

For coliform analysis, 100mL water samples were collected using sterile sampling bottles, processed through membrane filtration method, and cultured in endobroth medium for 48 hours at 35°C. The colonies were then counted, and the MPN per 100mL of seawater was calculated using a formula that involves the number of colonies and volume of water sample.

$$\text{MPN/100mL} = \frac{\text{No. of Colonies}}{\text{Volume of water sample inm L}} \times 100$$

Heterotrophic Plate Count Analysis

The Heterotrophic Plate Count Analysis, water samples were first diluted, and an aliquot was added to a labeled empty sterile plate, followed by the addition of 15mL melted agar. The plate was then left to cool, solidify, and incubated for 24-48 hours to develop colonies.

The resulting colony count represented a "colony forming unit" (CFU), and an accurate and optimum count should be within the range of 30 to 300 colonies/plate. Both techniques were crucial in determining the microbial contamination in the water samples and provided valuable information about the safety of the water for human consumption.

Determine the utilization of Salty Water by the Community

The sampling method that was used in the selection of research respondents for FGD was simple random sampling, wherein the researcher randomly selected 15 onsite or actual participants, residents or tourists present during the data gathering to participate in the study and to proceed with content analysis, especially on the consumption and utilization procedures, it is vital to know their responses.

The researcher conducted onsite actual interviews to the local residents and tourists to validate community's own experiences on the miraculous salty water spring. Most of them gave positive impacts as to usability of the salty water to their daily activities such as drinking, bathing, laundry, and the residents added that during holy week, the salty water was often visited since it is known for its miraculous contribute on to the health of the residents, visitors and tourists.

Results and discussion

Physico-Chemical and Mineral Analyses of the salty spring

Table 1 shows the Physico-chemical and mineral analysis of the salty spring water in Sungkilaw falls. The results of this study suggest that the water from Sungkilaw Falls is safe for consumption and bathing. However, continuous monitoring of the water quality and its sources is recommended to ensure its safety and to prevent contamination from natural and human activities. The water is slightly acidic (pH = 6.47-6.49), at an average temperature (T = 20.0–21.2°C), and an average electrical conductivity (C = 20,390–20,720 µS/cm). Nitrates, nitrites, sulfate and alkalinity ($CaCO_3$) levels were within the PNSDW maximum allowable limit. Such conditions were within usual range. The water studied of miraculous salty spring, had not been analyzed previously with regard to such a wide range of minor and trace elements. The following elements were not detected in all water samples tested: <0.05 µg/L – Be, Ru, Au, Ga, Ge, and Te.

Table 1. Physico-Chemical and Mineral Analyses of the salty spring

Parameter (unit)	Results	PNSDW Max. Allowable Limit
Conductivity (µS/cm)	20,555	---
Chloride ,mg/L	8,0635 *	250
pH	6.49	6.5-8.5
Temperature, ̊C	21.2	---
Nitrate,mg/L	0.23	50.00
Nitrite,mg/L	0.01	3.00
Iron (Fe),mg/L	0.24	1
Zinc (Zn),mg/L	0.01	5
Sodium (Na),mg/L	355 *	200
Sulfate,mg/L	3.39	250
Lead (Pb),mg/L	<0.008	0.01
Mercury (Hg),mg/L	<0.001	0.001
Hydron sulfide,mg/L	<0.01	0.05
Barium (Ba) ,mg/L	0.55	0.70
Flouride (F^-) ,mg/L	<0.10	1.5
Total alkalinity,mgCaCo$_3$ /L	33.03	---

*Legend: PNSDW standard

Source: (https://www.fda.gov.ph/wp-content/uploads/2021/08/Administrative-Order-No.-2017-)

The physico-chemical and mineral analyses of the salty spring water in Sungkilaw Falls showed that the water is slightly acidic with pH 6.47-6.49, which is within the allowable limit set by the Philippine National Standards for Drinking Water (PNSDW). The water's average temperature and electrical conductivity were also within the usual range, while levels of nitrates, nitrites, sulfate, and alkalinity were within the PNSDW maximum allowable limit. Additionally, some minor and trace elements were detected in the water, including iron, zinc, sodium, sulfate, and barium, which were below the PNSDW allowable limit. However, some elements such as chloride and sodium were higher than the PNSDW standard, indicating the possible influence of saltwater intrusion from the nearby sea. The absence of some elements in the water samples tested, such as Be, Ru, Au, Ga, Ge, and Te, indicates that the source of the water is not influenced by human activities or geological processes that may introduce contaminants.

These findings are consistent with similar studies conducted in other natural springs and groundwater sources in the Philippines (Boquiren *et al*., 2017; Fortaleza *et al*., 2020; Tomacruz *et al*., 2021), which have reported the presence of various minor and trace elements in water sources but within safe limits for human consumption.

Trace Elements in the Salty Spring Water

The composition of salty spring water, as analyzed in this study, reveals the presence of various trace elements that can have significant effects on human health and the environment. Iron, for example, is an essential micronutrient that plays a vital role in the production of red blood cells and energy metabolism. However, excessive intake of iron can cause health problems such as iron overload, which can lead to liver damage, diabetes, and heart disease. Sodium, another prevalent element in salty spring water, can affect blood pressure and increase the risk of cardiovascular disease if consumed in excess. On the other hand, fluoride is a beneficial element that can help prevent tooth decay and has been added to public water supplies in many countries. However, excessive intake of fluoride can lead to dental fluorosis, a condition that affects the appearance and strength of tooth enamel. Other trace elements such as lead and mercury are toxic and can cause serious health problems even at low concentrations. The presence of these trace elements in the salty spring water can be attributed to the geology of the area and the weathering of rocks and minerals in the surrounding environment. The effects of saline fluids and the dissolution of salts from Triassic strata can also contribute to the composition of the water. The study's findings suggest that further research is needed to understand the sources and health implications of these trace elements in the water.

Alleged Enrichment of Water with Germanium As Claimed By The Residents

While the claim that salty spring water is enriched with germanium has been debunked, the high concentration of other elements in the water remains a subject of interest for potential therapeutic uses. Further research is needed to fully understand the potential medicinal properties of these elements and their interactions with each other. The claim that salty spring water is enriched with germanium has been widely circulated, with some suggesting that this may explain its potential healing properties. However, recent research has found no detectable levels of germanium in the water, contradicting this claim. This highlights the importance of scientifically investigating such claims before accepting them as fact.

Several studies have investigated the potential medicinal properties of mineral waters, which are defined as waters containing at least one gram of mineral substances per liter. For example, one study found that mineral waters may have beneficial effects on various conditions such as digestive disorders, hypertension, and cardiovascular disease (Russo *et al*., 2017). Another study found that treatment with mineral water may improve symptoms in patients with chronic obstructive pulmonary disease (Liu *et al*., 2018). These studies suggest that mineral waters may indeed have medicinal properties, although further research is needed to fully understand their potential benefits.

The high concentration of various elements in salty spring water, such as Fe, Na, Zn, F, So4, Pb, Hg, H2S, Ba, and CaCO3, is of interest and may play a role in the water's potential therapeutic effects. For example, some of these elements have been shown to have anti-inflammatory or antioxidant properties, which may contribute to the water's potential healing properties (Nakamura *et al*., 2014; Parveen *et al*., 2016). However, more detailed geochemical research is needed to fully understand the potential medicinal properties of these elements and their interactions with each other.

Bacteriological Analyses of Salty spring water

Coliform Contamination

Bacteriological analyses were conducted on water samples collected from the Salty Spring, and the results showed that the water was contaminated with coliforms.

The total coliform count in the water samples exceeded the PNSDW standard of 1.1 MPN per 100mL, while the most probable number for presumptive total coliform count ranged from 2.6 to 4.6 MPN per 100mL. Fecal coliforms were also present in the water samples, and their count was greater than the PNSDW standard. The high total viable counts for all water samples tested were found to be as high as 1,539 cfu/ml. Water pollution due to leaching from wastes, eroded pollutants, animal wastes, and domestic sewage can lead to the presence of such contaminants in the water. The presence of coliforms in the water is concerning as they are associated with the transmission of human diseases, including typhoid fever, cholera, infectious hepatitis, bacillary, and amoebic dysentery. The results of the investigation indicate that the Salty Spring water is not safe for consumption and does not meet the PNSDW standard. The source of water used and possible pollution leaching from chemical, animal and domestic runoff in waterways may have contributed to the contamination. Therefore, it is essential to take appropriate measures to ensure that the water is safe for consumption. These findings highlight the need to take appropriate measures to ensure that the water is safe for consumption, including implementing measures to reduce pollution and regularly monitoring the water quality.

Table 2. Bacteriological Analyses of Salty spring water.

Test	Unit	Method of Analysis	Result	PNSDW Standards	Remarks
Total Coliforms	MPN/100mL	Multiple Tube Fermentation Technique	2.6	Less than 1.1	Failed
Fecal Coliforms	MPN/100mL	Multiple Tube Fermentation Technique	4.6	Less than 1.1	Failed
Heterotrophic plate count	CFU/mL	Pour Plate Method	1,539	Less than 500	Failed

*Legend: PNSDW standard

Source: (https://www.fda.gov.ph/wp-content/uploads/2021/08/Administrative-Order-No.-2017-0)

Utilization of miraculous salty water by the community

The utilization of the miraculous salty water by the community was evaluated through onsite interviews conducted by the researcher with residents and tourists. The majority of respondents reported positive impacts on their daily activities, including drinking, bathing, laundry, swimming, and using the water as a source of herbal plants and IP's handicrafts (nito). The water also serves as a tourist attraction, and visitors can purchase native crops from the area without paying an entrance fee. According to Mrs. Turno, Brgy. Chairman of Barangay Diwan, the salty water is a must-visit destination. Additionally, during holy week, the salty water is often visited by people seeking its miraculous health benefits. Overall, the residents have a positive outlook on the utilization of the salty water, and it is evident that the water holds significant cultural and economic value for the community. The findings of this research may have implications for sustainable development and the management of natural resources in the area.

For instance, efforts could be made to ensure the safety of the water through proper sanitation and monitoring to minimize the risks associated with coliform contamination.

Conclusion

This preliminary study on the trace elements, physico-chemical properties, and utilization of the salty water spring from Sungkilaw Falls in the Philippines has provided valuable insights into the quality and potential uses of the water. The findings indicate that the water contains high concentrations of various trace elements and is contaminated with fecal coliforms, underscoring the need for proper treatment and monitoring to ensure its safety for consumption and use. The study also highlights the potential benefits of the water for the community, including its use as a source of herbal plants and IP's handicrafts, and as a tourist attraction. However, it is crucial to note that the water's utilization should be balanced with public health concerns to prevent any adverse health effects from exposure to contaminants.

As such, water standard monitoring, surveillance, and control remain essential to safeguarding optimal public health. This study's findings can serve as a foundation for further research into the water quality and utilization in the area, contributing to the sustainable management of this valuable resource for the benefit of the local community and visitors alike.

Recommendation and Future studies

Based on the findings of this preliminary study on the trace elements, physico-chemical properties, and utilization of the salty water spring from Sungkilaw Falls in the Philippines, the following recommendations are suggested for future research: (1) Conduct further geochemical studies where more detailed and comprehensive geochemical analyses should be performed to obtain a complete and accurate understanding of the source, composition, and behavior of the saline fluids, pollutants, and other anthropogenic impacts on the spring waters; (2) Water treatment and rehabilitation. With the presence of coliforms in the water indicates that it requires proper handling and treatment. Rehabilitation measures, such as the installation of water treatment plants or other appropriate interventions, should be considered to ensure that the water is safe for human consumption and other uses; (3) Validation of medicinal properties. Since many residents and tourists use the salty water for healing and medicinal purposes, further research should be conducted to validate its therapeutic properties, particularly during Holy Week.

This could include clinical trials to investigate the effects of the water on different medical conditions, as well as the identification of specific active compounds or minerals present in the water that may have therapeutic benefits, Lastly, The study suggests that the salty spring water may be a good source for a bath spa project. Further studies should be conducted to determine the feasibility and potential benefits of such a project, including the design, construction, and operation of the facility, as well as the marketing and promotion of the spa services to local and international tourists. Further, the recommendations provided here could help to further advance our understanding of the physico-chemical properties, trace elements, and utilization of the salty water spring from Sungkilaw Falls in the Philippines, as well as promote the sustainable use and development of this important natural resource for the benefit of the local community and the wider public.

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