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Research Article

A Comparative Assessment of Water Quality for Tap and Shallow Wells in Kyawama Compound of Solwezi District

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About Article

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ABSTRACT

All water sources used for domestic purposes must be safe and meet the World Health Organization's (WHO) water quality standards. In most of the developing countries, shallow wells are critical in providing water for communities in settlement areas. However, poor sanitation and industrial activities can cause multiple contamination both from fecal matter and chemical effluents, which affects water quality. This study assessed water quality from shallow wells and tap water sources in Kyawama of Solwezi District of Zambia. Analysis of pH, conductivity, turbidity, microbial contamination, and chemical pollutants revealed substantial differences after the analysis. Tap water generally met WHO and Zambian outlined water safety standards, while shallow well water exhibited high contamination levels of coliform bacteria, specifically E. coli. The Water Quality Index (WQI) affirms that shallow well water from Kyawama compound is unsafe and could pose a risk to the people consuming untreated, as the WQI values indicate poor to unfit for human consumption status compared to the excellent to very good quality of kiosk tap water. The research strongly recommends that the community should by all means avoid using untreated shallow well water for drinking until it is properly treated or boiled properly. Furthermore, the study advocates for improved sanitation infrastructure guided by the local authorities, regular clean and safe drinking water should be supplied to this area, regular water quality monitoring, and public education programs to enhance overall water quality and public health in the area.

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1. INTRODUCTION

Water is a vital natural resource with significant social and economic impact and implications for human sustenance (Kumar, 2018). The absence of water would impact and jeopardise the very existence of humans (Zhang, 2017). Surface water and groundwater are actually the primary sources of drinking water that supports most life globally (Paun *et al.*, 2016). In various regions and places of the world, groundwater serves as the predominant supply for drinking water, especially in places where surface water is a challenge to find, or it's mostly contaminated (WHO, 2006).

Currently, over 1.3 billion people struggle or lack access to clean drinking water which is really a huge challenge and it's grown in recent years, and this issue has continued to grow it's projected that nearly two-thirds of countries on earth will face or experience water stress by 2025 (Kumar, 2018). Water scarcity and shortage is a significant challenge in the study are which is North-Western Province, particularly in Solwezi. Solwezi is one of Zambia's fastest-growing cities and has the population continue to grow at a faster rate there will be more water shortage challenges. The water challenges being faces by developing countries in the present day include limited access to clean safe treated water, inadequate sanitation outlined infrastructure, widespread waterborne diseases such as typhoid, Cholera, Hepatitis A, and many more, water scarcity and shortages caused and worsened by climate change, insufficient investment in water management, and potential conflicts over water resources where the people settle in water sheds, sources and wetlands. As the United Nations (2020) highlights, "Water scarcity affects more than 40 percent of the global population currently and is projected to rise with climate change and the population continue to increase, causing A chain reaction which extends to critical threat to food security, health, and poverty." These issues are an additive to poor health outcomes, hinder economic development at a greater extent, and exacerbate poverty even more. Addressing these issues require comprehensive and tactful approaches, that includes infrastructure development, governance enhancements and improvements, conservation measures that leads to the protection of these water sources. (IPCC, 2014; WHO and UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP), 2021).

Multiple researchers have reviewed that an adequate quantity and acceptable quality of water are actually essential for human survival and wellbeing, though maintaining water quality still continues to remain a challenge in water resources management (Mukate *et al.*, 2019). In general, the quality of water bodies can be assessed through changes in their physical, chemical, and biological characteristics that are affected mostly by human activities or natural phenomena at least (Britto *et al.*, 2018). The how suitable is this water for human sustenance and consumption is often arrived at or describes by using water quality index (WQI), which reduces complex water quality collected data into a single value ranging from 0 to 300 that almost everyone cane interpret and understand (Ramakrishnaiah *et al.*, 2009; Bhaven *et al.*, 2011; Kushtagi *et al.*, 2012).

Even if groundwater is in general sense of higher quality than surface water, it is also vulnerable to contamination from both natural and anthropogenic activities. Sanitation challenges, mostly caused by rapid population growth and urbanization, pose significant risks to groundwater quality and other activities like agriculture, mining, and massive earth moving and construction affect ground water. Efforts to ensure access to clean water, in line with SDGs (Sustainable Development Goals), must address sanitation challenges and implement effective all waste management strategies. Protecting groundwater requires careful and comprehensive planning and strict enforcement to control and mitigate pollution risks and ensure microbial safety (UNDP, 2018).

2. LITERATURE REVIEW

Access to clean and sustainable water should be a priority to all living organisms and more especially humans, in particular developing countries where water sources are often and mostly contaminated (WHO, 2017). Lots of studies conducted highlight the risks associated with shallow well water contamination due to poorly managed sanitation and industrial effluents (Fewtrell & Bartram, 2001). Prüss Ustün *et al.* (2019) highlights that mostly ground water pollution caused by human activities and settlements shifts. Research by Wright *et al.* (2004) Had shed light and exclaims that shallow wells are highly vulnerable to microbial contamination and especially from coliform bacteria such as E. coli, a key indicator of faecal pollution. Similar studies in Africa, like "accessing safe drinking water in sub-Sahara Africa"; by C. Emenike *et al.* (2017) confirms that poor sanitation and lack of proper settlement audits had contributed to ground water pollution. There are high disparities when it comes to Water Quality Index (WQI) in both rural and urban areas like Kyawama compound showing significant differences in water safety. Some study conducted by Bain *et al.* (2014) Also adds and demonstrate that while tap water often meets safety standards, alternative water sources frequently fail, because that water might be coming from a contaminated source only made fit for consumption through water treatment. To deal with this issue, most of the scholars recommend water treatment, improved sanitation layouts, and community education to control, mitigate deal with potential health risks (Howard *et al.*, 2020). These findings properly align with the current study's analysis results or outcomes in Kyawama. In another study Lucheleng'anga *et al.* (2009). shows the effects of poorly managed sewage or sanitation facilities and how they were contributing factors for cholera out breaks in George compound, Lusaka, Zambia. Mining activities and industries have caused a significant harm on shallow wells water and continues to sabotage ground water safety, this writer also highlights how sulphur dioxide a by-product of copper production process has affected not only water but life in all aspects on the Copperbelt where his study area is located, Aubrey Mando *et al.* (2024), surface and ground water quality in Chingola district.

What sets this study apart is that there has never been a specific study published looking at water quality in the area mentioned at least non published anywhere, the closest study was done in Luanshya district by Winter Mwape, 2023. water pollution in urban areas with focus on boreholes water pollution. This work will stand as a reference point for future research, and as an action point for ground water safety management by local authorities like municipalities.

3. METHODOLOGY

3.1. Sampling

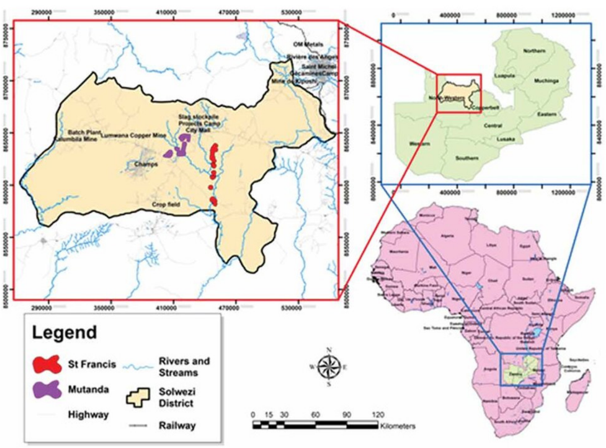
The sampling process was performed as follows:

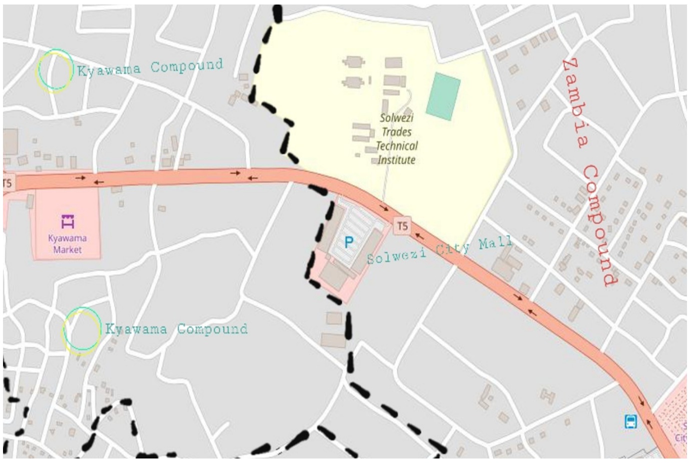
• *Tap Water:* tap water was sampled from kiosks that are randomly selected in Kyawama compound of Solwezi district, as the area has only few households connected to the main water systems managed by NWWSSCL. Nine kiosks were randomly selected are located in different parts of the vast compound, ensuring they were dispersed across the compound. Each selected kiosk receives water from the water treatment plant owned and operated by NWWSSCL.

• *Well Water:* well water samples were also sampled from the shallow wells that were randomly selected from all sides of the compound this includes, central, East, West, North and South of Kyawama compound. Because the area receives inadequate or erratic water supply, households have resorted in doing hand dug shallow wells as a source of water for home use. Three samples were collected from each section.

The sampling involved a bucket or container with a rope to it, which was lowered into the well to draw water. The collected water was used to rinse the 500ml sterilized glass bottles three times, then finally filled them with the water. The filled bottles were then placed in a cooler box kept at 1 to 3°C and transported to the North-Western Water Supply and Sanitation Company laboratory for testing. Three samples were collected from each water source (both kiosk taps and shallow wells) at different times of the day morning, afternoon and evening, and this was conducted in the rain season.

This method follows best outlined sampling practices, that Includes collecting samples from mid-depth, using sterile glass bottles, proper labeling was done, as KYA 1 to KYA 10, sampling was done properly and by all means to minimize contamination of samples, and ensuring proper handling. The samples were taken or transported quickly in a cool box which contained ice cubes to maintain standard conditions more especially temperature. Water samples were collected in sterilized 500 mL glass bottles and transported and delivered to North-Western Water Supply and Sanitation Company Limited laboratory for analysis and when they reached an inventory was created for both sets of water before the commencement of testing.





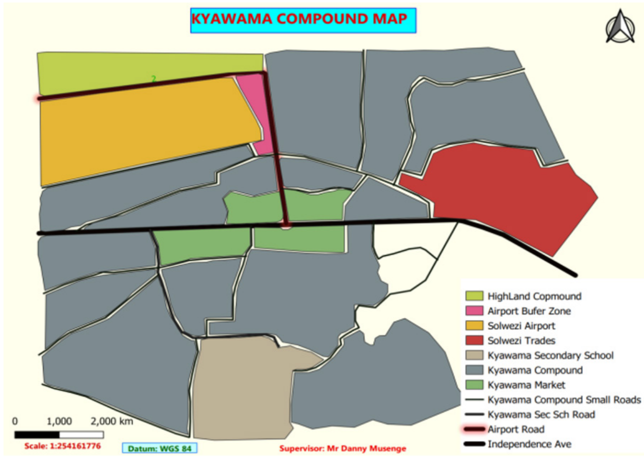


Figure 1. Map of Kyawama compound showing the study site

3.2. Experimental procedures and analytical method

Both sets of samples were properly tested and analyzed following the laboratory's established best and properly outlined practices there is possible, which adhered to global recognized methods and standard operating procedures (SOPs) as outlined by WEF (2023), ZABS (Zambia Bureau of Standards 2010), and EPA (2016). The samples were kept at a temperature range required which is from 1 to 2°C in a cool box that also contained ice cubes to maintain this temperature range and was promptly transported to the laboratory owned by North-western water supply and sanitation company limited within two to three hours of sample collection, (ZABS sampling water quality standards), (World Health Organisation Guidelines for Drinking-water Quality). Immediately the samples reached the laboratory, sorting was done and an inventory was created, and the testing and analysis commenced. All glassware that was used in the testing and analysis and all equipment utilized in the study were sterilized thoroughly using an autoclave following the proper outlined procedures by the laboratory.

Various physicochemical parameters were assessed, including electrolytic conductivity (EC), potential Hydrogen (pH), total dissolved solids (TDS), cloudiness or haziness of water (turbidity), and total hardness, chosen based on their relevance to both local and international drinking water standards and guidelines such as those provided by ZABS and WHO.

Hardness was determined through a wet chemistry process which involved the titration. On-site measurements of TDS, EC, and pH were tested using a Hanna pH meter (model H19812-S), and results were recorded in a researcher's notebook and at a later stage they were transferred to standardized laboratory forms for more and detailed analysis of samples. Microbiological testing, assessments and analysis were carried out using the membrane filtration technique. Suitable growth media was prepared using, distilled water, M.ENDO AGAR, ethanol (for total coliforms testing), and, Aurin or Corallin or otherwise commonly known as Rosolic acid (for fecal coliforms testing), were used, they were all incubated for the recommended hours, after the incubation the bacterial grew and could be seen, with microbial counts determined using the most probable number method that was recommended by the North-western Water Supply and Sanitation Company Limited (NWWSSCL) laboratory.

Heavy metal analysis involved treating the samples with acids, diluting them to the required testing ratios, and then were subjected to an analysis using a Varian 55B atomic absorption spectrometer. Parameter measurements or outcomes were reported in various units, such as EC in μS, turbidity in Nephelometric Turbidity Unit (NTU), and concentrations of total hardness, calcium, copper, cobalt, lead, and magnesium in mg/L. Coliform counts were noted and reported as the number of colonies per 100 mL of water sampled with 3,000 being too numerous to count.

3.3. Data analysis

Each experiment was conducted twice, and the findings were indicated as average values in the experiments. The collected data underwent analysis using IBM SPSS and Excel 2010. The significance of the mean difference in parameters between the two sets of water samples was determined through t-test statistical analysis. The noted or recorded values for each parameter underwent thorough comparison with the established WHO and ZABS standards and guidelines for drinking water. Additionally, graphs illustrating the parameters for tap water and shallow wells water, alongside the WHO and ZABS guidelines and standards, were included in table 1 and figures 1 all the way to 7 of the outcome results. Furthermore, Water Quality Indices were computed for the two sets of water samples using the weighted arithmetic index method (Brown *et al.*, 1972), utilizing the WQI formula WQI = $(\Sigma^{n}_{i=0}(wi.qi))/(\Sigma^{n}_{i=0}(wi))$. After the testing and analysis of both water samples, and interpreting the results, tap water was classified as good quality of water, whilst shallow wells water was in the range of inferior quality of water or unfit for human consumption.

4. RESULTS AND DISCUSSION

4.1. Quality of tap water

Table 2 Outlines the picked or selected specific physical, chemical, and microbiological characteristics of samples from taps. In addition, it documents the minimum, maximum, mean values, and standard deviation of the parameters. Consequently, it assesses the quality of kiosk's tap water provided to Kyawama compound by NWWSSCL and done by comparing it to the standards and guidelines set and provided by ZABS and WHO.

4.2. Quality of well water

Table 3 Displays the average values of physical, chemical, and microbiological parameters found in these shallow wells water, alongside a comparison to the standards and guidelines put by ZABS and world health organisation. In addition, the analysis includes the examination of the minimum, maximum, mean values, and standard deviation for each measured parameter.

4.3. Water Quality Index (WQI)

Immediately after assessing the water samples using the Water Quality Index (WQI), the Water Quality Index (WQI) showed that tap water ranged from an index value of 46.37 which is excellent to an index value of 88.73 which is termed as good water quality. In disparity, shallow well water ranged from a good water index value of 69.20 to an unfit-for-drinking value of 1,081.24. The mean value water quality index for shallow wells water was at 285.78, indicating inferior quality or unfit for human consumption, while tap water had a mean WQI of 64.10, indicating good quality, (as shown in Table 6). And because of these unfavorable findings for well water, it is advisable to promote community practices such as proper treatment of adding chlorine in recommended quantities or boiling the water properly before drinking.

Table 1. Some selected parameters of drinking water standards, tap water and well water

STD/SAMPLE ID	PARAMETERS											
	pH	**EC**	**Turb**	**TH**	**TEMP**	**TDS**	**Ca2+**	**Mg2+**	**Cl-**	**NO3-**	**E-Coli**	**F.C**
Tap water	5.54	195.60	3.10	83.4	25.8	94.40	50.18	53	0.21	0.04	0	0
Well water	5.44	230.4	34.60	2.40	25.7	155	0.37	2.04	31.28	5.64	713	383
ZABS	7.00	150	5.00	500	25	1000	200	150	300	10	0	0
WHO	7.25	1000	<5	350	25	500	100	50	250	10	0	0

Unit of measure: EC-μS, Turbidity – NTU, (Total hardness, Calcium, Copper, Cobalt, Lead, magnesium, chlorides, nitrates,) – mg/L,

Table 2. Mean and standard deviation of measured parameters in tap water

SA ID	PARAMETERS										
	pH	EC	Turb	TH	TDS	TEMP	Ca2+	Mg2+	Cl-	NO3-	E-Coli	F.C
KY01	5.50	110	8.58	42	50	25.9	25.2	12.8	0.20	0.01	0.00	0.00
KY02	5.85	380	1.55	172	190	25.7	103.2	51.6	0.19	0.02	0.00	0.00
KY03	5.55	310	1.86	125	150	25.8	75.3	31.5	0.22	0.01	0.00	0.00
KY04	4.90	70	2.90	52	30	25.7	31.2	15.6	0.28	0.04	0.00	0.00
KY05	4.90	110	0.91	42	50	25.8	25.2	12.9	0.19	0.01	0.00	0.00
KY06	5.30	90	1.98	71	40	25.9	42.6	21.3	0.22	0.01	0.00	0.00
KY07	5.60	310	4.87	142	150	25.6	85.4	32.7	0.22	0.06	0.00	0.00
KY08	5.60	240	2.65	40	120	25.5	24.5	11.8	0.18	0.08	0.00	0.00
KY09	6.80	140	3.01	65	70	26.1	39.1	19.5	0.15	0.09	0.00	0.00
Min	4.90	70	0.91	40	30	25.5	24.5	11.8	0.15	0.01	0.0	0.0
Max	6.80	380	8.58	172	190	26.1	103.2	51.6	0.28	0.09	0	0
Mean	5.56	195.6	3.10	83.4	94.4	25.8	50.19	23.63	0.21	0.04	0.00	0.00
SD	0.56	115.55	5.42	49.75	58.76	0.18	29.85	13.16	0.04	0.03	0.00	0.00

Table 3. Mean and standard deviation of measured parameters in shallow wells water

SA ID	PARAMETERS											
	pH	EC	Turb	TH	TDS	TEMP	Ca2+	Mg2+	Cl-	NO3-	E-Coli	F.C
SW01	5.95	285	179	2.02	141	25.7	0.17	1.87	34.9	4.5	208	380
SW 02	5.04	382	9	2.48	192	25.7	0.56	1.92	37.5	9.7	150	48
SW 03	5.07	234	19	2.55	117	25.9	0.19	2.36	27.5	5.8	41	6
SW 04	5.37	296	41	3.25	149	25.8	0.93	2.32	39.9	10.6	175	28
SW 05	5.61	94	15	2.40	47	25.7	0.03	2.37	19.9	2.1	TNTC	98
SW 06	5.29	151	8	2.89	76	25.6	0.51	2.38	29.9	2.4	26	15
SW 07	5.02	202	19	2.10	100	25.7	0.25	1.85	24.9	5.5	180	45
SW 08	5.27	257	11	2.15	128	25.4	0.49	1.66	32.5	9.3	200	196
SW 09	5.82	213	5	1.99	106	26.0	0.16	1.83	35.9	4.2	152	10
SW10	5.97	190	30	2.16	95	25.8	0.37	1.79	29.9	2.3	TNTC	TNTC
Min	5.02	94	5	1.99	47	25.4	0.03	1.66	19.9	2.1	26	6
Max	5.97	382	179	2.89	192	26.0	0.93	2.38	39.9	10.6	3000	3000
Mean	5.44	230.4	34.6	2.40	115.1	25.7	0.37	2.04	31.28	5.64	713.2	382.6
SD	0.37	80.72	52.25	0.41	40.53	0.16	0.26	0.28	6.12	3.20	1,206.82	927.01

Table 4. Water Quality Classification Based on WQI Value

Class	WQI Value	Water Quality Status (WQS)
A	0 – 50	Excellent water quality
B	50.01 – 100	Good water quality
C	100.01 – 200	Poor water quality
D	200.01 – 300	Inferior quality of water
E	> 300	Water unsuitable for drinking

Table 5. Water Quality Index for tap water samples

SA ID	KY01	KY02	KY03	KY04	KY05	KY06	KY07	KY08	KY09	Min	Max	Mean	SD
WQI	88.73	79.56	73.13	58.10	46.37	50.36	78.01	54.91	47.75	46.37	88.73	64.10	15.86

Table 6. Water Quality Index for well water samples

SA ID	SW01	SW02	SW03	SW04	SW05	SW06	SW07	SW08	SW09	SW10	Min	Max	mean	SD
WQI	1081.24	102.02	154.75	282.02	368.72	69.20	159.52	118.15	70.76	451.43	69.20	1081.24	285.78	308.26

4.5. pH

The potential hydrogen (pH) levels in the kiosk tap water samples ranged from 4.90 to 6.80, whereas that of the shallow wells water samples had a range from 5.05 to 5.97. the two sets of water which is tap and shallow well water had pH values that ranged from 6.5 to 8, giving an average pH of 5.56 for kiosk's tap water and 5.44 for shallow well water, indicating slightly acidic conditions. This change in pH is commonly observed in most areas of Solwezi Township, particularly from November to April or just in the rain season. Figure 1, below displays the mean potential hydrogen values for tap water, shallow wells water, and both WHO and ZABS standard guidelines.

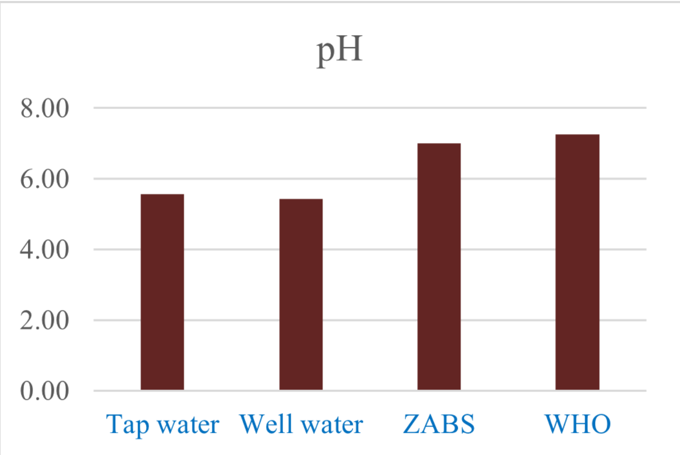


Figure 2. pH for water samples and standards

The electrolytic conductivity of water is mostly determined by its concentration of dissolved minerals, known as Total Dissolved Solids (TDS). Electrical resistance in (R) is measured in Ohms (Ω), and its inverse, electrical conductance, is used to express electrolytic conductivity. Figure 2 Presents the electrolytic conductivity values for water samples from both sources: taps and shallow wells water, along with the values from the two standard guidelines. The electrical conductivity for water samples from kiosk taps had a range from a mean value of 70 µS to 380 µS. Whilst, samples from hand dug shallow wells showed mean electrolytic conductivity values ranging from 94 µS to 382 µS. The peak electrical conductivity value recorded was 380 µS for tap water and 382 µS for shallow wells water. Both these values were below the World Health Organization (WHO) guideline which is 400 µS and that of the Zambia Bureau of Standards (ZABS) guideline which is 1,500 µS, that was used as a benchmark in the study.

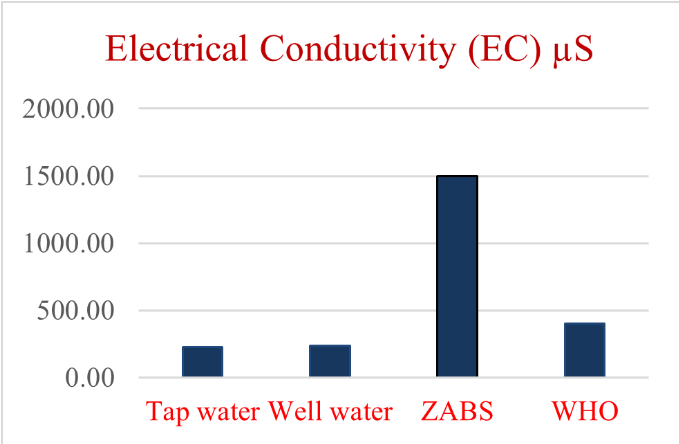


Figure 3. Electrical conductivity (µS) for water samples and standards

Figure 3 Illustrates the turbidity values for water samples from both sources, tap water and shallow well water alongside two standard guidelines. The turbidity of samples collected from nine taps ranged from a mean value of 0.91 NTU to 8.58 NTU. On the other thought, the turbidity of samples from shallow wells ranged more widely, with mean values starting from 5 NTU to 179 NTU. Having the highest turbidity recorded value of 179 NTU for shallow wells water, which actually exceeds both the World Health Organization (WHO) guideline of less than or equal to one (1) NTU and the Zambia Bureau of Standards (ZABS) guideline of less than or equal to five (5) NTU. Even the highest kiosks' tap water turbidity value of 8.58 NTU went over these standards, indicating some serious concerns regarding water clarity and quality in these sources.

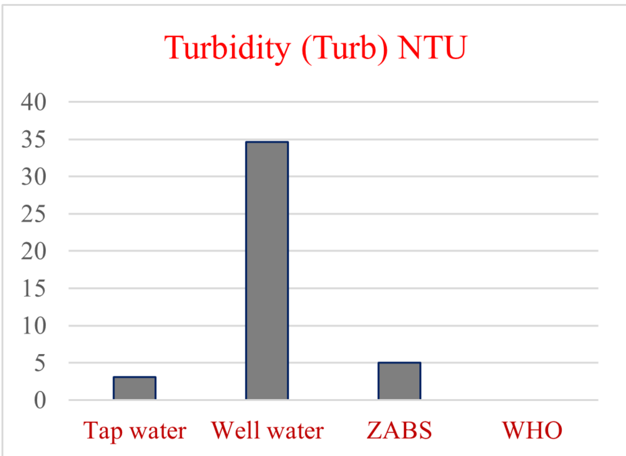


Figure 4. Turbidity values (NTU) for water samples and standards

The mean chloride values for tap water ranged from a minimum of 0.15 mg/L to a maximum of 0.28 mg/L. In contrast, the mean chloride values for well water varied between 19.9 mg/L and 39.9 mg/L. These values were compiled and compared with the standards set by the two referenced studies. Both the mean chloride levels in tap and well water were found to be below the established standards of 200 mg/L by WHO and 250 mg/L by ZABS, as illustrated in Figure 4 below.

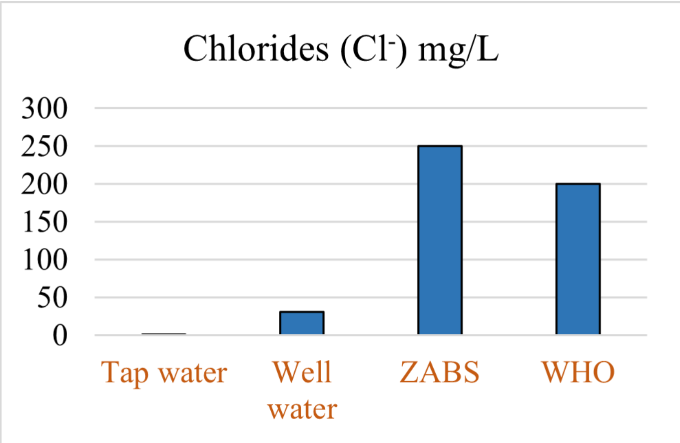


Figure 5. Chloride values for water samples and standards

The average calcium values for tap water ranged from a minimum of 24.5 mg/L to a maximum of 103.2 mg/L. In comparison, the mean calcium values for well water varied from 0.03 mg/L to 0.93 mg/L. These values were compiled and compared with the standards from the two referenced studies. Both the mean calcium levels in tap and well water were below the standards set by WHO (100 mg/L) and ZABS (200 mg/L), as shown in Figure 5 below.

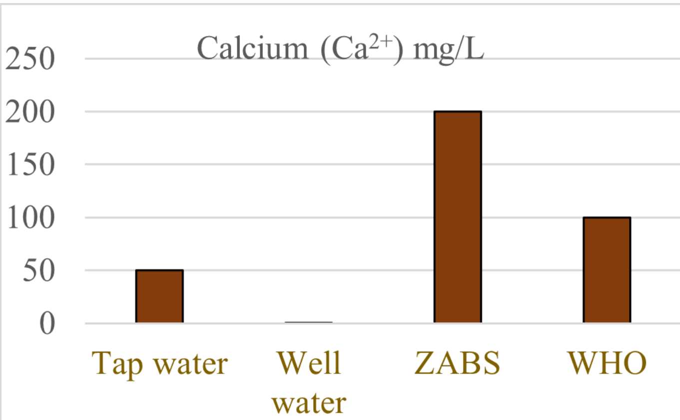


Figure 6. Calcium values for water samples and standards

The mean magnesium values for tap water ranged from a minimum of 11.8 mg/L to a maximum of 51.6 mg/L, while for well water, the values varied between 1.66 mg/L and 2.38 mg/L. These measurements were compiled and compared against the standards set by WHO (50 mg/L) and ZABS (150 mg/L). The mean magnesium levels in both tap and well water was found to be within the limits specified by these standards. This data is illustrated in Figure 6 below. Additionally, the comparison indicates that tap water, although reaching the upper limit of the WHO standard, remains significantly below the ZABS threshold. Well water, on the other hand, exhibits much lower magnesium concentrations, comfortably meeting both standards. This demonstrates that both sources of water are safe to drink concerning magnesium content alone, adhering to international and national guidelines.

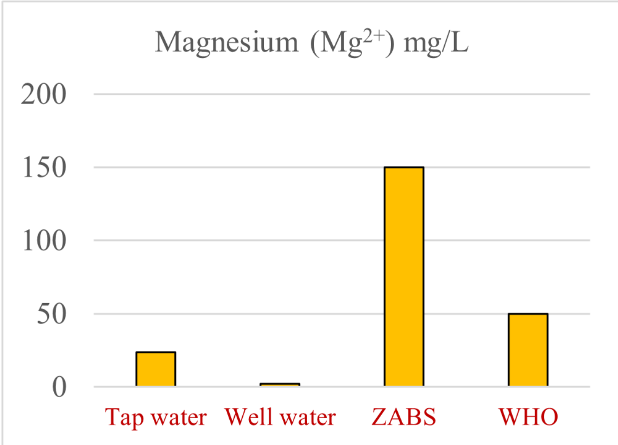


Figure 7. Magnesium values for water samples and standards

The mean total hardness values for tap water ranged from a minimum of 40 mg/L to a maximum of 172 mg/L. In comparison, the mean total hardness values for well water ranged from a minimum of 1.99 mg/L to a maximum of 2.89 mg/L. These values were compiled and compared against the standards set by the World Health Organization (WHO) and the Zambia Bureau of Standards (ZABS), which are 200 mg/L and 500 mg/L, respectively. Both the mean total hardness values for tap water and well water were found to be well below these standard limits. This comparison is showed in Figure 7 below. To give more insightful and further context, total hardness in water is actually caused by the presence of calcium and magnesium ions as magnesium and calcium dissolve in water. While the values for tap water are significantly higher than those for well water, they are both still within safe and acceptable limits for consumption and use according to the referenced standards. This shows that the water, whether from tap or well sources, poses no significant risk of when it comes to hardness-related issues such as scale formation in pipes and appliances or adverse health effects. The results underscore the quality and safety of the water being studied.

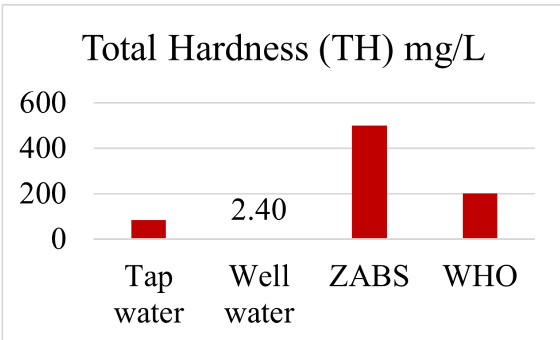


Figure 8. Total hardness in water samples and standards

The mean total dissolved solids (TDS) values for tap water ranged from a minimum of 30 mg/L to a maximum of 190 mg/L. For well water, the mean TDS values ranged from 47 mg/L to 192 mg/L. These values were compiled and compared with the standards set by the World Health Organization (WHO), which is 500 mg/L, and the Zambia Bureau of Standards (ZABS), which is 1000 mg/L. Both the mean or average TDS values for tap and well water was below or within allowable standard limits, indicating good water quality. This is illustrated in Figure 8, below. Total dissolved solids (TDS) measures all the content of inorganic and organic substances combined in water. High TDS levels definitely affect water taste, hardness, and cause scale buildup in pipes and appliances such as pots after boiling water in them. The observed TDS levels in the two sets of water which is tap and shallow wells water samples suggest that both sets of water is safe for human consumption and use, without risk. These findings uncover the reliability and quality of the studied water sources, ensuring they meet international and national or local standards for safety and usability for the water.

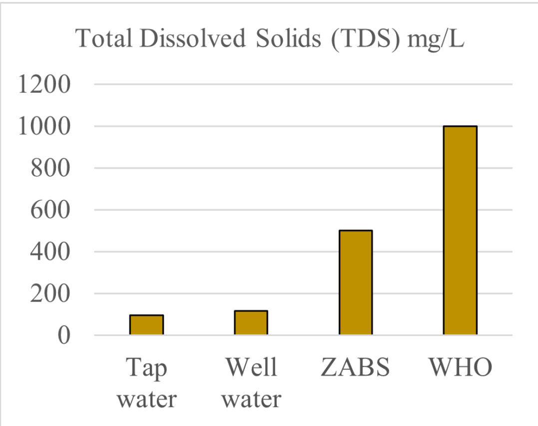


Figure 9. Total dissolved solids in water samples and standards

The average total coliform count for tap water was none or zero (0), indicating that it contained no contamination. But, the average total coliform count for shallow well water was significant, having a range from 26 to Too Numerous to Count (TNTC), with TNTC being set at 3,000 counts for statistical analysis. All these values were put together and compared with the standards and
guidelines provided by the World Health Organization (WHO) and that of Zambia Bureau of Standards (ZABS), of which both standards are set at a value of zero (0) coliform counts. While the mean calcium levels in the two (2) sets of water which are tap and shallow wells water were below the WHO and ZABS standards, the mean or average total coliform count for shallow well water was alarmingly or dangerously high at 713.20. These high levels of contamination in these shallow wells indicates that this water from Kyawama compound is not suitable for human consumption more especially drinking to be exact. This comparison is displayed and showed in Figure 5 below. Total coliforms are bacteria that are commonly used as an indicator of water quality and the potential presence of harmful pathogens such as E. coli bacteria in the water. The absence of coliforms in tap water signifies it's safe for consumption, whereas the high coliform counts in in shallow wells water suggests significant contamination, complications and serious health risk if consumed without proper treatment.

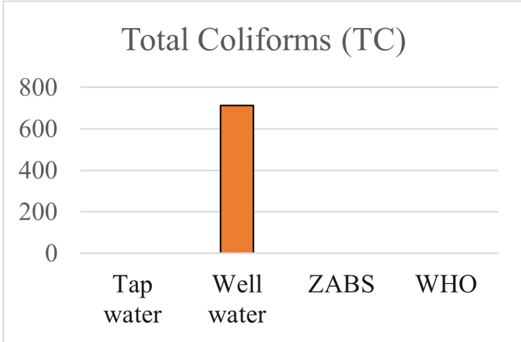


Figure 8. Total coliforms in water samples and standards

5. CONCLUSION

In conclusion, this study and research puts together a contrast and comparison in the water quality between the tap water supplied by northwestern water supply and sanitation company limited and the shallow wells water of Kyawama compound of Solwezi District, northwestern Zambia. As per this research tap water generally meets drinking water safety standards for both international and national, the shallow wells exhibit high coliform bacteria contamination levels, making it actually unsafe for consumption or drinking. The findings emphasises the dire need for properly treating the shallow wells water before consumption or drinking, improving sanitation or sewage infrastructure because the area has no serviceable sewer lines but heavily depend on hand dug pit latrines which are also in close proximity with these shallow wells, a regular monitoring of these water sources, and educating this community and other surrounding communities that might be facing the same challenges on safe drinking water practices. These measures are crucial to ensuring the safety and health of residents relying on these essential water sources.

RECOMMENDATION

Based on the findings, it is recommended that further research should be conducted in the districts of North-Western Province not just Solwezi but other districts too, like Kasempa, Chavuma, Kalumbila, Mufumbwe, Lumwana and many other districts in this province, with immediate action taken to ensure the safety of water from shallow wells in the Kyawama compound. The community should be advised to treat or boil well water before consumption to reduce health risks associated with coliform contamination, such as cholera, typhoid fever, dysentery, giardiasis, hepatitis A, cryptosporidiosis, and E. coli infections, which can cause symptoms like stomach cramps, diarrhoea (often bloody), and, in severe cases, kidney failure. In addition, government authorities should endeavour to improve sanitation infrastructure such as serviceable sewer lines to prevent ground water contamination. Methodical or systematic monitoring of both shallow well and kiosk tap water sources is crucial to maintain ongoing safety. Community education programs on safe proper safe water practices should also be implemented to raise awareness and encourage healthier habits more especially when it comes to water. These actions will help improve overall water quality and protect public health.

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