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Assessment of Reverse Osmosis Treated Drinking Water Quality in Vavuniya Urban Council Area: A Comprehensive Analysis

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Abstract

Community-based reverse osmosis (RO) water treatment plants have been introduced as a temporary solution to provide safe drinking water in CKDu-affected rural dry zones of Sri Lanka. In the Vavuniya Urban Council, the drinking water trend has been shifted from groundwater to RO-treated water. This study examined the chemical quality of RO drinking water by analyzing samples from 25 high-consumption RO centers, which were tested at the Land Use Division Laboratory, Irrigation Department, Colombo. Physicochemical parameters such as pH, electrical conductivity, total dissolved solids, turbidity, nitrate, calcium, alkalinity, and chloride were compared with Sri Lankan Standards (SLS) and WHO standards. Results showed electrical conductivity of 47.55±26.36 µs/cm (<300 µs/cm), total dissolved solids of 47.56±26.22 mg/L (<500 mg/L), turbidity 0 NTU (<5 NTU or <2 NTU), nitrate 0 meq/L (<0.806 meq/L), calcium 2.22±1.74 ppm (<100 mg/L), alkalinity 15.3±7.06 ppm (<500 mg/L or 200 mg/L), and chloride 0.12±0.07 meq/L (<7.05 meq/L), all well below permissible levels. However, pH averaged 4.87±0.40, which is below the standard 6.5–8.5 or 6.5–9.2 range, indicaties increased acidity. While RO treatment effectively removes contaminants, it also eliminates essential minerals and ions, reducing water's natural balance and increasing acidity. The study emphasizes the need for further research to quantify mineral levels in RO-treated water and address low pH issues. It recommends post-treatment mineral re-addition and pH adjustment to improve water safety and health benefits for the residents of Vavuniya.

Keywords: drinking water quality, reverse osmosis (RO), physicochemical parameters, Sri Lankan Standards, acidity

1. Introduction

Water is the most essential resource on Earth, sustaining life and supporting social and economic progress. It plays a crucial role not only in daily human activities but also in the broader functioning of ecosystems and economies. Water is an indispensable and irreplaceable natural resource necessary for the survival of human beings, as well as plants, animals, and all living organisms. In this sense, water is one of the most widely consumed and highly contested resources at the global level (Mishra, 2023).

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According to the guidelines of the World Health Organization (WHO), the recommended limits for certain minerals in safe and healthy drinking water are as follows: Calcium (Ca) < 100 mg/L, Magnesium (Mg) < 30 mg/L, Sodium (Na^+) < 200 mg/L, Iron (Fe) < 0.3 mg/L, Fluoride (F^-) < 1.5 mg/L, Nitrate (NO_3^-) < 50 mg/L, Chloride (Cl^-) < 250 mg/L, Electrical Conductivity (EC) < 300 µS/cm, and Total Dissolved Solids (TDS) < 500 mg/L. In addition, the pH level of drinking water should range between 6.5 and 9.2, turbidity should be maintained below 2 NTU, and alkalinity should remain below 200 mg/L. However, the mineral content of drinking water may vary depending on its source and the purification process employed. Furthermore, the individual requirement for mineral intake differs based on factors such as age, gender, and health status (World Health Organization, 2023).

In recent times, the quality of drinking water has significantly deteriorated due to increased chemical contamination and higher hardness levels. These factors pose serious risks to human health and development (Madarasinghe, 2015). With the growing global population, the demand for safe and high-quality drinking water has risen substantially. Consequently, the consumption of drinking water purified through reverse osmosis (RO) has increased markedly (Imbulana, 2022).

Reverse osmosis (RO) is an advanced water purification process that uses pressure to push water through a semi-permeable membrane with microscopic pores as small as 0.001 microns. This synthetic membrane acts as a selective barrier, allowing only pure water molecules to pass while rejecting dissolved salts, minerals, chemicals, heavy metals, and microorganisms. By filtering out pollutants such as chlorine, calcium, salt and sediments, RO provides clean, safe, and better-tasting drinking water that is demineralized, deionized, and virtually contaminant-free (PURETEC Industrial Water, 2023; AQUA CURE, 2021).

Vavuniya district, located in the Northern Province of Sri Lanka, is part of the dry zone and faces numerous challenges in accessing safe drinking water. The district is also considered a region with high poverty levels. The prevalence of kidney disease in the area has been linked to multiple factors, including the high fluoride content in drinking water (Piyasiri & Senanayake, 2016). Furthermore, Vavuniya receives relatively short rainfall periods, which leads to seasonal fluctuations in water availability, making a continuous and reliable water supply challenging. Areas under the Vavuniya Urban Council are characterized by crystalline rock formations, resulting in limited groundwater storage capacity. Consequently, residents face drinking water issues due to both insufficient groundwater and increased mineral content, particularly elevated calcium and chloride levels (Chandrajith et al., 2011).

In response to these challenges, there is a growing preference among the population for reverse osmosis (RO) purified water over municipal piped water, well water, or reservoir water. RO, a process where water is sent through membrane layers, filters out pollutants, chlorine, calcium, salt, and sediments from drinking water. This trend has recently gained momentum, with a rise in privately operated RO treatment facilities within the Vavuniya Urban Council area. However, it is important to note that water purified through reverse osmosis cannot be assumed to be universally safe or healthy in all respects.

Despite previous studies on water resources, groundwater depletion, and reservoir maintenance, no research has specifically focused on the sanitary drinking water requirements of this region. This study therefore examines the quality of RO-treated drinking water in Vavuniya Urban Council, which includes 11 Grama Niladhari Divisions, characterized by high temperatures averaging 28.5°C. The research aims to explore the quality of the recently trending drinking water sources and proposes the use of RO treated water as a solution to local drinking water issues.

2. Objectives of the Study

The main objective of this study is to assess the physicochemical quality of RO-purified drinking water supplied within the Vavuniya Urban Council area.

The specific objectives are:

1. to analyze the physicochemical parameters (pH, EC, TDS, Total Hardness, Calcium, Magnesium, Chloride, and Nitrate) of RO-purified drinking water collected from selected treatment plants within the Vavuniya Urban Council area.

2. to compare the analyzed water quality parameters with the Sri Lanka Standards Institute (SLSI) and World Health Organization (WHO) guidelines to assess the suitability of the RO-treated water for human consumption.

3. Materials and Methods

3.1. Sampling for Drinking Water Testing

To evaluate the quality of drinking water purified through reverse osmosis (RO), a systematic sampling strategy was employed. Samples were collected from RO treatment plants located within the administrative limits of the Vavuniya Urban Council in the Northern Province of Sri Lanka (Figure 1). The study specifically targeted 11 Grama Niladhari Divisions, where RO-treated water is the primary source of drinking water for a majority of residents. Twenty-five samples of RO purified water were collected in the study area, and laboratory testing confirmed its reliability for city residents.

A total of 25 drinking water samples were collected directly from 25 different RO treatment plants located in the surroundings of Vavuniya Urban Council , that are frequently accessed by the urban population. The plants were chosen based on their high level of consumption by residents, ensuring that the sampling reflected the most representative sources of drinking water within the region. To avoid bias and ensure reliability, a random sampling technique was adopted.

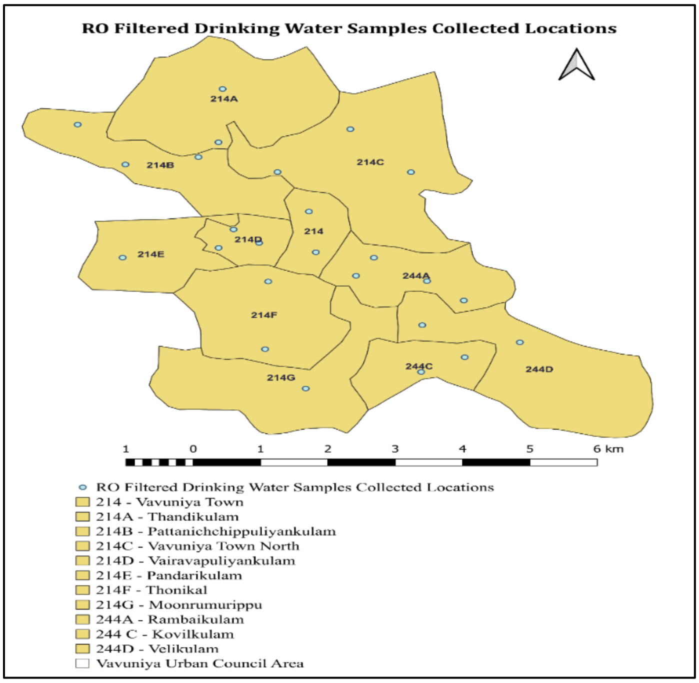


Figure 1. Map of Study area RO Filtered Drinking Water Samples Collected Locations.
Source: Generated by the Author using QGIS 3.34, 2023.

All collected samples were placed in sterilized containers to prevent contamination, accurately labeled with details such as the location, date, and time of collection, and transported under controlled conditions to maintain their original properties. Some RO treatment plants obtain water directly from groundwater wells, while others receive water from the National Water Supply and Drainage Board. In both cases, the surface and groundwater sources are affected by high levels of dissolved minerals such as calcium and chloride, resulting from long-term rock–water interactions. The wells draw water from crystalline hard rock aquifers typical of the Vavuniya District, which are mainly composed of high-grade metamorphic rocks like charnockites and granites. This geological setting greatly influences the quantity and chemical composition of the water used for RO treatment. The geographical distribution of the selected RO treatment plants, which form the major drinking water supply points for residents of Vavuniya Urban Council, is illustrated in Figure 1.

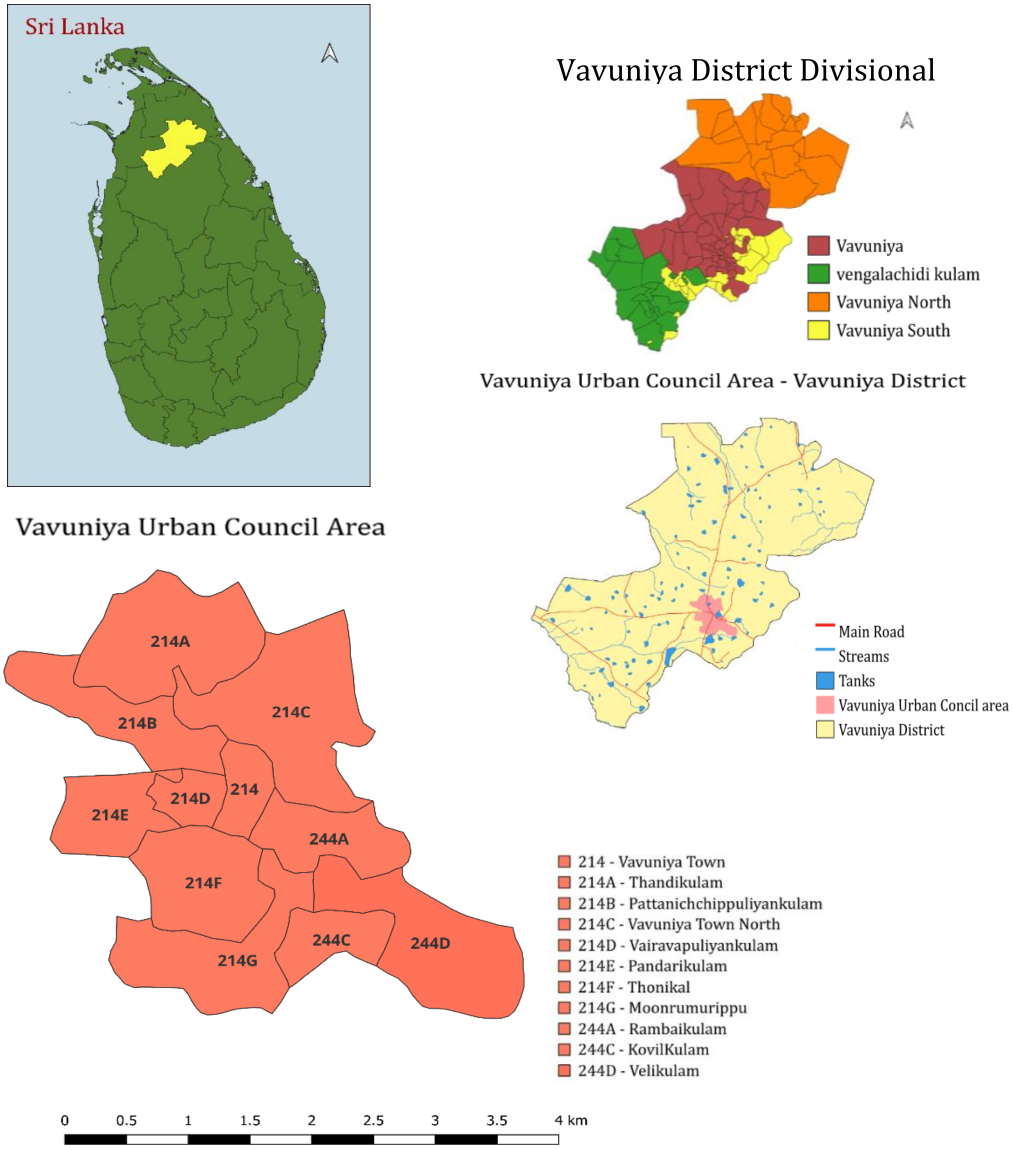


Figure 2. The Spatial Location in the Study Area.
Source: Created by the author using Survey Department Data, Sri Lanka, 2023.

3.2. Sampling Dates and Process

The collection of water samples was carried out over three consecutive days, on March 4, 5, and 6, 2023, to capture a representative cross-section of drinking water across the study area. By conducting the sampling over multiple days, any short-term variability in water quality was minimized.

Immediately after collection, the samples were stored securely in sterilized plastic containers to preserve their integrity. Each sample was sealed, carefully labeled, and kept under controlled temperature conditions during transportation to reduce the risk of chemical or biological alteration.

On March 7, 2023, all samples were submitted to the Land Use Division Laboratory of the Colombo Irrigation Department for comprehensive laboratory testing. The analyses focused on the chemical properties of the RO-purified drinking water, and the results were compared against established drinking water quality standards. This ensured a scientific, unbiased evaluation of water safety and suitability for human consumption.

3.3. Laboratory Testing

Laboratory analysis was performed to examine the chemical characteristics of the drinking water samples. The parameters tested included pH level, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Calcium (Ca^{2+}) content, Chloride (Cl^{-}) concentration, Nitrate (NO_3^{-}) levels, Chlorine intensity (Cl_2), Turbidity and Alkalinity.

To ensure accuracy and precision, these parameters were measured using advanced laboratory instruments, including a pH Meter, Electrical Conductivity Meter, and Electronic Turbidity Meter, as shown in Figure 3. The selection of these instruments was based on their reliability and widespread acceptance in water quality monitoring.

The laboratory results were obtained on May 7, 2023, following thorough analysis. Each test was conducted in accordance with standard scientific procedures to ensure validity. This laboratory examination provided dependable and accurate data, thereby strengthening the credibility of the study. Further details, including the sampling locations, the origins of collected water, and the corresponding laboratory results, are provided in the Appendix section of this report for reference.

Figure 3. Images Captured during lab experiments

3.4. Data Analysis

The chemical parameters of the RO-purified drinking water samples were scientifically analyzed and compared with recognized water quality standards. This comparative assessment enabled the evaluation of whether the water met safe drinking requirements and highlighted potential risks associated with its consumption.

For visualization, the results were processed using Microsoft Excel, where line graphs were generated to demonstrate variations and trends across different sampling locations which have an elevation ranging from 90 m (300 ft) to sea level. These graphical representations facilitated a clear understanding of spatial and chemical fluctuations in water quality parameters.

Additionally, the geographical distribution of the RO treatment plants selected for this study was mapped using QGIS software. This spatial analysis provided a visual representation of the location of RO plants in relation to the urban landscape, helping to contextualize the availability and accessibility of purified drinking water for residents of the Vavuniya Urban Council area.By combining chemical analysis with statistical processing and spatial visualization, this study ensured that the findings were both scientifically valid and practically informative, contributing to a comprehensive understanding of drinking water quality in the region.

4. Result and Discussion

The present study investigated the quality of drinking water treated by reverse osmosis (RO) in 25 outlets distributed across 11 Grama Niladhari Divisions within the Vavuniya Urban area. RO technology is increasingly used as a water purification method in Sri Lanka, particularly in urban and semi urban settings, due to its effectiveness in removing dissolved salts, organic contaminants, and other impurities. However, while RO significantly improves the physical and chemical quality of water, it may also alter its mineral composition and physicochemical balance, sometimes creating secondary concerns for health and safety.

This study focused on key chemical and physical parameters commonly used to assess drinking water quality: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Chlorine Intensity (CI), Nitrate (NO_3^-), Calcium (Ca^{2+}), Alkalinity, and Turbidity. These parameters collectively provide insight into whether the treated water complies with both Sri Lanka Standards (SLS) which is framework led by the Ministry of Health, based on the Sri Lanka Standard (SLS) 614, which aligns with WHO guidelines and international guidelines such as those established by the World Health Organization (WHO) which is a water safety conceptual frame work. Table 1 provides the summarized results of the analysis.

The following subsections discuss each parameter in detail, highlighting the observed values, comparison with permissible limits, possible causes of variation, and implications for public health and water system management.

Table 1: Water Parameters and Results

Parameters	**Measurements**	**Range**
pH Level	4.87 ± 0.40	4.34 - 5.71
EC (µS/cm)	47.55 ± 26.36 µS/cm	18.7µS/cm - 141.3 µS/cm
TDS (mg/l)	47.56 $\pm 26.22\ mg/l$	19 mg/l - 141 mg/l
Cl^- (meq/l)	0.12 ± 0.07 meq/l	0.04 meq/l - 0.36 meq/l
NO_3^-(meq/l)	0	0
Ca^{2+} (ppm)	2.22 $\pm 1.74\ ppm$	0.56 ppm - 7.01ppm
Alkalinity (ppm)	15.3 $\pm 7.06\ ppm$	8.80 ppm - 42 ppm
Turbidity (NTU)	0	0

Source: Land Use Division Laboratory, Irrigation Department, Colombo (2023).

The unit mg/L (milligrams per liter) indicates the amount of a substance present in one liter of water by weight. The unit meq/L (milliequivalents per liter), expresses the concentration based on the chemical activity or charge of ions.

4.1.pH Analysis

pH is one of the most fundamental indicators of water quality. It measures the hydrogen ion concentration and indicates whether the water is acidic, neutral, or alkaline. Maintaining an acceptable pH level is essential not only for human health but also for the longevity of water distribution systems. According to Sri Lankan drinking water standards, the permissible pH range is 6.5 - 8.5. The WHO further extends the acceptable upper limit to 9.2, acknowledging that natural variations may occur across regions. Deviations from this range may result in undesirable taste, corrosiveness, and potential health risks.

The analysis of 25 RO-treated water samples revealed pH values ranging from 4.34 to 5.71, with a mean of 4.87. This result is striking because none of the samples fell within the acceptable range; instead, all 25 samples were highly acidic. The lowest pH (4.34) was detected in water collected from Kovil Puthukulam, while the highest (5.71) was still below the lower permissible limit of 6.5. Thus, 100% of the tested samples are unsuitable for direct human consumption according to both SLS and WHO guidelines.

The acidic nature of RO-treated water is largely attributable to the removal of buffering minerals such as calcium, magnesium, and bicarbonates during the RO filtration process. While the removal of contaminants is beneficial, the loss of essential ions destabilizes water chemistry, leading to a fall in pH. Continuous consumption of such acidic water may cause irritation to the digestive tract, disturb the body’s natural pH balance, and erode dental enamel. In addition, acidic water can contribute to the gradual corrosion of pipelines and storage systems, which may affect water safety over time.

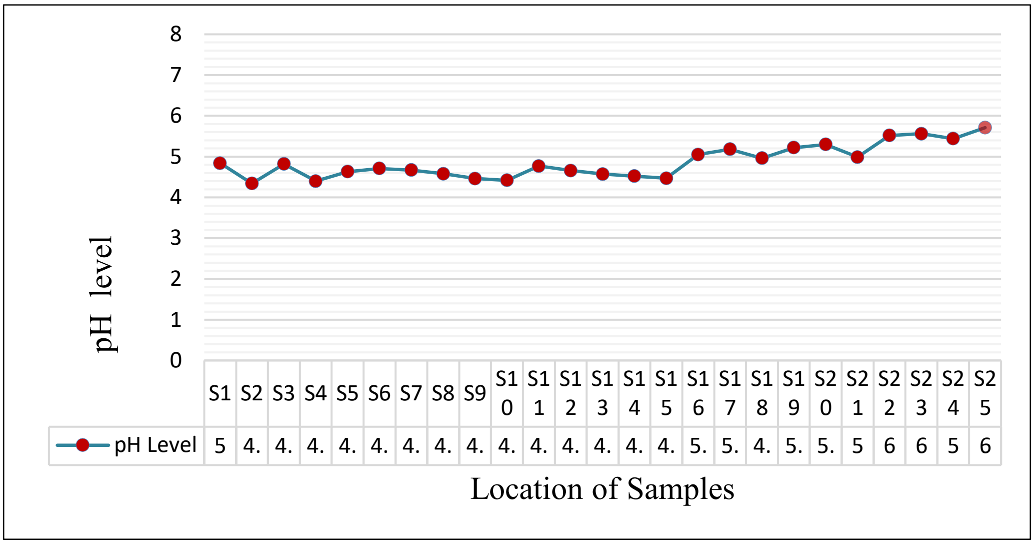


Figure 4. pH Level
Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023).

These findings align with concerns raised in earlier research, such as Janna et al. (2015), who highlighted the adverse health consequences of consuming demineralized acidic water. Therefore, while RO provides microbial safety, post-treatment remineralization or pH correction is essential before distribution to the community.

4.2.Electrical Conductivity (EC)

Electrical conductivity (EC) reflects the concentration of dissolved ions in water and is often used as a quick proxy for overall salinity and mineral content. High EC values typically indicate elevated levels of salts such as sodium, calcium, chloride, and bicarbonates, which may impart a salty taste and affect palatability. Conversely, extremely low EC values, while indicative of purity, may suggest excessive removal of beneficial minerals (Atlas Scientific, 2023).

The WHO recommends a desirable EC value of 300 µS/cm, though it does not set a strict health-based guideline. The Sri Lanka Standards Institution (SLSI) does not prescribe a maximum EC level, reflecting the fact that EC itself is not directly harmful but serves as an indicator of mineral presence. In this study, the mean EC value of the 25 samples was 47.55 µS/cm, ranging between 18.7 µS/cm and 141.3 µS/cm. All samples fell well below the WHO guideline of 300 µS/cm. This confirms that the RO systems in Vavuniya effectively reduced ionic content, yielding very low-conductivity water.

While low EC demonstrates the effectiveness of RO treatment in producing high-purity water, it also indicates a lack of dissolved minerals that could affect both taste and stability. Such water may have a flat taste and, in some cases, increased corrosive potential in plumbing systems. Overall, the results suggest that the RO-treated water is chemically safe with respect to EC. Figure 5 illustrates the distribution of EC values across all samples, showing a consistent trend of low conductivity.

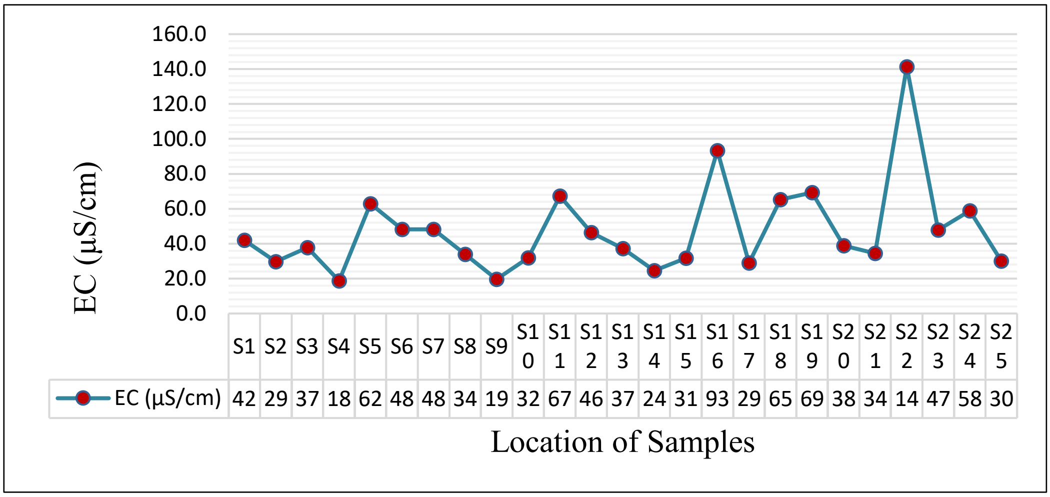


Figure 5. Electrical Conductivity

Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023).

4.3.Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) include both inorganic salts such as calcium, magnesium, sodium, and potassium and organic (carbon-based) compounds. In pure water, dissolved solids are primarily composed of mineral salts, but in contaminated water, both mineral salts and organic compounds such as hydrocarbons and urea may also be present (Bisleri Drink Company, 2020). TDS is therefore a widely recognized parameter for assessing overall water quality, as it reflects both natural mineral content and potential contamination.

High TDS levels can cause unpleasant taste, scaling in pipes, and in some cases, adverse health effects. Conversely, excessively low TDS values may indicate demineralized water, which lacks essential nutrients. According to the Sri Lanka Standards (SLS), the maximum desirable TDS level for drinking water is 500 mg/L. The World Health Organization (WHO) further provides a classification system: water with TDS below 300 mg/L is considered excellent, 300–600 mg/L as good, 600–900 mg/L as fair, 900–1200 mg/L as poor, and above 1200 mg/L as unacceptable (WHO, 2017).

In this study, TDS values of the 25 RO-treated drinking water samples ranged from 19 mg/L to 141 mg/L, with the lowest recorded in Rambaikulam. All samples were well below the SLS permissible limit of 500 mg/L, confirming suitability for human consumption. Importantly, based on WHO classification, all samples fell into the “excellent” category, highlighting their high purity and suitability for safe consumption. The distribution of TDS levels across the analyzed samples is illustrated in Figure 6.

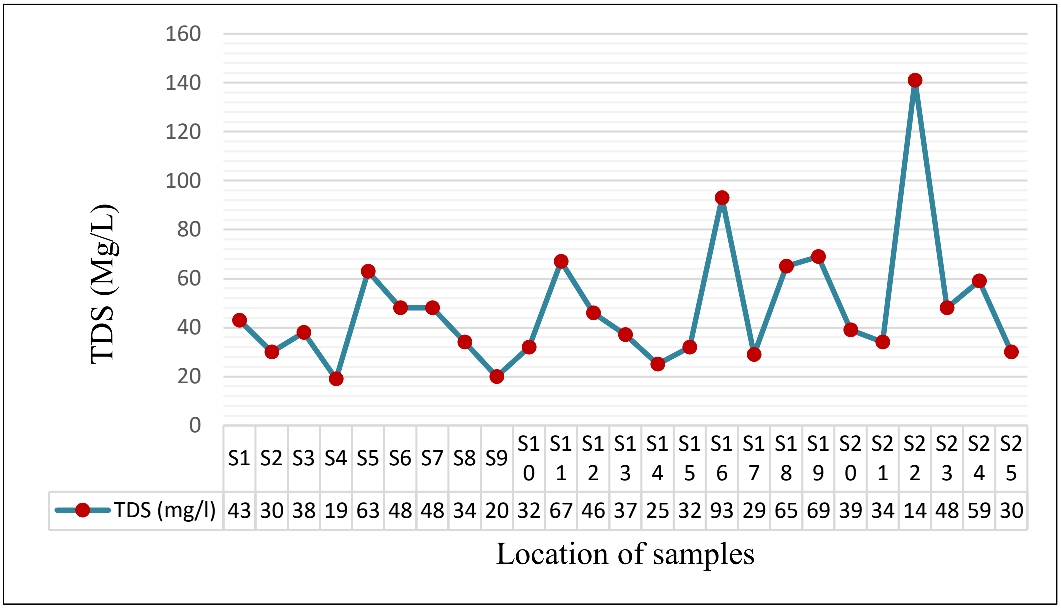


Figure 6. Total Dissolved Solids (TDS)

Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023).

Nevertheless, the absence of dissolved minerals raises questions about the nutritional quality of the water. Essential minerals such as calcium, magnesium, and potassium, normally present in natural groundwater, are almost entirely absent after RO treatment. Over time, exclusive reliance on such demineralized water may contribute to mineral deficiencies.

4.4.Chlorine Intensity (CI):

Chlorine is commonly added during water treatment to ensure disinfection and prevent microbial growth during storage and distribution. According to SLS, the recommended chlorine concentration in drinking water is 7.05 meq/L. In this study, chlorine levels were found to be extremely low, with a mean concentration of 0.12 meq/L, ranging from 0.05 to 0.36 meq/L. All samples were well below the SLS recommended level.

While this indicates the absence of excessive chlorination (which could cause taste and odor issues), the lack of adequate residual chlorine raises concerns. Without residual disinfectant, there is a risk of bacterial regrowth in storage tanks and pipelines, potentially leading to microbial contamination after treatment.

Maintaining a sufficient level of residual chlorine is therefore essential to ensure microbiological safety in distribution systems (Nezaj et al., 2024). Although the chemical safety of the RO-treated water is confirmed, additional disinfection or controlled chlorination should be considered in post-treatment. Figure 7 illustrates the variation of chlorine levels across the samples.

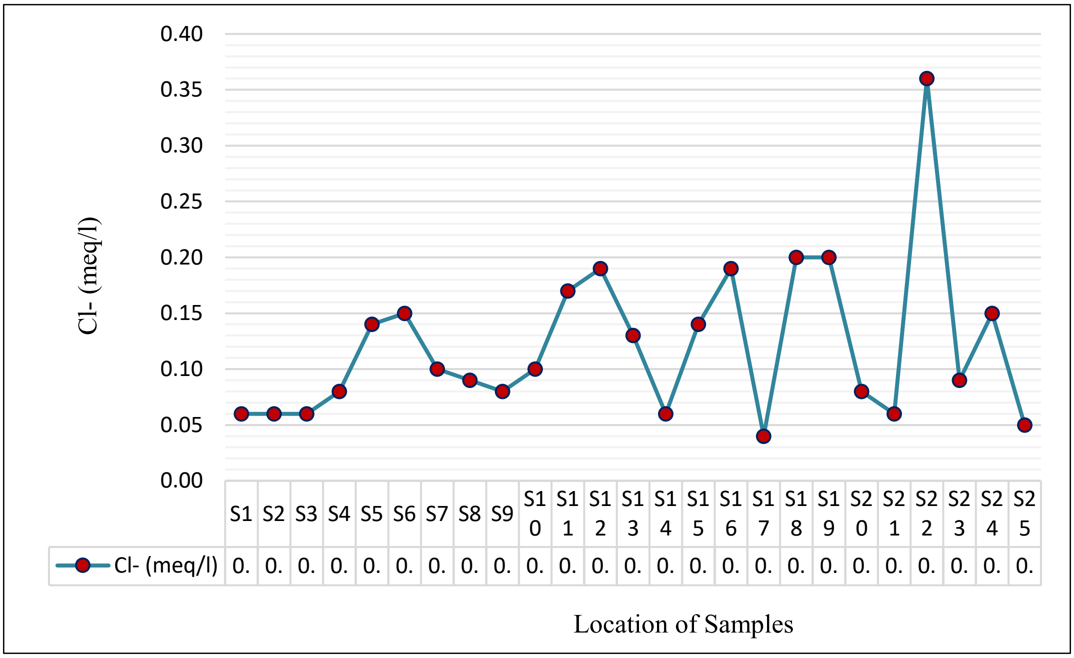


Figure 7. Chlorine Intensity (CI)
Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023)

4.5. Nitrate Levels (NO_3^-):

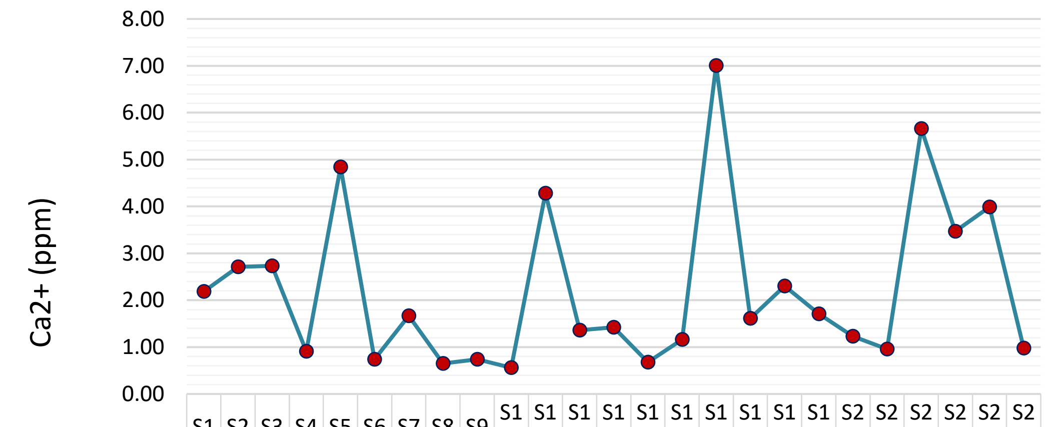
Nitrate contamination in drinking water is a major concern, especially in agricultural areas where fertilizer runoff and wastewater seepage are common (Abascal et al., 2022). According to the Sri Lanka Standards (SLS), the desirable nitrate concentration in drinking water is 0.806 meq/L.

The analysis of the 25-reverse osmosis (RO) treated drinking water samples in this study revealed that 100% of the samples had nitrate levels below 0.806 meq/L, with all samples recording zero values. This indicates that no nitrate contamination was detected in the analyzed samples. Therefore, the RO-treated water from the study area is considered safe and suitable for human consumption with respect to nitrate content.

4.6. Calcium Content (Ca_2^+)

Calcium is an essential mineral in drinking water, contributing to bone health, cardiovascular function, and overall human nutrition. Low calcium levels in drinking water may reduce the contribution of water to daily dietary mineral intake (National Research Council (US) Safe Drinking Water Committee, 1980).

According to the Sri Lanka Standards (SLS), the desirable calcium concentration in drinking water is 100 meq/L. In this study, the mean calcium level of the 25-reverse osmosis (RO) treated drinking water samples was 2.22 meq/L, with observed values ranging from 0.56 meq/L to 7.01 meq/L. All samples were well below the SLS permissible limit, indicating that the RO-treated water is chemically safe with respect to calcium content. The variation in calcium concentrations across the analyzed samples is illustrated in Figure 8.



	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25
Ca2+ (ppm)	2.1	2.7	2.7	0.9	4.8	0.7	1.6	0.6	0.7	0.5	4.2	1.3	1.4	0.6	1.1	7.0	1.6	2.3	1.7	1.2	0.9	5.6	3.4	3.9	0.9

Figure 8. Calcium Content (Ca_2^+)
Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023)

The low calcium levels are consistent with the demineralizing effect of RO treatment, which removes most dissolved salts, including beneficial minerals. While this ensures high water purity, it also suggests that the water provides minimal dietary calcium.

4.7. Alkalinity

Alkalinity is a measure of water's capacity to resist changes in pH that would make it acidic or to neutralize acids, thereby maintaining a stable pH (Campbell, 2022). According to the Sri Lanka Standards (SLS), the desirable alkalinity in drinking water is 500 meq/L. In this study, the mean alkalinity of the 25-reverse osmosis (RO) treated drinking water samples was found to be 15.30 meq/L, with observed values ranging from 8.80 meq/L to 42 meq/L. All samples were well below the SLS permissible limit of 500 meq/L, indicating that the RO-treated water from the study area is safe and suitable for human consumption with respect to alkalinity. The variation in alkalinity levels among the analyzed samples is illustrated in Figure 9.

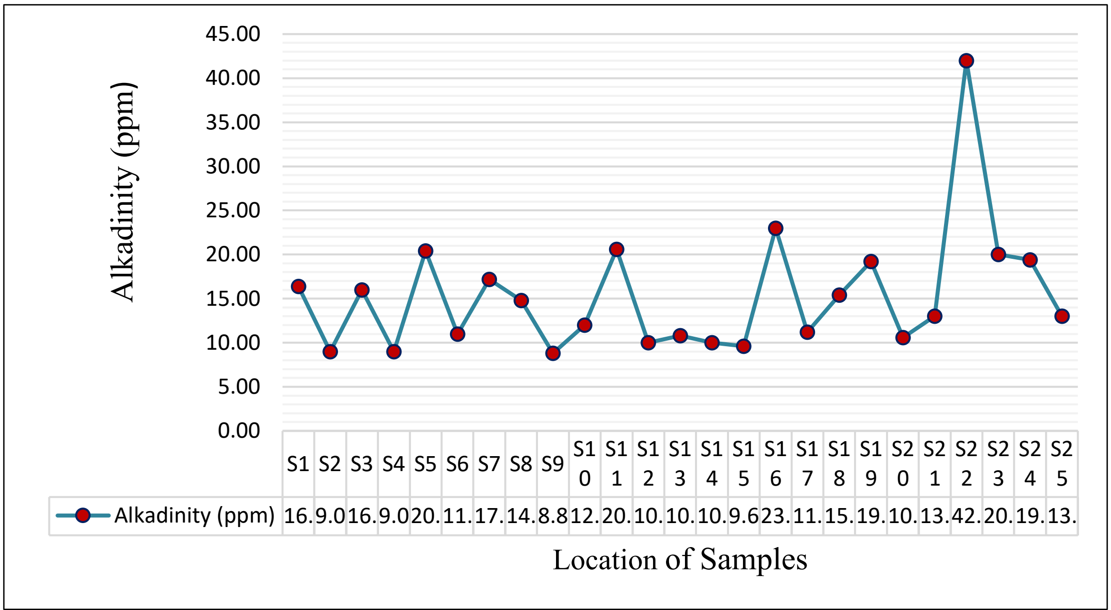


Figure 9. Alkalinity (ppm)
Source: Created by the author based on laboratory data (Land Use Division Laboratory, 2023).

4.8. Turbidity

Turbidity is a measure of the clarity of water, caused by fine suspended particles that scatter light and create a cloudy appearance (AQUALABO, 2024). It is an important parameter in drinking water quality assessment, as high turbidity not only reduces aesthetic quality but can also provide a medium for microbial growth.

According to the Sri Lanka Standards (SLS), the desirable limit for turbidity in drinking water is 5 NTU. In this study, the analysis of 25 reverse osmosis (RO) treated drinking water samples revealed turbidity values of zero in all cases. These results are well within the permissible limit, confirming that the RO-treated water is free from suspended impurities and visually clear, making it suitable for human consumption with respect to turbidity.

5. Limitation

Due to a shortage of required chemicals, it was not possible to conduct fluoride level testing in the reverse osmosis (RO) water samples. Both calcium and fluoride are important parameters in assessing drinking water quality; therefore, the inability to analyze fluoride represents a significant limitation in this study. Nevertheless, other key parameters were successfully measured to evaluate the quality of RO-treated water. For future studies, it will be important to include fluoride analysis and to assess water quality across different seasons and locations to obtain a more comprehensive understanding

Table 1: Water Analysis Report

Project:	Water Quality Testing	**Location of Sample:**	Vavuniya Urban Council Area
Sampled by:	S.Gamsathvani	**Laboratory:**	Land Use Division Lab, Irrigation Department, Colombo – 7
Type of Samples:	Reverse Osmosis Filter Water	**Received On:**	2023 March 07
No. of Samples:	25	**Completed On:**	2023 May 31

Table 2: RO filter Water Laboratory Analysis Report

Lab No & Village Name	**Parameter**							
	pH Level	EC (µS/cm)	TDS (mg/l)	Cl^- (meq/l)	NO_3^- (meq/l)	Ca^{2-} (ppm)	Alkalinity (ppm)	Turbidity (NTU)
S1 - Kovilkulam	4.84	42.0	43	0.06	0	2.19	16.40	0
S2 - Kovilputhukulam	4.34	29.7	30	0.06	0	2.71	9.00	0
S3 - Terkiluppaikkulam	4.82	37.7	38	0.06	0	2.73	16.00	0
S4 - Rambaikulam	4.40	18.7	19	0.08	0	0.91	9.00	0
S5 - Soosai Pillayarkulam	4.63	62.8	63	0.14	0	4.84	20.40	0
S6 - Sagayamathapuram	4.71	48.3	48	0.15	0	0.74	11.00	0
S7 - Rambaikulam	4.67	48.3	48	0.10	0	1.67	17.20	0
S8 - Poonthoddam	4.58	34.0	34	0.09	0	0.65	14.80	0
S9 - Periyarkulam	4.46	19.7	20	0.08	0	0.74	8.80	0
S10 - Vairavar puliyankulam	4.42	32.0	32	0.10	0	0.56	12.00	0
S11 - Ukkulamkulam	4.77	67.2	67	0.17	0	4.28	20.60	0
S12 - Thonikal	4.66	46.4	46	0.19	0	1.36	10.00	0
S13 - Thekawatta	4.57	37.3	37	0.13	0	1.42	10.80	0
S14 - Moondru Morippu	4.52	24.6	25	0.06	0	0.68	10.00	0
S15 - Goodshed Road	4.47	31.7	32	0.14	0	1.16	9.60	0
S16 - Paddakadu	5.05	93.3	93	0.19	0	7.01	23.00	0

S17 - Paddanichchi Puliyankulam	5.18	29.0	29	0.04	0	1.61	11.20	0
S18 - Veppankulam	4.96	65.3	65	0.20	0	2.30	15.40	0
S19 - Jaffna Road	5.22	69.3	69	0.20	0	1.71	19.20	0
S20 - Thandikulam	5.30	38.9	39	0.08	0	1.23	10.60	0
S21 - Thirunavatkulam	4.99	34.4	34	0.06	0	0.96	13.00	0
S22 - Kurumankadu	5.52	141.3	141	0.36	0	5.66	42.00	0
S23 - Chinnaputhukkulam Border	5.56	47.8	48	0.09	0	3.47	20.00	0
S24 - Velikkulam	5.44	58.9	59	0.15	0	3.99	19.40	0
S25 - Vavuniya Town	5.71	30.1	30	0.05	0	0.98	13.00	0

Checked by: K.A.A.Manatarga (Laboratory TA) | **Authorized by:** G.A.R.Silva
Date: 2023 May 31 **Date:** 2023 June 01

Table 3: Drinking Water Quality Standards - 2023

Parameter	SLS Standards	WHO Standrads
pH	6.5 - 8.5	6.5 - 9.2
EC	-	300 μS/cm
TDS	< 500 mg/L	< 500 mg/L
Cl^-	< 250 mg/L (< 7.05meq/L)	< 250 mg/L (< 7.05 meq/L)
NO_3^-	< 50 mg/L (< 0.806meq/L)	< 50 mg/L (< 0.806meq/L)
Ca^{2-}	< 100 mg/L	< 100 mg/L
Alkalinity	< 500 mg/L	< 200 mg/L
Tubidity	< 5NTU	< 2NTU
F-	< 1 mg/L	1.5 mg/L

SLS – Sri Lanka Standards Institution
WHO – World Health Organization

6. Conclusion

This study evaluated the chemical and physical quality of reverse osmosis (RO) treated drinking water collected from 25 outlets across 11 Grama

Niladhari Divisions within the Vavuniya Urban Council area. The results revealed that while RO treatment effectively removes contaminants, salts, and impurities, it also significantly alters the mineral composition and chemical balance of drinking water.

The findings showed that all tested samples had pH values below the acceptable standards of both SLS (6.5–8.5) and WHO (6.5–9.2), indicating that the RO water in the study area is highly acidic. This acidity, caused by the removal of buffering minerals during treatment, may have long-term implications for human health, water distribution systems, and household storage facilities. Similarly, essential minerals such as calcium were present only in negligible amounts, reflecting the demineralizing effect of RO purification. Although this ensures high purity, it also reduces the nutritional value of the water.

On the positive side, parameters such as TDS, EC, alkalinity, chloride, nitrate, and turbidity were all within permissible limits, confirming the chemical safety of the water. The absence of nitrate contamination and turbidity, along with very low TDS levels, demonstrates that the RO plants in Vavuniya are successful in delivering water that is free from common chemical and microbial risks. However, the extremely low residual chlorine levels indicate a potential vulnerability to microbial regrowth during storage and distribution.

Sample 22 (Kurumankadu) shows higher values compared to other areas. This location is a densely populated area, and the treatment plant is operated in a small shop. It is likely that the owner, who may not have proper technical knowledge, is not maintaining the RO membrane correctly. In addition, the system may be running at a low voltage, which can reduce filtration efficiency. These factors could have caused the variation in the test results. It is recommended to revisit and recheck the plant to confirm its condition and also examine whether there is any issue with the local groundwater quality.

Overall, while RO treated water in Vavuniya meets several international and national safety standards, the study highlights critical concerns regarding its acidity and lack of essential minerals. To address these issues, it is recommended that post-treatment processes such as remineralization and pH adjustment be introduced before community distribution. Additionally, proper disinfection management should be maintained to ensure microbiological safety.

Future research should include fluoride analysis, which was a limitation of the present study, as well as seasonal monitoring to better understand temporal variations in water quality. A more comprehensive assessment would help in establishing long-term strategies for safe, sustainable, and nutritionally adequate drinking water supply in the Vavuniya district.

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