https://doi.org/10.65646/3rc20dmw3j0641

THE USE OF RAINWATER AS A RELIABLE ALTERNATIVE FOR DRINKING PURPOSE IN DRY ZONES IN SRI LANKA: A COMPARATIVE STUDY IN THE MEDAWACHCHIYA AND KEBITHIGOLLEWA AREA, ANURADHAPURA

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Access to safe drinking water remains a critical public health issue in the dry zone of Sri Lanka, particularly the North Central Province (NCP), where the prevalence of chronic kidney disease of unknown aetiology (CKDu) is high. This study investigates the safety and suitability of rainwater as an alternative drinking water source by comparing its quality with six commonly used water sources: well water (WLW), tube well water (TWW), tap water (TPW), tank water (TNW), reverse osmosis water (ROW), rainwater (RNW), and spring water (SPW) in Medawachchiya (MED) and Kebithigollewa (KEB) divisions. In this study, 53 families from the MED division and 72 families from the KEB division were randomly selected. A total of 213 water samples commonly consumed by these families were collected in triplicate from their respective l sources. The collected water samples were analyzed in for key chemical parameters, including pH, conductivity, total hardness, and alkalinity and were evaluated against the drinking water standards introduced by the World Health Organization (WHO) and Sri Lankan Standards Institution (SLSI). According to the results, the pH values of all the water samples were within the acceptable limits (6.5−8.5). The conductivity of the different water sources in both areas was increasing in the order of ROW (32.9±1.85 µS/cm) < RNW (33.7±16.3 µS/cm) < TNW (268.55±1.55 µS/cm) < TPW (559±128 µS/cm) < TWW (765±80 µS/cm) < WLW (860±526 µS/cm). The total hardness of most of the water sources in both regions fell within the acceptable range (250 – 600 ppm), while some WLW and TWW samples in both regions recorded higher values (>700 ppm). The alkalinity of TPW, WLW, and TNW demonstrated extreme values (>850 ppm) in both regions. RNW and ROW exhibited significantly lower conductivities (<50 µS/cm) while RNW showed lower hardness (<12 ppm) and alkalinity (<128.0 ppm) than ROW in both regions. The results highlight that there was no significant difference (Mann-Whitney test, $p>0.05$) between the ROW and RNW in terms of the water quality parameters tested. Therefore, rainwater can be promoted as a reliable source of drinking water in the dry zone of Sri Lanka following verification of its microbiological safety.

Keywords: CKDu, drinking water, ground water, North Central Province, rainwater harvesting, Sri Lanka

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INTRODUCTION

Water, the most critical element for sustaining life on any planet, is of utmost importance for the overall well-being of living organisms. However, its quality has significantly deteriorated due to human activities such as industrial waste disposal and the use of agrochemicals. The quality of the island's surface and groundwater is further influenced by its climate, soil, topography, and geological conditions (Imbulana et al., 2006).
Access to pure and safe drinking water for the public remains a critical challenge in dry zones such as the North Central Province (NCP) of Sri Lanka. This issue is particularly relevant in the context of Chorionic Kidney Diseases of unknown aetiology (CKDu), a non-communicable disease with a high prevalence in these areas. The NCP largely relies on various local water sources for daily water needs, However, not all water sources meet Sri Lanka Standards Institute (SLSI) or World Health Organization (WHO) guidelines (*Guidelines for Drinking-Water Quality*, 2011; *Guidelines for Drinking-Water Quality*, 2017) for drinking water. Rainwater harvesting has been common in rural areas of Sri Lanka since ancient times. However, in recent decades, these traditional systems have been largely abandoned or underused due to misconceptions about the safety of rainwater and inconsistent rainfall patterns. According to the WHO guidelines, the maximum permissible levels of total hardness and total dissolved solids (TDS) are 500 ppm and 600 ppm respectively. Both regulations specify a pH range of drinking water of 6.5 to 8.5 (Wanasinghe et al., 2018). The human population in the NCP area faces a major challenge due to the lack of safe drinking water sources and this study aims to assess the quality of drinking water sources, in the Anuradhapura district, especially in areas at risk of kidney disease, and to promote rainwater as a safe and sustainable primary drinking source.

METHODOLOGY

Sample collection

A total of 213 water samples were collected from various sources such as well water (WLW), tube well water (TWW), tap water (TPW), tank water (TNW), RO water (ROW), spring water (SPW), and rainwater (RNW) in Medawachchiya (MED) and Kebithigollewa (KEB) divisions of Anuradhapura district in the North Central Province of Sri Lanka. A total of three to five water samples were collected from randomly selected households in each ward. According to the map of each Division, major wards were selected for sampling. From MED Division: Poonewa, Mahakumbukgollewa, Ethakada, Hirallugama, Mahadivulwewa, Isinbessagama, Walpola, Yakawewa, Puleliya, Medawachchiya, Kanadara Divulwewa, Kirigalwewa and From KEB Division: Halmillawetiya, Kahatagollewa, Wahalkada North, Thiththagonewa, Ethalwiddawewa, Kebithigollewa, Gonumeriyawa, Handagala Kirimetiyawa, Gonuhathdenawa, & Bandara Ulpatha were covered. A total of 53 families and 72 families were included in the study to represent the 12 wards in MED division and 10 wards in KEB division respectively, based on their drinking water sources. All the water samples were collected during the months from October 2024 to February 2025.

The pH, Electrical Conductivity (EC) and Total Dissolves Solids (TDS) in water samples were measured on-site using a portable pH meter (SUWU-01323, China) and an EC/TDS meter (YW-662, China). Water samples were collected in polypropylene bottles, transported to the laboratory under cooled conditions, and stored at 8 °C in a refrigerator until further analysis. Alkalinity was measured by titrating with H_2SO_4 in the presence of phenolphthalein and methyl orange indicator respectively. Total hardness was measured by EDTA titration at pH 10 using Eriochrome Black T indicator (Yappert M. Cecilia & DuPre Donald B, 1997).

RESULTS AND DISCUSSION

Observation during sampling revealed that six types of water sources were used by residents in the MED division, while seven types were used in the KEB division. The quality of the water sources was compared separately for the two areas; the results are presented in Table 1 and Table 2. These two tables show the number of water samples (N) based on the drinking water sources used by randomly selected households, along with the statistical results obtained using the Mann-Whitney test *($p < 0.05$)*, due to the non-normal data distribution.

Table 1: Relationship among the median values of conductivity, hardness, and alkalinity of different water sources in MED divisions.

Water Type	Conductivity (µS/cm)	Total Hardness ($CaCO_3$ ppm)	Alkalinity ($CaCO_3$ ppm)
ROW (N=35)	31.05^{a1*}	8.00^{a2*}	138.7^{a3*}
RNW (N=9)	50.03^{b1}	11.38^{ab2}	138.7^{a3}
TNW (N=8)	270.0^{c1}	185.7^{c2}	505.0^{b3}
TPW (N=17)	332.5^{c1}	18.4^{b2}	613.3^{b3}
TWW (N=13)	550.0^{cd1}	250.1^{cd2}	1620.0^{c3}
WLW (N=37)	760.5^{d1}	333.3^{d2}	1740.0^{c3}

**Different letters indicate the significant difference among the water resources and different numbers indicates the parameter that used for the statistical analysis; Mann-Whitney Test ($p < 0.05$).*

According to the results in Table 1, ROW showed the best water quality among six different water sources. The conductivity of ROW (31.05 µS/cm) was significantly different from that of all the other sources, while RNW water showed the second-best conductivity (50.03 µS/cm). The alkalinity and total hardness of RNW and ROW were not significantly different. According to SLSI standards, the permissible limits for conductivity, hardness and alkalinity are 800 µS/cm, 250 ppm as $CaCO_3$, 200 ppm as $CaCO_3$, respectively (Wanasinghe et al., 2018). Both ROW and RNW were found to be below these maximum permissible levels.

Table 2: Relationship and the median values of conductivity, hardness, and alkalinity of different water sources in KEB divisions.

Water Type	Conductivity (µS/cm)	Total Hardness ($CaCO_3$ ppm)	Alkalinity ($CaCO_3$ ppm)
ROW (N=13)	34.75^{b1*}	7.75^{s2*}	147.3^{a3*}
RNW (N=21)	23.40^{a1}	6.75^{a2}	112.0^{a3}
TNW (N=5)	267.0^{c1}	60.0^{c2}	530.0^{c3}
TPW (N=4)	708.8^{d1}	267.5^{d2}	2040^{d3}
TWW (N=21)	813.0^{d1}	290.0^{d2}	2120^{d3}
WLW (N=41)	882.0^{d1}	310.0^{d2}	2200^{d3}
SPW (N=4)	97.43^{b1}	31.0^{b2}	217.0^{b3}

**Different letters indicate the significant difference among the water resources and different numbers indicates the parameter that used for the statistical analysis; Mann-Whitney Test ($p < 0.05$).*

In the KEB division, people used SPW (Sinhaya Ulpatha, Bandara Ulpatha, Gonumeriyawa Ulpatha, Kebithigollewa Ulpatha) in addition to the six water sources consumed by the population in the MED division. Mainly, ROW, RNW and SPW are the popular drinking water sources in KEB.

In contrast to the MED division, the RNW of KEB showed better quality than all the other sources, while ROW was the second-best drinking water source. The alkalinity of both ROW and RNW was not significantly different. The SPW was another special drinking water source, while all the quality parameters were within the desirable range but showed significantly higher values than the RNW and ROW. The water quality of TWW, WLW, and TPW was the same and was higher than all the other sources. The alkalinity values of TPW, TWW, and WLW showed extreme values above 2000 ppm.

Hardness of TPW in the MED showed a significantly lower value compared to KEB while not showing a significant difference between the conductivity and alkalinity of TPW in both areas. The quality of TPW in the studied areas was different from point to point since the source was different. Comparably, the TPW in MED showed better quality than KEB. The conductivity values of TWW and WLW in both divisions showed values above 650 µS/cm, while the alkalinity of the same water hardness, conductivity, and alkalinity of WLW and TWW in both areas showed the same quality without a significant difference. Currently, all the above water sources are very rarely consumed as drinking water, as they are aware that drinking water quality is one of the major reasons for CKDu and they consumed ROW or RNW, or SWW for drinking, while TWW and WLW were used for other purposes. The ROW is most popular due to its low mineral content and safety, but financially it is not prominent in low-income families. As there was no significant difference in the basic physicochemical water quality parameters between ROW and RNW in these areas (Mann-Whitney test, $p > 0.05$), a properly implemented rainwater harvesting system could be introduced as an alternative source of drinking water, pending further studies on microbiological parameters such as total coliforms and *Escherichia coli*.

CONCLUSIONS/RECOMMENDATIONS

This study clearly demonstrates the differences in water quality among the various water sources available in Anuradhapura. Three water resources; ROW, RNW and SPW are assessed and stratified by the drinking water quality standards. Since SPW is not available in every areas in the dry zone and ROW is not considered cost-effective, properly harvested RNW present available and sustainable alternative drinking water source. Even though the water quality of RNW is at a satisfactory level, further studies are needed to assess biological water quality parameters and to investigate potentially hazardous substances such as heavy metals, dissolved organic compounds in RNW.

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