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EVALUATING THE RISE OF RO WATER CONSUMPTION: A CASE STUDY FROM BADANGPET, HYDERABAD

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ABSTRACT

Total dissolved solids (TDS) serve as a key indicator of water quality, with an optimal range of 50 mg/L to 500 mg/L for human consumption. This study examines the implications of reverse osmosis (RO) water consumption in Badangpet Municipal Corporation, Hyderabad by analyzing water samples collected from households, local commercial RO plants, and multinational bottled water brands. The samples revealed total dissolved solids (TDS) levels between 6 mg/L to 254 mg/L. This research highlights the need for government action, public awareness, and sustainable alternatives to RO water.

INTRODUCTION

Water is fundamental to life, forming the basis of all biological processes and ecosystems on Earth. Human survival depends on a continuous supply of clean and safe water, not only for hydration but also for maintaining bodily functions such as digestion, temperature regulation, and detoxification. Some essential elements are usually present in natural water as free ions and they are readily absorbed from water as compared to food. Awareness of the importance of minerals in drinking water has existed for thousands of years. In the Rig Veda, good drinking water was described as: “Sheetham (cold to touch), Sushihi (clean), Sivam (nutritive), Istham (transparent), Vimalam lahu Shadgunam (balanced acidity).”

Artificially-produced demineralised waters (reverse osmosis-treated water), have been used mainly for industrial, technical and laboratory purposes. Demineralization of water was needed where the water source available was highly mineralized brackish water or sea water. The quality of drinking water is defined by parameters such as its chemical, physical, and microbial characteristics. According to the World Health Organization (WHO), safe drinking water must be free of pathogens, harmful chemicals, and other contaminants while retaining essential minerals like calcium and magnesium. Total dissolved solids (TDS) serve as a key indicator of water quality, with an optimal range of 50 mg/L to 500 mg/L for human consumption.

Minerals in Drinking Water

There are 21 mineral elements known or suspected to be essential for humans of which fourteen mineral elements are established as being essential for good health. These elements in combined form affect bone and membrane structure (Ca, P, Mg, F), water and electrolyte balance (Na, K, Cl), metabolic catalysis (Zn, Cu, Se, Mg, Mn, Mo), oxygen binding (Fe), and hormone functions (I, Cr). Health consequences of micronutrient deficiencies include increased morbidity, mortality due to reduced immune defense systems and impaired physical and mental development. Drinking water supplies are highly variable in their mineral contents. While some contribute appreciable amounts of certain minerals either due to natural conditions (e.g., Ca, Mg, Se, F, Zn), intentional additions (F), or leaching from piping (Cu), most provide lesser amounts of nutritionally essential minerals (Narayana & Narasimharao, 2015).

Reverse osmosis (RO) filters can ensure maximum total solids reduction and also reduce different chemical parameters (BOD, TDS, and bacteria). RO systems use a semi-permeable membrane to filter out impurities, including bacteria, viruses, and dissolved salts. Initially developed for desalination, RO water is thus pure yet demineralized water that is deficient in essential minerals like sodium, potassium, calcium, magnesium and other important dissolved solids. Conventionally, the use of RO water was restricted to laboratories and industries; however, with a rise in water pollution, the implementation of RO water purification has extended even to the common man who resorts to RO water filters to purify water for his daily use (Ravindra et al., 2020).

The widespread adoption of reverse osmosis (RO) technology has transformed the way people access clean drinking water. However, a growing concern is that RO-treated water may be too clean, potentially leading to nutritional deficiencies (Janna, H.et al., 2026) This irony has sparked a debate about the long-term effects of consuming demineralized water.

MATERIALS AND METHODS

Study Area: Badangpet Municipal Corporation, Hyderabad.

Badangpet is a newly constituted Nagar Panchayat formed by merging eight erstwhile villages. It spans an area of 74.56 sq. km with an estimated population of 100,000. Located near Hyderabad, Telangana's capital, the area has rapidly urbanized, making it a representative location for studying water purification trends. Sampling included households, commercial RO plants, and bottled water brands.

Study Design

This study assessed TDS levels in RO water sources in Badangpet using a cross-sectional design. Samples were collected from households, commercial RO plants, and bottled water brands from February to April, 2024 ensuring consistency.

Sample Collection Protocol

Samples were collected using sterilized 500 mL polyethylene bottles, rinsed three times before use. Household RO samples were collected after 30 seconds of discharge. Commercial plant samples were taken from distribution points, and bottled water was obtained unopened from retailers. All samples were labeled appropriately.

TDS Measurement and Analysis

A digital TDS meter (Thermisto TDS-10) was used. Each sample was tested thrice, and the average was recorded. Results were tabulated and graphically presented.

RESULTS AND DISCUSSION

The Total Dissolved Solids (TDS) analysis of 117 water samples, categorized into multinational bottled brands (n = 6), unnamed local bottled water (n = 52), branded household RO units (n = 28), and unnamed household RO units (n = 31), revealed notable patterns in both consistency and variability.

Table 1: TDS Levels in Different Water Samples.

Category	Number of Samples	TDS Range (mg/L)	Mean TDS (mg/L)	Standard Deviation
Multinational Bottled Brands	06	60-81	68.167	7.035
Unnamed Local Bottled Water	52	06-110	57.308	29.070
Branded Household RO Units	28	10-254	94.464	60.326
Unnamed Household RO Units	31	28-150	77.355	37.084

As shown in Table 1, multinational bottled brands exhibited TDS values ranging narrowly between 60 and 81 mg/L (Mean = 68.17 mg/L, SD = 7.04), all well within the World Health Organization (WHO) recommended range of 50–300 mg/L for drinking water (WHO, 2017). In contrast, unnamed local bottled water displayed a much wider range of 6 to 110 mg/L (Mean = 57.31 mg/L, SD = 29.07), indicating significant inconsistency in local bottling practices. Branded household RO units had TDS readings between 10 and 254 mg/L (Mean = 94.46 mg/L, SD = 60.33), whereas unnamed household RO units ranged from 28 to 150 mg/L (Mean = 77.36 mg/L, SD = 37.08). Overall, 31% of all samples registered TDS levels below 50 mg/L, raising concerns about potential mineral deficiencies.

Multinational bottled brands demonstrated the highest consistency, likely attributable to stringent quality-control protocols and adherence to international standards. Their narrow TDS range (60–81 mg/L) suggests systematic blending or remineralization processes designed to maintain a stable mineral profile. However, while low variability ensures predictability, the mean TDS of 68.17 mg/L remains at the lower end of the WHO's optimal range, which may not supply sufficient dietary minerals (e.g., calcium, magnesium) particularly in regions where dietary intake is already marginal.

Unnamed local bottled water sources, by contrast, exhibited highly variable TDS values, spanning from as low as 6 mg/L to as high as 110 mg/L (SD = 29.07). This variability aligns with earlier findings regarding inadequate regulation and monitoring of local bottling operations. In some instances, values below 20 mg/L indicate nearly demineralized water, which, if consumed exclusively, could contribute to hypoelectrolytic conditions over prolonged periods. Conversely, samples approaching 110 mg/L may reflect insufficient reverse osmosis efficiency or variability in source water, potentially retaining undesirable ions. Such inconsistency not only undermines consumer confidence but may also pose intermittent health risks depending on the mineral profile of each batch.

Household RO units further underscore the importance of maintenance and brand reputation. Branded RO units achieved a mean TDS of 94.46 mg/L, with a wide spread (10–254 mg/L, SD = 60.33), suggesting that even branded systems can produce outliers, especially if filters are overdue for replacement or if water source quality fluctuates. In contrast, unnamed household RO systems averaged 77.36 mg/L (28–150 mg/L, SD = 37.08), indicating slightly better central tendency but still considerable variability. The higher standard deviation among branded units may be due to a few poorly maintained units skewing the distribution; regular filter replacement schedules and user awareness of maintenance protocols are crucial.

The finding that 31% of all samples fell below 50 mg/L (i.e., essentially demineralized) is particularly noteworthy. A TDS below 50 mg/L is associated with low mineral content and can lead to adverse health outcomes, including electrolyte imbalance, reduced buffer capacity against acidic load, and potential cardiovascular stress (Nimone et al., 2025). In our dataset, the majority of samples registering such low values came from local bottled and RO-treated sources. This corroborates, who found that populations consuming consistently low-TDS water exhibited higher incidence of mineral-deficiency disorders (Gupta et al., 2016).

Policy implications become evident when juxtaposing these results against regulatory frameworks. While multinational brands comply with WHO guidelines, local producers and household systems lack uniform enforcement. Saini R D, (2017) documented similar regulatory gaps in local bottling industries, leading to significant public health risks. Moreover, argued, the absence of mandatory remineralization protocols in commercial bottling and RO manufacturing standards exacerbates the problem. Implementing mandatory TDS monitoring and remineralization—either via fixed cartridges in RO units or through controlled mineral addition in bottled products—would mitigate the risk of supplying excessively demineralized water.

Several recommendations emerge from this combined analysis. First, centralized regulatory agencies must define and enforce permitted TDS ranges for all bottled and RO-treated water, ideally aligning with WHO’s 50–300 mg/L optimum range. Second, incentivizing the adoption of remineralization technology—such as alkaline cartridges for RO systems—would help maintain mineral content, especially in geographies where baseline groundwater mineral levels are low. Third, local water bodies and municipal authorities should establish low-cost TDS testing centers and mandate quarterly monitoring for licensed bottled water producers; this approach has proven effective in other regions. Finally, public awareness campaigns, leveraging mass media and community workshops, should educate consumers about the importance of balanced TDS levels and proper RO unit maintenance.

In summary, the combined results and discussion highlight critical disparities in TDS consistency across water sources. Multinational bottled brands offer stable, though low-mineral, products, whereas unnamed local brands exhibit dangerously variable profiles. Household RO units, even those branded, remain susceptible to maintenance lapses, resulting in wide variance. The substantial proportion (31%) of water samples below 50 mg/L underscores a public health concern necessitating regulatory action, technology-driven solutions, and consumer education.

CONCLUSION

This study underscores the importance of optimal TDS in drinking water. With 31% of samples below the 50 mg/L threshold, the need for regulation and public education is urgent. Branded and multinational sources fare better, but all require improvements in remineralization and consistency. A multi-stakeholder approach involving government, private players, and citizens is vital.

Future Scope of Study

Further research should focus on designing affordable remineralization systems, conducting longitudinal health studies on low-TDS water, and integrating advanced purification technologies into public water infrastructure.

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