

Temporal Trends of Greywater and Tertiary Effluent Quality: Implications for Urban Reuse

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Abstract

The effective reuse of wastewater is essential in water-stressed urban regions. A longitudinal study was performed over 8 weeks, evaluating raw greywater (GW) and tertiary-treated sewage effluent (TSE), with tap water (Tw) as the control. Weekly samples were obtained from two points: the feed water inlets (INL) and the corresponding storage tanks (STK), and Tw was obtained from the tap in the laboratory. Water quality was assessed using on-site measurements (temperature, pH, EC, and free chlorine) and laboratory measurements (solids, organic content, nutrients, ions, and disinfection indicators).

GW was found to be highly biodegradable, with turbidity averaging 67.68 ± 53.63 NTU, color showing 370 ± 222 Pt-Co, and COD, BOD₅, and TOC values of 122.54 ± 93.1 mg/L, 53.33 ± 25.25 mg/L, and 21.12 ± 7.76 mg/L, respectively. The BOD₅/COD ratio (0.23–0.79) confirmed the presence of biodegradable organic and ammonium-N (2.18 ± 0.81 mg/L). Conversely, TSE presented low organic levels (COD < 40 mg/L, BOD₅ < 8 mg/L) but higher ionic loads, with EC 1685.60 ± 116.54 μ S/cm, sodium 125.07 ± 17.24 mg/L, chloride 274.32 ± 30.01 mg/L, sulfate 268.40 ± 22.72 mg/L, and nitrate 17.87 ± 2.40 mg/L. The residual chlorine content was in the following order: GW>Tw>TSE. More importantly, variations in INL and STK demonstrated that storage conditions influenced water quality, with greater differences in GW solids/organics and slight ionic accumulation in the TSE.

These findings highlight the importance of source-specific treatments: solid and organic matter removal for GW and salinity and nutrient control for TSE. The insights from this study are particularly relevant for arid regions such as Qatar, which relies heavily on desalination for water reuse, and the Netherlands, where circular water management practices support sustainable resource recovery. Both examples highlight the importance of developing adaptive reuse frameworks that consider the local climate, variations in water quality, and long-term soil and ecosystem resilience.

Index Terms

Greywater, Treated Sewage Effluent, Longitudinal Water Quality, Wastewater Reuse, Decentralized Systems