Turning Wastewater into Value: Craft Beer as a Model for Circular Water Reuse

DEMOCRATIA - AQUA - TECHNICA

Daria Ilić[1], Maja Turk Sekulić[2]

[1]*BioSense Institute, University of Novi Sad, Serbia*
[2]*Faculty of Technical Sciences, University of Novi Sad, Serbia*

Water scarcity and climate change are intensifying the need for innovative and sustainable water management strategies. Among these, water reuse has emerged as a practical solution to reduce pressure on conventional freshwater resources. In the Lisbon Metropolitan Area, reclaimed water is increasingly applied across agriculture, urban services, and industrial sectors. A particularly innovative example is its application in the brewing industry, where advanced treatment of wastewater has enabled the production of high-quality water suitable for beer brewing [1]. This proof-of-concept, exemplified by the VIRA Beer project, demonstrates not only the technical feasibility of safe reuse in food and beverage production but also highlights the potential of reclaimed water to engage the public, promote circular economy principles, and reshape perceptions of water sustainability

Introduction

Water reuse has become a key strategy in addressing global challenges of scarcity and climate change. Although properly treated reclaimed water poses negligible health risks, public acceptance often lags behind technological progress. Studies show that while there is hesitation toward direct consumption, people are more open to reuse for irrigation, street cleaning, or industrial applications. Awareness campaigns emphasizing drought resilience and sustainability can significantly improve acceptance.

In Lisbon, water reuse is already recognized as a natural component of urban water management. The city relies on distant reservoirs and overexploited aquifers, which has driven investment in efficiency measures and alternative sources. Between 2014 and 2018, potable water demand was reduced by 50% through leakage control and improved efficiency. A strategic plan for 2020–2025 further strengthens reuse initiatives, aiming to deliver 1.6 million m³ of reclaimed water annually through 55 km of pipelines, 13 storage tanks, and 19 pumping stations. Public perception is also shifting, with 41% of residents considering potable reuse feasible in the near future, and 10% convinced it is already being practiced.

This context creates a strong foundation for exploring reclaimed water applications in the brewing industry, where pilot projects in Lisbon, such as the production of beer from treated wastewater, demonstrate both technical feasibility and the potential to reshape public attitudes toward circular water use.

Water Reuse in the Beverage Industry: VIRA Beer

A notable proof-of-concept project in Lisbon demonstrates this approach [2]: VIRA Beer, an artisanal craft beer brewed using *água+* from the Beirolas WWTP. The reclaimed water underwent complementary treatment, including ozonation, reverse osmosis, and continuous monitoring, ensuring potable-quality safety. This project, awarded the Water Reuse Europe Innovation

Prize 2021, highlights both the technical feasibility of using reclaimed water in food and beverage production and the potential for breweries to co-locate with wastewater treatment plants, promoting circular water management.

Table 1. *Essential Parameters of Treated Water for Potable Reuse.*

Parameter	UF (before O3)	O3 (after advanced treatment)	Comment / Relevance
Pharmaceuticals (PhCs, µg/L)	0.01–3.83	< LOQ	Below detection, safe for craft beer
PFAS (ng/L)	0.31–6.0	< 0.30	Below LOQ, no risk from persistent chemicals
THMs (µg/L)	0.76–8.63	1.60	Far below EU limits
HAAs (µg/L)	2.60	< 1.0	By-products of disinfection minimal
NDMA (ng/L)	2.61	1.26	Below guideline values
Turbidity (NTU)	0.12	0.08	Very low, clear water
Transmittance (%)	70	99	High optical clarity
TOC (mg/L)	4.99	0.24	Low organic carbon
EC (mS/cm)	1.078	0.014	Low salinity, neutral for beer
pH	6.9	5.1	Slightly acidic after O3, still safe
Nitrate (mg NO_3/L)	28.47	2.74	Reduced, safe for consumption
Ammonium (mg NH_4/L)	1.29	0.07	Removed, safe for beverage production
Total Nitrogen (mg N/L)	11.10	0.54	Reduced to safe levels
Total Phosphorus (mg P/L)	3.21	0.02	Minimal nutrients remaining
E. coli (MPN/100 mL)	0	0	Pathogen-free, safe for beer

Pilot-Scale Potable Reuse

The B-WaterSmart project [3] demonstrated the feasibility of producing potable-quality water from municipal wastewater for craft beer production at the Beirolas Water Resource Recovery Facility (WRRF) in Lisbon, Portugal. A pilot unit was installed featuring advanced tertiary treatments, including ultrafiltration (UF), ozonation (O3), biologically active granular activated carbon (BAC) filtration, and reverse osmosis (RO) (Figure 1). Four multi-barrier direct potable reuse (DPR) schemes were tested continuously (24/7) to evaluate operational performance and water quality. All treatment schemes produced water meeting EU and Portuguese drinking water standards, with pathogen indicators absent and levels of PFAS, pharmaceuticals, and disinfection byproducts below quantification limits (Table 1.). The downstream beer production steps, including boiling, acted as additional safety barriers, ensuring safe application in beverage production. Operational monitoring identified UF+Cl2+RO as the most energy-efficient option, while artificial storage buffers and optional final chlorination were recommended for maintaining microbiological stability during storage.

Conclusion

- ✓ **Compliance with safety standards**
- ✓ **Consistent water quality**
- ✓ **Reduced dependency on freshwater sources**
- ✓ **Integration with advanced treatment technologies**
- ✓ **Demonstrated feasibility in beverage industry**

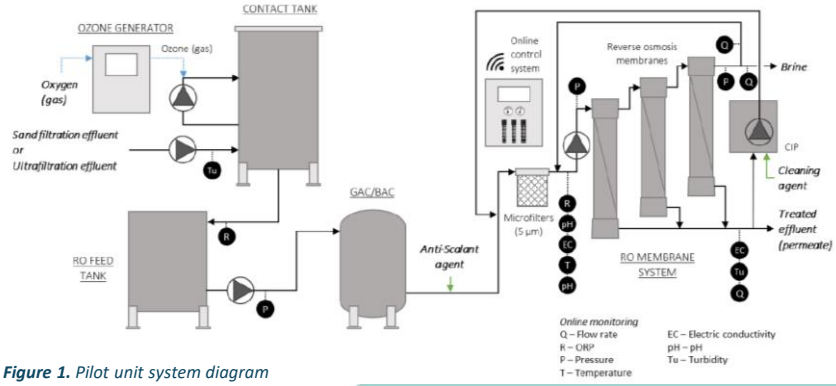

Figure 1. *Pilot unit system diagram*

[1] Cordeiro, S., et al. (2023). *Water Reuse, a Sustainable Alternative in the Context of Water Scarcity and Climate Change in the Lisbon Metropolitan Area*. Sustainability, 15(16), 12578
[2] Viegas, R.M.C., et al. (2025). Pilot-scale demonstration of advanced wastewater treatment for direct potable water reuse for beer production. Separation and Purification Technology.
[3] European Commission. (2024). B-WaterSmart solutions for Lisbon. https://tinyurl.com/3akwxbne

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