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Growth Performance of Hydroponic Crops and Assessment of Potential Food Safety Risks from Light Greywater Use

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Abstract

The EU water reuse regulation (2020/741) identifies a knowledge gap concerning potential human health risks from micropollutant accumulation, including pharmaceuticals, in crops irrigated with reclaimed water. Greywater (GW), particularly from sinks and showers, is considered suitable for reuse due to its lower organic load compared to blackwater (Zraunig et al., 2019). This study examined the fate of pharmaceuticals in light GW reused in a decentralized hydroponic system growing lettuce and mint, focusing on plant growth and human health risk assessment (HHRA). During the low tourist season, light GW was collected from hotel guestroom sinks and showers in Lloret de Mar, Spain. Lettuce and mint were cultivated in hydroponic channels using three water types: 1) control with clean nutrient solution (CTRL); 2) untreated GW; and 3) GW amended with nutrients (GW+). Water was refreshed biweekly; crops were harvested after 4 weeks. Plant growth was evaluated through metrics like relative growth rate and leaf weight ratio (Pérez-Harguindeguy et al., 2013). Sixty pharmaceuticals were analysed via UPLC-QqLIT (Montemurro et al., 2020). HHRA was assessed by comparing estimated daily intake (EDI) with thresholds such as the lowest daily therapeutic dose (Snyder et al., 2010) and the threshold of toxicological concern (Kroes et al., 2004). The study assessed the potential of treated GW to support plant growth and the associated accumulation of pharmaceuticals. While GW alone could support plant growth, it lacked sufficient nutrients, resulting in lower leaf count, dry weight, and leaf area compared to CTRL. Nutrient depletion, specifically total nitrogen and phosphorus, was observed after 3.5 days in the system. Plants grown in GW showed signs of nutrient stress, such as higher root mass and smaller, thicker leaves. However, plants grown in GW+ showed enhanced growth, producing greater dry weight, larger leaves, and higher photosynthetic efficiency than CTRL plants. Pharmaceutical accumulation was also evaluated in edible (leaves/stems) and non-edible (roots) parts of lettuce. Few compounds (e.g., acetaminophen, atenolol, azithromycin, citalopram, metoprolol and its transformation product metoprolol acid, propanol, sotalol, triclosan, trimethoprim) were detected in the roots. Only a few compounds (e.g., levamisole, hydrochlorothiazide, and codeine) were found in edible parts, with levels slightly lower in GW+ than in GW. A HHRA based on EDI of levamisole showed exposure levels far below safety thresholds, suggesting no health risks even with lifelong consumption of such lettuce. This indicates that while GW can be enhanced for better plant growth, pharmaceutical uptake remains minimal and within safe limits. Reusing light GW in hydroponic agriculture did not impair plant health, inducing minor morphological adaptations. Pharmaceutical uptake was minimal, and the detected compounds in edible parts posed no health concern. These findings support the viability of decentralized GW reuse for hydroponic food production and sustainable

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irrigation in tourism-related facilities.

Keywords: Greywater, hydroponics, edible plants, human health risk assessment, pharmaceuticals

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