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RESEARCH

Unlocking the potential of *Euglena gracilis* cultivated in piggery wastewater: biomass production, nutrient removal, and biostimulant potential in lettuce and tomato plants

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Abstract

Microalgae are increasingly recognized as a valuable resource for bolstering sustainability in agriculture. However, current research and patents primarily focus on *Chlorella* spp., *Scenedesmus* spp., and *Spirulina* spp., thus leaving the vast diversity of microalgae relatively unexplored for agricultural applications. *Euglena gracilis* (Euglenophyta) is a microalga renowned for its resilience to diverse environmental stressors and capability to produce a variety of bioactive metabolites. This study investigated the potential of cultivating *E. gracilis* in piggery wastewater for nutrient recycling and as a source of beneficial biomolecules, particularly for biostimulant use. Utilizing raw wastewater diluted to 25% (P25) and pre-treated wastewater with photo-Fenton (PF), the research found that *E. gracilis* exhibited elevated cell density, biomass concentration, and overall cell health in both wastewaters compared to a synthetic medium (BG11-NPK). This was due to its efficient removal of nutrients, especially ammoniacal-nitrogen and phosphate, resulting in a biomass rich in polyunsaturated fatty acids, amino acids, and paramylon content. The whole-cell biomass significantly enhanced the germination index of lettuce and tomato seeds compared to the water control. Additionally, it promoted cell expansion and root formation in cucumber cotyledons, exhibiting similarities to phytohormones such as gibberellin, cytokinin, and auxin. Furthermore, it is suggested that *E. gracilis* biomass contains molecules related to resistance to environmental stresses, particularly in tomatoes, given the enhancement in the seedling vigor index. *E. gracilis* exhibited remarkable adaptability to piggery wastewater, recycling nutrients and yielding biomass rich in bioactive molecules with potential as plant biostimulants. These findings significantly contribute to understanding *E. gracilis*'s potential applications in agriculture and developing a circular bioeconomy.

Keywords Cultivation · Swine effluent · Nutrient recycling · Biochemical composition · Sustainable agriculture

INTRODUCTION

The increase in the global population, projected to surpass 9 billion people by 2050, has been triggering a series of challenges, particularly in agricultural production (Alexandratos and Bruinsma 2012). This raises secondary concerns related to increased water and energy consumption, substantial generation of wastewater and agro-industrial waste, and the intensive use of fertilizers and chemical inputs (Ramírez Mérida and Rodríguez Padrón 2023). There is a global consensus on the urgent need to explore new alternatives for more sustainable agriculture while simultaneously adopting new approaches to wastewater management (Ferreira et al. 2019; Muhie 2022; Mutale-Joan et al. 2022).

Microalgae have garnered significant attention as a promising solution to simultaneously address challenges in

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