Integration of an innovative biological treatment with physical or chemical disinfection for wastewater reuse

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HIGHLIGHTS

• SBBGR system showed high effectiveness in removing TSS, COD and nitrogen.
• Pathogen removal by a compact system may encourage wastewater reuse in agriculture.
• SBBGR system showed disinfection efficiency higher than conventional WWTP.
• E. coli content after biological treatment was only 10^3 MPN/100 mL.
• E. coli concentration after UV or PAA disinfection was less than 10 MPN/100 mL.

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GRAPHICAL ABSTRACT

In the present paper, the effectiveness of a Sequencing Batch Biofilter Granular Reactor (SBBGR) and its integration with different disinfection strategies (UV irradiation, peracetic acid) for producing an effluent suitable for agricultural use was evaluated. The plant treated raw domestic sewage, and its performances were evaluated in terms of the removal efficiency of a wide group of physical, chemical and microbiological parameters. The SBBGR resulted really efficient in removing suspended solids, COD and nitrogen with an average effluent concentration of 5, 32 and 10 mg/L, respectively. Lower removal efficiency was observed for phosphorus with an average concentration in the effluent of 3 mg/L. Plant effluent was also characterized by an average electrical conductivity and sodium adsorption ratio of 680 μS/cm and 2.9, respectively. Therefore, according to these gross parameters, the SBBGR effluent was conformed to the national standards required in Italy for agricultural reuse. Moreover, disinfection performances of the SBBGR was higher than that of conventional municipal wastewater treatment plants and met the quality criteria suggested by WHO (Escherichia coli < 1000 CFU/100 mL) for agricultural reuse. In particular, the biological treatment by SBBGR removed 3.8 ± 0.4 log units of Giardia lamblia, 2.8 ± 0.8 log units of E. coli, 2.5 ± 0.7 log units of total coliforms, 2.0 ± 0.3 log units of Clostridium perfringens, 2.0 ± 0.4 log units of Cryptosporidium parvum and 1.7 ± 0.7 log units of Somatic coliphages. The investigated disinfection processes (UV and peracetic acid) resulted very effective for total coliforms, E. coli and somatic coliphages. In particular, a UV radiation and peracetic acid doses of 40 mJ/cm² and 1 mg/L respectively reduced E. coli content in the effluent below the limit for agricultural reuse in Italy (10 CFU/100 mL). Conversely, they were both ineffective on C. perfringens spores.

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