

Shifts in Aerobic Granular Sludge Bacteriome Driven by Seawater Intrusion in Wastewater

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Abstract

High salinity levels in wastewater treatment plants (WWTPs) can be attributed to multiple sources, including seawater intrusion in wastewater streams. In coastal WWTPs, this phenomenon is becoming more frequent, causing transient salinity shocks on the microbial populations involved in the treatment process. Aerobic granular sludge (AGS) has emerged as a revolutionary technology that has been adopted worldwide for treating several types of wastewater. Much of its success is related to its great tolerance to extreme environments, including high-saline wastewater. In this study, a laboratory-scale AGS reactor was exposed to different salinity stresses over 286 days. First, over 131 days, the seawater content in wastewater was gradually increased in the feeding regime (1.5 – 15 g/L). For the remainder of the operation, the AGS had to deal with daily salinity oscillations, ranging from high (7.5 g/L) to very high (22.5 g/L) seawater levels in wastewater. Throughout the operation, the removal performance of organic carbon, ammonium, and phosphate was consistently effective, despite the daily fluctuations in the seawater content of the wastewater. This was likely ensured by the nutrient removal-related taxa present in the AGS core microbiome, which was highly diverse and resilient to changes in wastewater composition. Over time, enrichment of the core microbiome with halotolerant taxa and extracellular polymeric substance producers proved crucial for maintaining the integrity and stability of the reactor's performance. The findings of this work underscore the flexibility and robustness of AGS communities in thriving under diverse environmental challenges and adapting to sustain AGS reactor performance.

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Keywords

Aerobic granular sludge; Wastewater; Salinity; Seawater Intrusion; Removal performance; Microbiome.