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Use of microalgae for treating municipal wastewater reverse osmosis concentrate and resource recovery

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RESEARCH OBJECTIVE

Management of reject streams generated from reverse osmosis (RO) processes poses one of the major economic and environmental challenges facing the water utilities in the practice of municipal wastewater reclamation. This PhD study was focused on the assessment of the technological feasibility of algal treatment of reverse osmosis concentrate (ROC) and resource recovery in form of algal biomass for biofuel production as a potentially sustainable solution for ROC management.

RESEARCH QUESTIONS

The study sought to consider the following questions:

- How would microalgae species selection affect treatment performance in terms of the removal efficiency of nutrients and organic matter?
- How would the salinity of the ROC affect the treatment performance of the selected microalgae species and biomethane production through the anaerobic digestion of the algal biomass generated in treatment process?

WATER INDUSTRY BENEFITS

This lab-scale study demonstrated that the algal treatment was promising for removing N, P, and organic carbon from municipal wastewater ROC, and bioenergy production via digestion of algal biomass. The knowledge obtained from this work would help water utilities explore and implement opportunities for reducing GHG emissions, lowering treatment costs, and meeting renewable energy requirements, hence facilitating the transition to a circular economy.

FINDINGS TO DATE

The lab-scale tests showed microalgae species *Scenedesmus abundans* could grow well in a typical municipal wastewater ROC and simultaneously remove significant amounts of nutrients and organic matter (TN, up to 18 mg/L/d; TP, up to 8.2 mg/L/d; DOC, up to 12.4 mg/L/d) from it, predominantly through algal uptake within a short period (48 h). The treatment generated up to 360 mg dry cell weight (DCW) L/d of algal biomass. Direct digestion of the harvested algal biomass resulted in the production of up to 422 mL CH_4/g volatile solids, suggesting the addition of the un-pretreated biomass to anaerobic sludge digestion could lead to high energy production.

This study shows the high capacity of algal system for continuous treatment of the ROC stream despite fluctuations in salinity of influent. Optimising the application of algal-based treatment for treating ROC, specifically for ROC streams with high salt contents that conventional treatment

technologies often fail to effectively treat, offers a potential opportunity for advanced nutrient and organic matter remediation.

Table 1 Average TN, TP, and DOC concentration per cycle for 30 days semi-continuous treatment of ROC at TDS of 5 g/L (pH 8). Mean ± SD, n = 3.

Parameter	Raw ROC (mg/L)	Avg. concentration after 48 h treatment (mg/L)
DOC	65.2 ± 2.8	38.7 ± 0.1
TN	61.8 ± 1.4	23.7 ± 0.1
TP	20.3 ± 0.4	2.6 ± 0.0