Exploring the Bioremediation Potential of Green Macroalgae (Chaetomorpha crassa) for Sustainable Nitrogen Removal and Bioplastic Production in a Closed Seawater Recirculating Aquaculture System

Wilasinee Kotcharoen*[1], Tapanee Chuenkaek[1], Shinnosuke Yoshizawa[1], H.a.o. Wang[1], Naoki Wada[1], Yoshinori Takahashi[2], Kenji Takahashi[1], and Yutaka Takeuchi†[1]

[1]Kanazawa University – Japan
[2]Central Research Institute, Maruha Nichiro Corporation – Japan

Abstract

Growing demand for sustainable aquaculture and ecofriendly materials has spurred interest in algae-based solutions. This study examines the bioremediation potential of *Chaetomorpha crassa* for nitrogen removal in a closed seawater recirculating aquaculture system (RAS) and its feasibility for biomass plastic production. A lab-scale RAS was operated for 28 days with Nile tilapia (*Oreochromis niloticus*) at 35-ppt salinity and ambient temperatures (16∘C–26∘C) under natural illumination. A nitrification downflow hanging sponge reactor maintained total ammonia nitogen levels at < 0.2 mg/L. Over 14 days, nitrate nitrogen (NO3—N) levels increased from 0 to 17.1 mg-N/L. On day 14, 225 g of *C. crassa* was introduced, resulting in a rapid NO3– concentration decrease to 0.6 mg-N/L by day 23. The macroalgae grew steadily, reaching 300 g by day 28, with a 2% daily relative growth rate and a 0.8-mg-N/g/day NO3– uptake rate. Fish grew at 1% per day. *Chaetomorpha crassa* was also assessed for biomass plastic production, yielding 26.43% polysaccharides. Polymeric films and filaments, synthesized via a crosslinking reaction, demonstrated potential as biodegradable plastic alternatives. This study highlights *C. crassa*'s dual role in aquaculture: improving water quality while providing a sustainable source material for biodegradable plastics. This material's application in biofilters, fishery equipment, and packaging materials offers an innovative solution to plastic pollution, supporting circular bioeconomy principles in the seafood and marine industries.

Keywords: Nitrogen removal, Biomass plastics, Macroalgae, Polysaccharides, Nile tilapia

*Speaker
†Corresponding author: yutaka@se.kanazawa-u.ac.jp