World Academy of Science, Engineering and Technology
International Journal of Animal and Veterinary Sciences
Vol:16, No:11, 2022

Hydrodynamics of Periphyton Biofilters in Recirculating Aquaculture

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Abstract : Integrated Multi-Trophic Aquaculture systems (IMTA) have the potential to improve the sustainability of seafood production, generate organic fertilizer and feed, remove waste discharges and reduce energy use. IMTA can include periphyton biofilters where algae and microbes grow on surfaces, along with caught detritus and amphipods. Periphyton biofilters provide many advantages: nitrification, denitrification, primary production and ecological diversity. The goal of this study was to determine how biofilter hydraulic residence time (τ) effects periphyton biomass production, dissolved oxygen (DO) and nutrient removal. A pilot scale recirculating aquaculture system (RAS) was designed, constructed and operated at different hydraulic residence times (τ= 1, 2, 4, 6, 8 hours per tank). For each τ, a conservative tracer study was conducted to investigate system hydrodynamics. Data on periphyton weights, pH, nitrogen species, phosphorus, temperature and DO were collected. The tracer study for τ =1 hour revealed that the normalized time < τ, indicating short-circuiting. Periphyton biomass production rate was relatively unaffected by τ (R_e<1 for all τ). Average ammonia nitrogen removal was > 75% for all trials. Nitrate and nitrite did not accumulate in the RAS for τ≥4 hours due to enhanced denitrification in anoxic zones. For τ≥4 hours DO concentration was at a maximum of 4 mg L-1 after 14:00, and decreased to 0 mg L-1 during nighttime. At τ=1 hour, the RAS stayed > 2 mg L-1 and DO was more evenly distributed. For the validation trial, the culture tank was stocked with Centropomus undecimalis (common snook) and the system was operated at τ= 1 hr. Preliminary results showed that a RAS with an integrated periphyton biofilter could support fish health with low nutrient concentrations DO > 6 mg L-1.

Keywords : sustainable aquaculture, resource recovery, nitrogen, microalgae, hydrodynamics, integrated multi-trophic aquaculture
Conference Title : ICRAS 2022 : International Conference on Recirculating Aquaculture Systems
Conference Location : Tokyo, Japan
Conference Dates : November 10-11, 2022