ABSTRACT

The present study was aimed to develop a mathematical model for a recirculating aquaculture system (RAS) assuming that make up water for maintenance of nitrate-nitrogen concentration in the rearing tank would be added only when its concentration reaches its permissible limit. A mass balance approach is explored for various components of RAS. Five hundred goldfish were reared for a period of 90 days in a rearing tank capacity of 5 m^3 (RT5). The recirculation flow rate was fixed at 29000 L/day. In the study model expressions to predict the concentration of total ammonia nitrogen (TAN), nitrate- nitrogen (NO_3-N), nitrite- nitrogen (NO_2-N), dissolved oxygen (DO) and suspended solids (SS) were calibrated and evaluated. The calibrated model parameters were estimated as k_{TAN} (mg of TAN generated per kg of feed): 20000, M (mortality rate): 0.002 day^{-1}, α (percentage of feed conversion to suspended solids): 23.8, k_{oxy} (mg of oxygen required for fish respiration per kg of feed applied in unit time): 30000, K_{TAN} (mg of TAN produced per kg of feed): 20000, k_b (partial nitrification in the rearing tank): 0.86 and the reaction rate constants, k_1 and k_2: 84.65 day^{-1} and 42.03 day^{-1} respectively. The temperature growth coefficient (T_{GC}) was calculated to be 5.00×10^{-5}. The culture was repeated in the next season for 90 days and developed model expressions were validated. Further, based on the data obtained from RT5, four more hypothetical RASs of rearing tank capacities of 10 m^3 (RT10), 20 m^3 (RT20), 50 m^3 (RT50) and 100 m^3 (RT100) were conceptualized and accordingly economic analysis was performed with an aim to assess and compare the effects of culture size on profitability. The economic analysis clearly showed that recirculation system with rearing tank capacity equal to or more than 20 m^3 is commercially feasible. The influences of metal ions, which might have been present in water and fish disease, were not considered in the present study. Therefore, sub-models may be coupled to take care of mineral ions and disease aspect throughout the developed system. Though the model has been developed for goldfish, it may be tested for other freshwater species for its applicability.

Keywords: recirculating aquaculture system, mass balance, model, goldfish, economic analyses.