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Smart Biofilter for Effective Nitrogen Transformation in Aquaponic System with Automation

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Abstract

Aquaponics is a food production system that integrates aquaculture and hydroponics to grow plants that utilize fish waste and fish feed remains in aquaculture water into plant nutrients with the help of nitrifying bacteria. A general aquaponics system consists of a fish rearing tank, a biofilter and a hydroponic system where biofilter plays a crucial role in maintaining water quality by facilitating the growth of beneficial bacteria. Though the aquaponics system is a sustainable agricultural approach, lack of knowledge in implementing and maintenance with the cost are the main constraints in popularizing these systems. Therefore, the present study was aimed at designing and developing an automated aquaponics system with a cost effective smart filter. In this study juvenile stage Tilapia (Oreochromis mossambicus) were used in the aquaculture system while Nutrient Film technique (NFT) was used in the hydroponic system. The biofilter was designed using wire mesh, fiber foam cotton, filter sponge, alternative bio balls and seashells layers respectively along with an aerator. Automation and real time monitoring of the water circulation and biofilter monitoring was done using sensors and Arduino technology. The performance of the biofilter was evaluated measuring the ammonia and nitrate levels of the circulated water by taking samples at three points of the systems, at fish tank, biofilter and at the transit point of the hydroponic system, respectively. The system demonstrated a significant ammonia removal efficiency of 39.89%, effectively reducing toxic ammonia levels where it enabled maintaining ammonia level below 1 ppm. Additionally, the biofilter facilitated the formation of nitrates at a rate of 21.84%, indicating efficient nitrification. This process is beneficial as it converts harmful ammonia into a valuable nutrient. Further the system could maintain the pH level at 6.1-6.9 and Electric conductivity (EC) at 173-190 µS which were always within the acceptable ranges in an aquaponic system. The results indicated that biofilter effectively converted ammonia in aquaculture water. Automated aquaponic unit with the smart biofilter is a novel technological solution, facilitating convenient usage with automated monitoring and management unit which optimizes the production unit for sustainable use of resources.

Keywords: *Automated Aquaponic system, Biofilter, Economical, Nitrogen transformation*

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