Original Research Paper

Volume - 15 | Issue - 07 | July - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Aquatic Biology

WATER QUALITY ASSESSMENT IN FLOATING RAFT AQUAPONICS SYSTEM (FRAS)

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ABSTRACT Water is one of the important component in aquaponics system and it plays a vital role in ensuring effectiveness of working of the system. The present study was conducted to evaluate the quality of water used in the floating raft aquaponics system for 49 days. The experiment was carried out with the control and two treatments (T1= Tilapia, and T2= Rohu) with spinach (Spinacia oleracea) plant. Water temperature, pH, dissolved oxygen, nitrate, nitrite, phosphate and total hardness are among the important water quality parameters. The result showed variations in water quality parameters that existed in both tanks but these were favourable for the survival and growth of the fish. The average water quality parameters including water temperature (25°C, 27°C), pH (7.2, 7.3), dissolved oxygen (5.4 mg/l, 5.3 mg/l), nitrate (0.07 mg/l, 0.09 mg/l), nitrite (0.08 mg/l, 0.10 mg/l), phosphate (0.15 mg/l, 0.07 mg/l) and total hardness (266 mg/l, 240 mg/l) in T_1 and T_2 were observed respectively. Therefore, it could be concluded that the whole system was working properly and there was a perfect symbiosis between fish, microorganisms and plants.

KEYWORDS : Aquaponics, water quality, temperature, nitrate, hardness

INTRODUCTION

Aquaponics is a part of the overall agricultural approach known as integrated agri-aquaculture systems (IAAS) (Gooley and Gavine 2003). Aquaponics is the combination of aquaculture (fish or crustaceans) and hydroponic plant cultivation (hydroponic vegetables, flowers, and herbs) in a re-circulating system, utilizing the nutrients present in the aquaculture effluents to produce plants with commercial value (Ujjania et al., 2021).

Water quality is a very important requirement for aquaculture production to maintain and produce high-quality profitable products which will impact human health. As a result, any water quality change will affect the cultured species' development, growth, reproduction, and even mortality (Barker et al. 2009). Water quality is the most important environmental factor in aquaponics because it has a huge impact on fish health (Ekubo and Abowei, 2011).

Aquaponics fish culture generally requires good water quality conditions which include dissolved oxygen, carbon dioxide, ammonia, nitrate, nitrite and pH levels that are within acceptable species-specific limits (Mancuso, 2013). Many aquaculture operations generally regulate water quality parameters to identify hazards for welfare risk assessment. Regular monitoring and recording of critical water quality parameters are required because sudden changes in fish stocking density, growth rate, feeding rate or water volume changes can affect fish physiology, growth rate and feed efficiency, leading to pathological changes and even mortality under extreme conditions (MacIntrye et al., 2008).

The aquaponics system was developed to conserve water resources by controlling water quality, production schedule and fish products (Endut et al. 2009). Untreated water containing ammonia discharged into the ecosystem could cause eutrophication and other environmental problems (Hu et al. 2015). As a result, aquaponics systems can be used to reduce the effect of inorganic nitrogen accumulation which can be detrimental to fish growth. Ammonia in the aquaponics system is converted into nitrite and nitrate by nitrification bacteria, and nitrate is absorbed by plants as a nutrient (Liang and Chien, 2013). Furthermore, the plant can be considered as a bio-filter for the fish in a symbiotic relationship with mutual benefit by absorbing nutrients from farming waste and reducing ammonia through the nitrification process (Wahyuningsih et al. 2015).

The primary goal of the current study was to determine and compare various water parameters between aquaponics and control systems that might have an impact on fish.

MATERIALS AND METHODS

The study was conducted at the Department of Aquatic Biology (VNSGU), Surat, for 49 days in a rectangular aquaponics tank with dimensions of 26” length, 18” width, and 12” depth. The collected fish was acclimatized and released into an experimental fish tank. Good and healthy fingerlings were selected for the experiment. In “T_1” 16 healthy tilapia fingerlings were stocked, in “T_2” healthy rohu fingerlings were stocked and they were also 16 in number. Similarly, for the present study Spinach (Spinacia oleracea) was selected. Seeds were sowed at the garden of the Department of Aquatic Biology, VNSGU on 1st January 2021. Small-sized plants were grown over a period of 30 days which is very suitable for aquaponics. The plants were transferred to Styrofoam sheets on the same day when fish were stocked in aquaponics tanks.

Water quality parameters are of major concern in hazard identification for the welfare risk assessment of various aquaculture operations hence, aquaponics systems are not distinct from aquaculture. For the welfare of fish in an aquaponics system, water quality is the primary environmental consideration with the potential to markedly affect fish health. Fish exist in intimate contact with the water through the huge surface area of the gills and skin and it is widely acknowledged that fish are vulnerable to inappropriate water quality (Colt and Tomasso, 2002, MacIntrye et al., 2008).

The water quality parameters observed were Water temperature (°C), pH, Dissolved Oxygen (mg/l), Nitrate (mg/l), Nitrite (mg/l), Phosphate (mg/l) and total hardness (mg/l). Water parameters were measured weekly following the standard methods as described by Trivedy and Goel (1986) and APHA (2005).

RESULT AND DISCUSSION

Fish health and production depend on the quality of the water. In Table (1) and Figure (1), the water physicochemical parameters of the control and both treatments are mentioned. According to Bhatnagar et al. (2004), major carp can normally grow at a temperature between 28 and 32°C. Tilapia is usually kept in an aquaponics system at 25.2 to 28.3°C (Nelson, 2008). On the other hand, in the current study, the tank water temperature ranged from 23.70 to 27.0 °C. The neutral or slightly alkaline water is the best for aquaculture and fish productivity (Shah et al., 2022). The water pH was in the 7.20–8.20 range, which is preferred for the growth of nitrifying bacteria, fish, and plants. The optimum range of pH for nitrification is between 7.0 and 9.0. (Chen et al., 2006). According to Ibrahim and Ramzy (2013), Dissolved Oxygen is a key parameter for identifying different water masses. The dissolved oxygen in the water ranged from 4.90 to 5.40 mg/l, which is preferred for the growth of fish, plants, and nitrifiers. Warm water fish require dissolved oxygen concentrations above 5 mg/l for optimal growth (Masser et al., 1999).

Nitrate concentrations ranged from 0.01 to 0.09 mg/l including the control. While ammonia and nitrite-N are highly toxic to fish, nitrate is less toxic and is the most preferred form of nitrogen for higher plant growth (Rakocy et al., 2006). The nitrate concentrations in control and treatments are partially in line with the findings of Stone and Thomforde (2004), who concluded that nitrate is relatively nontoxic to fish and does not pose a threat to health except at extremely high levels (above 90 mg/L). The highly aerobic, gram-negative, chemoautotrophic bacteria found naturally in the system are responsible for the nitrification process, which results in the intermediate product known as nitrite (Lawson, 1995). The range of nitrite values recorded was 0.01 mg/l to 0.13 mg/l. According to Swann (1997), because the conversion rate in aquaponics is quick, the nitrite level was found to be similar to the permissible limits (0.5 mg/L).

The presence of various ions in water, such as nitrate, phosphate, and sodium, that are beneficial to plant growth. The minimum and maximum phosphate value was 0.01 mg/l and 0.15 mg/l in control and treatments. The hardness ranged from 110 to 266 mg/l. Although the observed total hardness values were slightly higher than the recommended values for a fish culture of 75-150 ppm (Bhatnagar and Devi, 2013).

CONCLUSION

It is concluded that variations in water quality parameters that existed in control and treatments but these were favourable for the survival and growth of fish. This new development has mainly been driven forward by researchers and risk-taking entrepreneurs worldwide but commercial-oriented production units are emerging with the participation of industry partners from both the aqua and horticultural sectors.

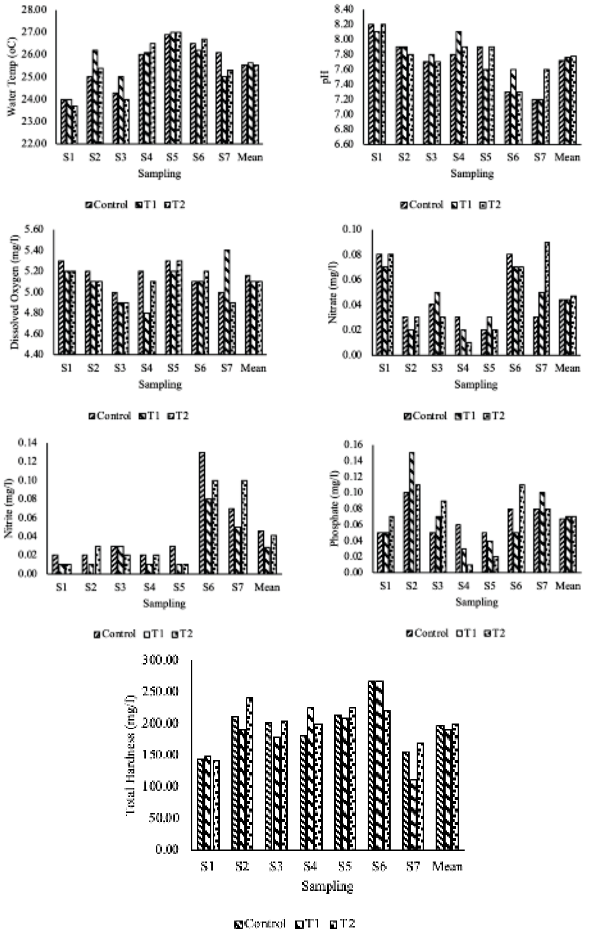

Figure 1: Physical and Chemical parameters of the examined water samples for control and treatments in floating raft aquaponics system

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