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Determination of Water Quality Parameters with Reference to Management of Aquaponics System

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ABSTRACT

The present study is the research components of master's degree program and research set up was fabricated. This research was conducted in 2 treatments that containing rohu and tilapia with tomato plants in10 replications. The important water quality parameters including air temperature, water temperature, pH, dissolved oxygen, electrical conductivity, total hardness, total alkalinity, ammonia, nitrate and nitrite were analyzed and average air temperature (28.7±0.18°C), water temperature (27.1±0.11 and 26.8±0.10°C), pH (7.5±0.03 and 7.5±0.02), dissolved oxygen (5.6±0.05 and 5.6±0.05 mg/l), electrical conductivity (226.3±0.58 and 225.6 ± 0.68 µs/cm^{-1}), total hardness (611.7±3.25 and 608.9±2.66 mg/l), total alkalinity (112.8±0.52 and 111.2±0.58 mg/l), ammonia (0.002±0.0001 and 0.001±0.0001 mg/l), nitrate (0.06±0.003 and 0.06±0.003 mg/l) and nitrite (0.04±0.002 and 0.05±0.002 mg/l) were noted in T_1 and T_2 respectively during experimental period. The result shows that all water quality parameters in both treatments were existed within the permissible for aquaculture except total hardness. On the basis of these result it also concluded that aquatic environment of developed aquaponic system was favorable for the fish survival and plant growth.

Keywords Aquaponics system, Water quality parameters, Rohu, Tilapia, Tomato.

INTRODUCTION

Since ancient the culture system is existed for food production and interest has been raised in integrated aquaculture systems along with increasing efforts to promote sustainable agriculture (Langdon *et al.* 2004). Aquaculture is the potential and most important to improve the food and nutrition status for human beings and contribute the economic components at all levels from household to national level (Filipski and Belton 2018). An integrated method that combines aquaculture and agriculture activities in available water and land. However, due to overuses of water resources these are decreasing day by day and resulting in water shortages (NFDB 2009). Furthermore, aquaculture practices large amount of water is required and it helps to increase the nutrition level of natural aquatic ecosystems by releasing aquaculture wastes in these circumstances aquaponics could be viable option to save land and water (Taufik 2012). Aquaponics is the combination

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Table 1. Water quality parameters in both treatments during the study. *Shah (2010), **Stone *et al.* (2013), ***Bhatnagar and Devi (2013).

		Observed values								
			T_1				T_2			Optimum
Parameters	Unit	Min	Max	Mean	SE	Min	Max	Mean	SE	values
Air temp	(°C)	25.3	29.8	28.7	0.18	25.3	29.8	28.7	0.18	-
Water temp	(°C)	25.1	29.1	27.1	0.11	24.4	28.2	26.8	0.10	25.0-32.0*
pH	-	7.1	8.1	7.5	0.03	7.1	7.9	7.5	0.02	6.5-8.4*
Dissolved oxygen	(mg/l)	5.1	6.8	5.6	0.05	5.2	6.8	5.6	0.05	5.0.-10.0*
Electrical conductivity	(µS/cm^{-1})	215.0	236.0	226.3	0.58	205.0	236.0	225.6	0.68	205.0**
Total hardness	(mg/l)	550.0	664.0	611.7	3.25	568.0	648.0	608.9	2.66	30.0-180.0***
Total alkalinity	(mg/l)	104.0	124.0	112.8	0.52	102.0	120.0	111.2	0.58	50.0-300.0***
Ammonia	(mg/l)	0.000	0.009	0.002	0.0001	0.000	0.007	0.001	0.0001	0.0-1.0***
Nitrate	(mg/l)	0.02	0.10	0.06	0.003	0.02	0.10	0.06	0.003	0.1-3.0***
Nitrite	(mg/l)	0.02	0.08	0.04	0.002	0.02	0.08	0.05	0.002	0.0-0.5***

of culture systems including aquaculture and plant cultivation in water circulation using the nutrients form aquaculture effluents to survive the plants (Zidni 2013, Yildiz *et al.* 2017, Goddek *et al*. 2019). It is one of the most important and efficient environmentally sustainable farming methods of this century (Somerville *et al.* 2014, Oladimeji *et al.* 2020). Plants may grow in the absence of soil by using natural fertilizers produced by the nitrifying bacteria during the nitrification process. The nutrient-rich fish water is used for plant growth, while the plants serve as biofilters for water purification (Estim and Mustafa 2010). The nitrogenous contents in simple form is converted by plants, fishes and bacteria which help to grow these food components (Rockey 2006, Tyson *et al.* 2011). Similarly, the importance of water quality in aquaponics management was describe by Hasan *et al.* (2017), Setiadi *et al.* (2018), Osman *et al.* (2021).

Fish survival and plants growth depends on the dissolved nutrients and water quality. Therefore, the aim of the present study is to determine the water quality in aquaponics system to better grow the fishes and plants.

MATERIALS AND METHODS

The study was carried outin circular fiber tanks (400 liters)for 60 days at the aquaponics unit at Department of Aquaculture, College of fisheries (MPUAT), Udaipur. For the research work conducted in 2 groups considered as T_1 and T_2 and were stocked by 10 specimens (finger lings) of *Labeo rohita* and *Oreochromis mossambicus* in 10 replications respectively. Similarly, these tanks were planted by 10 numbers of tomato (*Solanum lycopersicum*) plants by raft system.

The water samples were collected at 7 day interval to determine the important water quality parameters including air temperature, water temperature, pH, dissolved oxygen, electrical conductivity, total hardness, total alkalinity, ammonia, nitrate and nitrite to follow the standard method of APHA (2005).

RESULTS AND DISCUSSION

The living components specially fishes are the aquatic animal that highly dependent on the aquatic environment and external climate. Fish perform all biological functions in water because it totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance and reproduce, so maintain the optimum physico-chemical quality of water is essential for successful aqua-farming.

The temperature is the single most important fac-

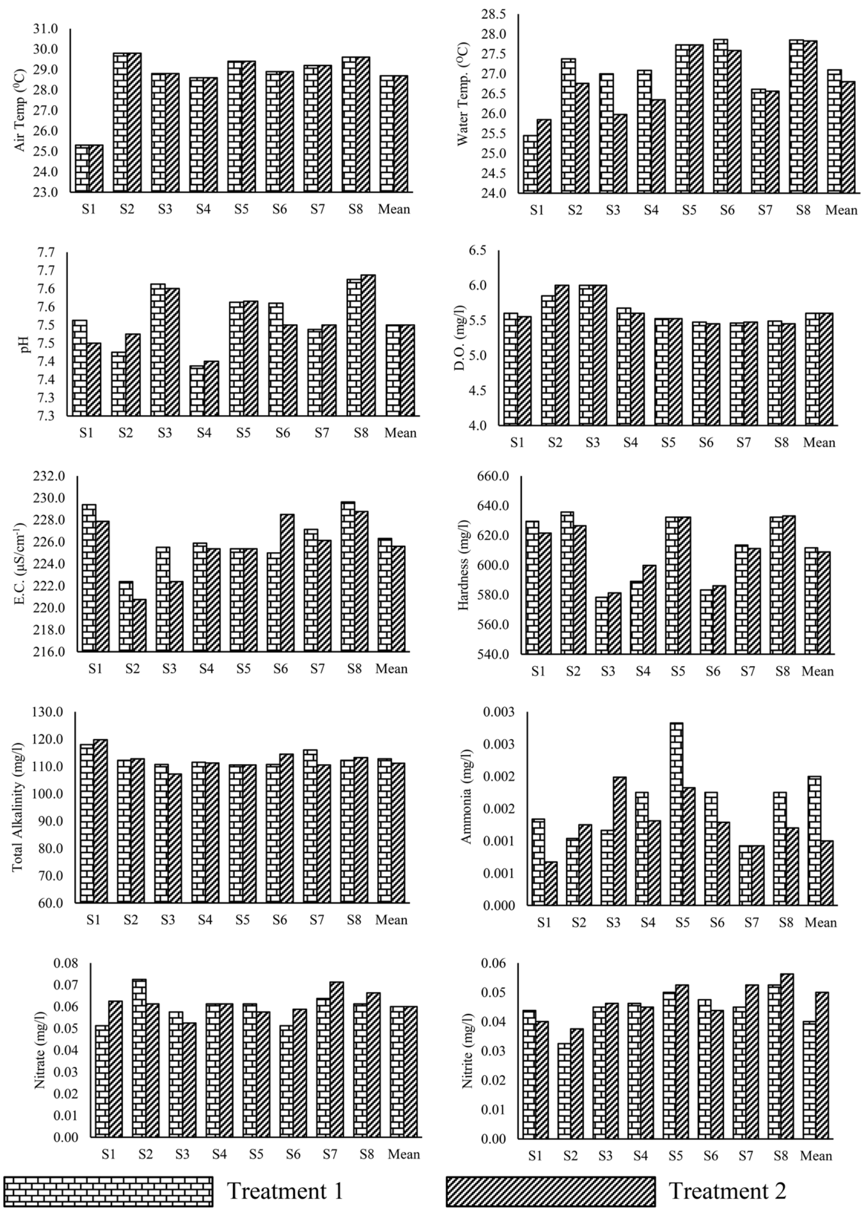

Fig. 1. Important physico-chemical parameters in different treatments of aquaponics system.

tor which affect the welfare of fish because behavior, feeding, growth, metabolic rates and reproduction of all fishes are depend on temperature. In present study, the average air temperature 27.1±0.11°C and 26.8±0.10°C was noted in T_1 and for T_2 respectively (Table 1 and Fig. 1). The observed range of temperature is suitable for fishes because it was within the range of optimum temperature (28 - 32 °C) for aquacultural practices (Bhatnagar *et al.* 2004), Nelson (2008) were also reported suitable range of temperature 25.2 to 28.3°C for tilapia in aquaponics system.

The chemical and biological properties of aquatic habitat is affected by the pH so its determination is very important and in T_1, T_2 of aquaponics system it was observed 7.5±0.03 and 7.5±0.02 respectively (Table 1 and Fig. 1) which shows that during the study the water of the aquaponics tanks was little alkaline and suitable for fish survive. Santhosh and Singh (2007) reported suitable range of pH for fish culture is between 6.7 and 9.5 and Chen *et al.* (2006) also stated that the range of pH (7.0 – 9.0) is optimum for nitrification and help to release the nitrogenous nutrients from the fish waste.

The dissolved oxygen in the aquatic environment affects the growth, survival, distribution, behavior and physiology of the aquatic organisms (Solis 1988). The average dissolved oxygen was found 5.6±0.05 mg/l in both treatments T_1 and T_2 (Table 1 and Fig. 1) which was within the optimum level and suitable for fish growth. According to Sallenave (2016), DO level in aquaponic systems depends the fish species and it should be kept at or above 5 ppm. Similarly, Bhatnagar and Singh (2010), Bhatnagar *et al.* (2004) suggested that DO level >5ppm is essential to support good fish production.

The conductivity of aquatic resource is depends on the ionic concentration, temperature and variations of dissolved solids. It is an index of the total ionic content of water and indicates freshness of water (Ogbeibu and Victor 1995) which can be used as indicator of primary production (chemical richness) and thus fish production. In the present research, it was observed 226.3±0.58 µS/cm^{-1} inT_1 and 225.6±0.68 µs/cm^{-1} for T_2 (Table 1 and Fig. 1). The observed conductivity was compared with prescribed limit of conductivity by Bhatnagar and Devi (2013) and found suitable for fish farming. Stone and Thomforde (2004) also reported that 100 to 2000 µ S/cm^{-1} electrical conductivity contain water is suitable for fish growth.

Hardness is predominantly caused by divalent cations such as calcium, magnesium which are essential components for metabolic reactions such as bone and scale formation in the fish. Total hardness for present work was 611.7±3.25 mg/l and 608.9±2.66 mg/l in T_1 and T_2 respectively (Table 1 and Fig. 1). Although the observed values of total hardness was much high than the recommended values 75–150 ppm (Bhatnagar *et al*. 2004) for fish culture.

Alkalinity is ability of water to resist changes in pH and is a measure of the total concentration of bases including carbonates, bicarbonates, hydroxides, phosphates and borates in pond water. Average total alkalinity was 112.8±0.52 mg/l in T_1 and in T_2 it is 111.2±0.58 mg/l (Table 1 and Fig. 1) and recommended range of total alkalinity for aquaculture is 80–200 ppm (Bhatnagar *et al.* 2004) which shows that total alkalinity was in favor and suitable for fish growth. It is also reported that total alkalinity in the water exceeds 300 mg/l has no negative effects on the fish (Buttner *et al.* 1993).

Ammonia is the by-product from excreta of fish and decomposition of organic matter such as excess feed, excreta, planktons. The mean values of Ammonia (0.002±0.0001 mg/l and 0.001±0.0001 mg/l) was observed in T_1 and T_2 respectively (Table 1 and Fig. 1) which is much lesser than the recommended values 1.00 mg/l (Nijh of and Bovendeur 1990) and 0.17–3.87 mg/l (Caldini *et al.* 2015) for aquaculture production which shows that the water of aquaponics system during the present study is nontoxic and safe for the fish survival.

Nitrite is an intermediate product of the aerobic nitrification and are toxic to the fish whereas the nitrate is harmless and is the product of autotrophic bacteria. In present study, the nitrate (0.06±0.003 mg/l) was observed in both the treatments while nitrite (0.04±0.002 mg/l and 0.05±0.002 mg/l) were observed in T_1 and T_2 respectively (Table 1 and Fig. 1). Despite the fact that nitrite is highly toxic and nitrate is a less lethal for fishes but it is suggested for better plant growth (Rakocy *et al.* 2006). The findings of present study is very less than the lethal limit and recommended by Bhatnagar *et al.* (2004), Santhosh and Singh (2007).

CONCLUSION

The findings of the present study on water quality parameters in both treatments of aquaponics system was noted optimum and it can be concluded that the aquatic environment of aquaponics system is conducive and favorable for fish and plants growth. It also can be concluded that the growing environment of an aquaponic system is favorable for bacteria for nitrification and nitrification process that help to produces the nutrients for plant growth.

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