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Study of certain physico-chemical water quality parameters of different commercial RAS systems culturing *Pangasius pangasius* located in Varanasi District, Uttar Pradesh

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Abstract
In freshwater RAS fish farming, water conditions are crucial and must be taken into account for sustained output. According to APHA (2017) regular operating procedures, assessments of the water quality parameters at three distinct freshwater RAS fish farms in the Varanasi district were made (2017). Temperature of the water is between 25.6 and 26.0 °C, dissolved oxygen concentration is between 6.22 and 7.8 mg/l, total alkalinity is between 136 and 142 mg/l, and total dissolved solids is between 229.72 and 313.67 mg/l. The Varanasi district's recorded water parameter values fall within the optimum suggested limits, indicating a very high potential for the establishment of sustainable freshwater fish farming in the area.

Keywords: RAS, water qualities, pangas

1. Introduction

Aquaculture has become the most promising sector playing a crucial role in global food production. It is the fastest growing component of agriculture sector. At present, the world's greatest challenges are to feed more than 9 billion people by 2050. A total first sale value of USD 401 billion is anticipated for the 179 million tons of fish produced globally in 2018, of which 82 million tons-worth USD 250 billion-were produced through aquaculture. Human consumption accounted for 156 million tons of the total, or 20.5 kg per person annually. 46 percent of the overall production and 52 percent of the fish used for human consumption were produced by aquaculture. (FAO, SOFIA, 2020) [12].

A species of catfish belonging to the family Pangasiidae in the Siluriform phylum is called *Pangasius pangasius*. One of the most significant and significant interior fisheries in the world, the Mekong River fishery, includes it as one of its key fish species. Its prolific spawning behavior, which results in relatively large numbers of larvae that are easily harvested from flowing rivers, is probably where the traditional development of capture-based aquaculture for this species began, particularly in Vietnam and to a lesser extent in Thailand and Cambodia.

Recirculatory Aquaculture Systems (RASs) are land-based aquatic systems that partially or entirely reuse water following mechanical and biological treatment in an effort to decrease water use, energy use, and nutrient release into the environment, preventing eutrophication. When water is scarce, RAS systems are a method for intensive fish production. Using a variety of components, the RAS system enables recycling of 90 to 99 percent of the water. RASs enable the best circumstances for fish production by giving the operator better control over environmental and water quality factors. (Heinen *et al*., 1996) [14].

A recirculating system also has a lot of issues, including low water temperature, low dissolved oxygen, high concentrations of waste metabolites, etc. High or low water temperatures, low DO levels, gas supersaturation, detectable amounts of dissolved ozone, higher waste metabolite concentrations, and the presence of specific cleaning agents or chemotherapeutants in the water can all contribute to the most prevalent water quality issues in RAS. (Twarowska *et al*. 1997) [28].

Water's physical and chemical characteristics have a significant role in its quality, which in turn influences how well it supports the growth and dispersion of fish and other aquatic life (Toma, 2012) [26].

2. Material and Methods
2.1 Site of experiment
The study was carried out at the different sites of commercial RAS situated in Varanasi district (fig 1). The operational freshwater RAS farms of Varanasi district from Uttar Pradesh were selected for the present study. Varanasi district (Fig 1) lies in between 25° 14' and 25° 23.5'N and 82° 56' and 83° 03'E is where the urban agglomeration is situated. The name of the villages where sites were situated are-Site 1-Village Majhwa, Site 2-Village chuppepur and Site 3-Village Khanuuan. There were 8 tanks in each site with capacity of 1 lakh litre. The study duration was of 60 days. Commercial diets were fed @ 8, 7.5, 7 and 6.5% body weight twice daily given in morning and evening. The diet was divided equally between the two feeding. Observations of certain water quality parameters were taken at fortnightly interval.

Fig 1: Map showing Varanasi district

2.2 Water quality parameters
During the research period, the water quality parameters of each unit, including temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solids, and total alkalinity, were measured every two weeks using the techniques described by APHA (2017) [1] and Boyd (2016). (1990). 500 ml plastic bottles were used to collect the water sample from research units in the Varanasi area. Water parameters were immediately assessed at the sampling location once the samples were collected and estimate total alkalinity using a water parameter analysis kit, but record the average values for the dissolved oxygen (DO) meter sensor that is dipped directly into the water. A digital pH meter was used to assess the water quality parameters as pH, mercury thermometer used to record the temperature (Zafar *et al*., 2015) [30].

3. Results and Discussion
Temperature, pH, oxygen, TDS, alkalinity, and other water quality factors, as well as their concentration levels, are important water quality parameters in a recirculating culture system (Cristea *et al*., 2002) [10]. The quality of water that supports the effective development and production of the desired organisms is referred to as water quality for aquaculture. The life, development, and output of commercial aquaculture species depend on maintaining acceptable water quality (Zafar *et al*., 2015) [30]. ANOVA was used to analyze the water quality characteristics of the samples and report the results in Table 1. Therefore, the findings of this research are mentioned in Table 1.

Table 1: Result of the certain physico-chemical parameters

Parameters	Site 1	Site 2	Site 3
Air temp. (°C)	(22.6-30.4) (28.70 ± 0.179)		
Water temp. (°C)	25.7±0.05	25.6±0.025	26.1±0.01
Electrical conductivity (mS/cm^{-1})	0.63±0.06	0.65±0.03	0.65±0.04
Total alkalinity (mg/l)	136.03±0.75	141.03±0.02	142.92±0.05
pH	7.3±0.7	7.6±0.2	7.8±0.4
Dissolved oxygen (mg/l)	6.22±0.05	7.02±0.05	7.15±0.5
TDS (mg/l)	229.72±0.005	313.67±0.05	241.1±0.1

According to ideal temperature needed for fish culture in a recirculating aquaculture system is between 21 and 27 °C. The observed temperature ranges 25.7 to 27.4 °C (Table 2) during the present study falls within the recommendation of many researchers. The ambient temperature changed during the course of this time due to seasonal fluctuations. Maintaining the ideal temperature promotes quicker development, better feed conversion, and enhanced disease resistance. Our study's findings concur with those made public earlier by Jagadeesh *et al*. (2007), who discovered that fish grow and survive best at temperatures between 25.4 and 26.9 °C. Bregnballe (2015) [7] proposed that the intake water of a recirculating aquaculture system raise the temperature of the water (RAS). There is a connection between eating and temperature, but only to a certain extent.

The metabolism and other physiological systems are impacted by pH variation (Sott and Sloman, 2004). In RAS, a pH of 7-8 is optimum for fish growth, according to Bocioc *et al*. (1998). pH can also have an influence on fish health. Determined that the pH range of 6.9 to 7.8 is suitable for fish production in RAS. In contrast to Shnel *et al*. prior study (2002) [23], when the pH value was tested between 6.1 and 7.6, the results of the current investigation were different. During the research period, Site 3 had the highest pH value (7.8) while Site 1 had the lowest (7.37). Therefore, a high rate of bacterial nitrification requires a pH greater than 7 (Bregnballe 2015) [7]. According to Santhosh and Singh's (2007) research, pond water should have a pH between 7.5 and 8.5 in order to support fish growth. If the pH is outside of this range, the fish experience stress. The pH of the water samples taken from several freshwater RAS farm locations in Varanasi area ranges from 7.3 to 7.8, which is within the researchers' recommended range. According to, the ideal pH range for fish culture is between 7 and 8.5.

Dissolved oxygen in water is a critical element for fisheries. Aquatic species must breathe in order to survive. Variable aeration and water exchange rates cause the concentration of dissolved oxygen to fluctuate during the experimental period. A large organic matter load may significantly lower the DO levels as well (Yeole and Patil, 2005) [29]. According to usual DO concentration for fish culture is 5.9 mg/l and the findings of the current investigation are consistent with their findings. According to Banerjee, dissolved oxygen concentrations below 5 mg/l are linked to unproductivity whereas concentrations above that level are linked to productivity (1967). It has commonly been advised to use DO levels higher than 5 mg L-l for intense cultivation methods. Similar to these results, DO between 6.22 to 7.15 mg/l (Table 2) was found at several RAS units in the Varanasi area, which is also within the same range as Ridha and Cruz (2001) [21]. According to Ridha and Cruz, the RAS should have dissolved oxygen concentrations between 5.9 and 6.9 mg L-l for fish to thrive properly (2001). In 2013 research by Jagadeesh *et al*., the dissolved oxygen content ranged from 6.93 to 7.80 mg/l. They said that this range is appropriate and suited for the optimal fish development in RAS.

Alkalinity is a key component of environmental ecology and a measure of water output (Banerjee, 1972) [3]. The total quantity of carbonates, bicarbonates and other ions in water is known as total alkalinity. Water contains both strong and weak bases, such as carbonates, bicarbonates and hydroxide, depending on its quantitative capacity (Karikari, 2013) [17]. Waters that are very alkaline offer a greater buffer against pH shift than fluids that are less alkaline (Losordo *et al*., 1998) [19]. Low buffering capacity and significant pH variations are characteristics of limited alkalinity water, which is characterized as having a total alkalinity of less than 20 mg/l (Tucker, 1982) [27]. A strong buffering capacity can stop excessive CO_2 accumulation and dangerous decreases in pH and alkalinity in recirculating systems, where photosynthesis is almost nonexistent. One of the possible causes of the increase in carbonate and bicarbonate levels and subsequent increase in alkalinity is the breakdown of organic waste (Jain *et al*., 1997; Chaurasia and Pandey, 2007) [16, 8]. In the current investigation, the alkalinity varied from 136.5 to 142.9 mg/l, falling between 30 to 180 mg/l. Fish require a total alkalinity range of 20 to 300 mg/l; anything less than that causes stress, according to Boyd (1982).

According to study by Sinha *et al*. (2013) [25], higher electric conductivity levels are a sign that the water contains more dissolved salts. The lowest value of conductivity was recorded in the Site 1 (0.63mS/cm) while the highest value was obtained in Site 3 (0.65 mS/cm). The electrical conductivity that was measured during the experiment agreed with the results of Zhang *et al*. (2011) [31]. Water samples from three distinct units, electrical conductivity was measured every two weeks, and the results are shown in Tables 1. According to study by Sinha *et al*. (2013) [25], higher electric conductivity levels are a sign that the water contains more dissolved salts. The electrical conductivity that was measured during the experiment agreed with the results of Zhang *et al*. (2011) [31].

Due to the increased organic matter in sand filters and the suppression of the bacterial process in biofilters, solid breakdown can negatively affect water quality, which in turn can affect fish health and the effectiveness of other unit processes in recirculating systems (Chen *et al*., 1993) [9]. Site 2 showed the lowest measurement (229.72 mg/l) and the highest TDS value (313 mg/l) according to Timmons *et al*. (2002). According to Sharma (2000), total dissolved solids have a range of 10 to 500 mg/L, and generally speaking, water hardness increases as TDS levels increase. Fluctuations in the ionic content of water are the primary source of variations in total dissolved solids (Gupta and Paul, 2013). Water exchange caused the ionic content of the water to differ depending on the treatment groups. The experiment's TDS levels confirm Sharma's findings (2000) [22].

4. Conclusion

Water quality factors are crucial for improving freshwater aquaculture productivity. The current study's measurements of the water parameters are within the optimal range of parameters suggested by previous studies, and as a result, they can serve as a standard data input for the water "health cards" for freshwater RAS fish farms in the Varanasi district. The Varanasi district, which has the finest water quality criteria, has a tremendous potential for sustainable growth of freshwater RAS fish farming as well as to improve the standard of living for the local fishing population, according to the study's findings.

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