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COMPARATIVE ASSESSMENT OF WATER QUALITY PARAMETERS OF FRESHWATER TIDAL EARTHEN PONDS AND STAGNANT CONCRETE TANKS FOR FISH PRODUCTION IN PORT HARCOURT, NIGERIA

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ABSTRACT
The cost of and demands for available land for residential and industrial purposes are increasing as the human population is increasing. Water quality is one of most critical factors besides good feed/feeding in fish production and it varies with culture systems or media amongst other factors. Surface water samples were collected from freshwater tidal earthen ponds (TEP) of African Regional Aquaculture Centre (ARAC), Aluu, Port Harcourt and stagnant concrete tanks (SCT) of Roone Fish Farm, Abuloma, Port Harcourt, once a month between March 2007 to August 2007 using standard methods. The samples were collected for some water quality parameters at low tide from the earthen ponds and on days when the water has not been changed from the concrete tanks. Data analyses were done using least significant difference to bring out differences between the two culture media. Total alkalinity was significantly higher in the SCT (68.33 ± 10.43mg /l) than in the TEP (30.50 ± 7.4lmg/l). There were no significant differences in the values of temperature, turbidity, pH, salinity, electrical conductivity (EC), dissolved oxygen (DO) and biological oxygen demand (BOD). The values of ammonia (0.90 ± 0.19mg/l) and phosphates (0.33 ± 0.13mg/l) in SCT were significantly higher than those of TEP (0.48 ± 0.16mg/l and 0.33 ± 0.60mg/l) respectively. The water quality parameters of the two culture media were similar except for alkalinity, ammonia, phosphate and sulphate. The values of ammonia exceeded the permissible limit of FEPA less than 0.01mg/l. Based on the similar water quality parameters of SCT and TEP, fish production in both fish culture media may be similar if change of water in SCT is done every other day. Ammonia level in the SCT can be reduced or eliminated if change of water of is observed daily, and in TEP if industrial effluents are not discharged into the source water.

KEYWORDS: evaluation, water quality parameters, culture media, Port Harcourt.

INTRODUCTION

Water is the culture environment for fish and other aquatic organisms. It is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion (Bronmark and Hansson, 2005). Based on this, access to adequate, regular and constant supply of good quality water is vital in any aquaculture project. According to Sikoki and Veen (2004), any water body is a potential medium for the production of aquatic organisms.

Water quality parameters can be divided into three main categories: physical (density, temperature); chemical (pH, conductivity, nutrients) and biological (bacteria, plankton and parasites) (Delince, 1992 and Moody, 2005). All living organisms have tolerable limits of water quality parameters in which they perform optimally. A sharp drop or an increase within these limits has adverse effects on their body functions (Davenport, 1993).

Fishes are reared in different culture media that can retain water and these are earthen ponds, concrete, plastic, wooden, metal, glass and fibre glass tanks. The recent increase in intensive aquaculture production in Nigeria will require effective water quality management for its success. The tidal freshwater earthen ponds are established to raise fish in areas that witness tidal regions (6 hourly) while concrete tanks are established where the lands are not suitable or there is scarcity of land for earthen ponds (Ezenwa, 2006).

Water quality is one of the most critical factors besides good feed/feeding in fish production. It is not constant; varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration.

Earthen pond culture system has been the conventional method of fish culture in Nigeria but recently, tank culture system is gaining grounds as lands become costly and scarce. There is need to maximize available lands and to have maximum control over the fish farm. The present study contributes to the existing knowledge of water quality parameters of freshwater tidal earthen ponds and stagnant concrete tanks in Port Harcourt. Its objectives were to find out which of the two culture media have better water quality for fish production, and to evaluate the effect of tide on these water quality parameters.

MATERIALS AND METHODS

Study areas

Water samples from freshwater tidal earthen ponds were collected from the African Regional Aquaculture Centre (ARAC), Aluu, Obio-Akpor Local Government Area. The centre has twelve (12) tidal earthen ponds of 20m x 10m x 1.5m in size but only three ponds were in used at the time of this study (Plate 1). The source water in these ponds is the nearby New Calabar River which is under tidal action (6 hourly). There are various human activities (Industrialization, fishing, laundry, etc) going on within and around this river. Change of water on these ponds is 6 hourly.

Water samples from stagnant concrete ponds were collected from Roone Fish Farm. The farm has four (4) concrete tanks of 2.5m x 5m x 1.5m (1), 3m x 3m x 1.5m (1) and 4m x 5m x 1.5m (2) in size (Plate 1). Complete change of water in the tanks is done every other day and source water is borehole.

Plate 1 ARAC tidal earthen ponds

Plate 2 Roone fish farm stagnant concrete tanks

Water sampling duration, collection and measurement
Water samples were collected from the two culture media once in month from March 2007 to August 2007 (6 months) using standard methods (APHA, 1998). They were collected from the tidal earthen ponds during the low tide and from the stagnant concrete tanks when the water has not been changed.

Data Analyses
Statistical Analysis System (SAS) (2003) was used to analyse data for least significant difference (LSD) to compare the water quality parameters of the two culture media.

RESULTS

Physico-chemical water quality parameters of TEP and SCT
Total alkalinity was significantly higher in the SCT (68.33 ± 10.43mg/l) then in the TEP (30.50 ± 7.41mg/l). There were no significant differences in the values of temperature turbidity, pH, salinity, electrical conductivity, (EC) dissolved oxygen (DO) and biological oxygen demand (BOD) in the TEP and SCT.
From Table 1 temperature (28.18 ± 6.63^{0}C) and turbidity (26.75 ± 16.70NTU) in the TEP were higher than those in the SCT (27.19 ± 0.52^{0}C and 26.50 ± 9.85NTU respectively). The PH (6.48 ± 0.13) and BOD (6.66 ± 0.78mg/l) in the SCT were higher than those of TEP (6.18 ± 0.10 and 6.35 ± 0.85mg/l respectively). However, the values of salinity (0.13 ± 0.03‰), EC (444.25 ± 115.15µs/cm and DO (6.33 ± 0.10mg/l) in the TEP were greater than salinity (0.07 ± 0.02 ‰), EC (304.7 ± 49.70µs/cm) and DO (4.34 ± 0.72mg/l) of the SCT.

Surface water nutrients of TEP and SCT
The values of ammonia (0.90 ± 0.19mg/l) and phosphate (0.33 ± 0.13mg/l) in SCT were significantly higher than ammonia (0.48 ± 0.16mg/l) and phosphate (0.33 ± 0.60mg/l) in TEP ($P<0.05$). Sulphate showed a opposite trend; significantly higher in TEP (5.37 ± 1.72mg/l) than in SCT (2.63 ± 0.55mg/l) (Table 2).

DISCUSSION

Alkalinity is the buffering (alkaline) capacity of the water. Waters with high alkalinity are undesirable because of the associated excessive hardness or high concentrations of sodium salts. The reported alkalinity in this present study is within the acceptable range for aquaculture practice (Boyd, 1981). The insignificant difference in the values of temperature, turbidity, pH, salinity, EC, DO and BOD in the TEP and SCT might be attributed to the same climate/weather conditions the two culture media were exposed to. TEP and SCT are located within Port Harcourt. Both culture media are out door fish culture media without shade/roof. Climate and/or weather influences the physico-chemical parameters of water.
The present temperature range is SCT agree with those of Adebayo and Adesoji (2008) reports of 26.2 – 26.5^{0}C for concrete tanks but disagree with that of earthen ponds (26.2^{0}C to 26.5^{0}C). The recorded temperature, turbidity, pH, salinity, EC, DO and BOD in TEP and SCT were within the permissible limit of Federal Environmental Protection Agency (FEPA) for aquaculture practice. The recorded pH (6.96 – 7.15) and DO (6.64mg/l – 6.89mg/l) for earthen ponds and pH (6.92 – 7.15) and DO (6.75mg/l – 6.83mg/l) for concrete tanks as reported by Adebayo and Adesoji (2008) were similar like the observations of the present study. That study reported that the two culture media had the same source water; pond and tank located in the same farm. The source water in TEP is from the New Calabar River. Industries are sited along this River by Aluu, and fishing, bathing and laundry activities are constantly going on. These human activities might possibly be the reason for the insignificant higher temperature and turbidity in TEP than SCT. SCT is free from influence of human activities. The insignificant higher PH in SCT than TEP could be linked with the source water. Source water of SCT is borehole; generally the pH of borehole water in Port Harcourt is acidic (Davies, 2008).
The tidal influence on TEP tends to buffer the pH of water in TEP. Tide introduces oxygen into the water. The possible reason for the insignificant higher BOD in SCT might be frequency of change of water in the tanks (every other day). Left – over feed, fish body wastes and plankton require oxygen for decomposition. BOD was measured on the days when tank water was not changed frequency of change of water in TEP was every six hours. Partial higher salinity and EC in TEP might be attributed to industrial inputs from the surrounding industries on New Calabar River. In the case of observed DO in TEP, tide could be the possible reason.
The high level of ammonia in TEP and SCT could be attributed to nitrogenous industrial effluents in New Calabar River and accumulation of left-over protein-rich feed and fish wastes respectively. Phosphate level in the source water (borehole) of SCT might be the possible reason for the present observation. The Roone Farm is sited on land that was previously used for crop farming. Organic fertilizers (animal droppings and faecal compost) were used by the farmers. Decomposition of these organic matters might be a contributor to the phosphate concentrations in the borehole water. According to Davies (2008), sulphate had positive correlations with EC and salinity. The higher EC and salinity in TEP might be the possible reason for the significant higher sulphate in TEP. However, the recorded sulphate could be linked to anthropogenic inputs from the industries sited along the watercourse of the New Calabar River.

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Table 1. Water quality parameters of tidal earthen ponds and stagnant concrete tanks

	Culture Medium	
Parameter	Tidal Earthen Pond	Stagnant Concrete Tank
Temperature (^oC)	28.18±6.63a	27.19±0.52a
Turbidity (NTU)	26.75±16.70a	26.50±9.85a
DO (mg/l)	6.33±0.10a	4.34±0.72a
pH	6.18±0.10a	6.48±0.13a
BOD (mg/l)	6.35±0.85a	6.66±0.78a
EC (µs/s)	444.25±115.15a	304.7±49.70a
TA (mg/l)	30.50±7.41b	68.33±10.43a
Salinity (‰)	0.13±0.03a	0.070.02a
Ammonia (mg/l)	0.48±0.16b	0.09±0..19a
Phosphorus (mg/l)	0.13±0.60b	0.33±0.13a
Sulphate (mg/l)	5.37±1.72a	2.63±0.55b

Means in a row with the different alphabet are significantly different (P<0.05)

Table 2. This study water quality paameters and FEPA values for aquaculture practice

Water quality parameters	**TEP Range**	**SCT Range**	**FEPA Range**
Temperature ((^oC)	26.50-32.70	24.30-29.40	20-35
Turbidity (NTU)	1.50-99.01	1.50-36.00	1.00-150.00
DO (mg/l)	1.60-7.90	2.0-7.70	>1.00
pH	5.65-6.45	6.05-7.05	5.00-9.00
BOD (mg/l)	1.35-9.75	2.85-9.75	10-20
EC (µs/s)	71.50-985.50	2.85-9.75	20.00-1500.00
TA (mg/l)	14.50-64.00	30.0-104.5	10.0-400
Salinity (‰)	0.00-0.04	0.00-0.05	0.00-0.10
Ammonia (mg/l)	0.02-0.80	0.17-1.84	≤0.01
Phosphate (mg/l)	0.05-0.29	0.06-1.08	0.01-3.0
Sulphate (mg/l)	1.40-8.50	1.45-3.70	1000