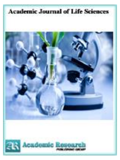

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Some Physico-Chemical Parameters of Plastic Tanks used for Fish Culture in Port Harcourt, Rivers State, Nigeria

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Abstract

Physico-chemistry quality is one of the most important factors besides good feed in plastic culture systems for fish production which varies with location or management amongst other factors. Some physical and chemical parameters in some outdoor plastic tanks used for fish culture in Roone Fish Farm (outdoor farm) and Hallelujah Fish Farms (indoor) in Port Harcourt, Nigeria were studied from October 2018 to September 2019. Some physico- chemical parameters (temperature, pH, electrical conductivity (EC), total dissolved solid (TDS), dissolved oxygen (DO) were measured in-situ while biological oxygen demand (BOD) and total organic carbon (TOC) were analyzed in the laboratory following standard methods. The data obtained were subjected to Tukey's comparison test. The observed results were: temperature (27.22±1.50 ℃), pH (6.79±0.83), TDS (14±58.10 mg/L), EC (25.25±15.20 µs/cm) and TOC (0.17±0.18 mg/L) (P>0.05). The recorded values for the measured parameters were within the acceptable limits for fish culture except for pH and DO that were below the acceptable limits. The study therefore recommends outdoor plastic tanks for fish production.

Keywords: Aquaculture; Outdoor culture; Plastic tanks; Water quality; Nigeria.

1. Introduction

Fish can be raised in any confined medium under the control of the owner [1]. The rearing medium ranges from an estimated size from 500 to 500,000 gallons capacity. These sizes of tanks depend on a variety of factors including; stocking rates, fish species specific, water supply, water quality and management. Fish culture is currently one of the fastest growing sectors of agriculture in the world. Farm-reared fresh fish is increasing in popularity and profitability. Jamu and Ayinla [2], reported the future of aquaculture in Africa lies in the increasing production efficiencies and intensities to produce more fish using less land, water and financial resources.

Plastics tanks represent a unique method to culturing fish in farms. The local method employs in growing fish in an outdoors/indoor system in rearing fish at high densities in a confined and a "controlled" environment [3]. Fish rearing- tanks serves as the entire home for the culture of fish. Fishes are reared in different culture media with different sizes and shapes that can retain water for a long period of time and these include earthen ponds, concrete, plastic, wooden, metal, glass and fiber glass tanks [1].Aquatic life requires the right quality of water to breed and survive. Sule, *et al.* [4], revealed that the quality of water in storage tanks depends on the source and handling of the storage tanks.

Water is the free solvent available in nature for sustenance of life. Aquatic organisms including fish deem physico-chemical parameters essential to carry out life process [5]. The quality of water includes physical, chemical and biological variables which influence the use of water by fish for culture purposes [6]. Abiotic and biotic parameters are used as an indicator for any perturbed aquatic environment [5].Variation in the physico-chemical parameters of the tanks above or below standard values has potential effects on the health and production of fish [7]. Good growth of fish in aquacultural practices depends on the limiting factor of physico-chemical parameters which include dissolved oxygen, pH, turbidity, nutrients, temperature, and water depth among others. Ellis, *et al.* [8], Conte [9] and Hastein [10] reported that poor water quality affects reared fish in aquaculture with regards to chronic stress, reduced condition factor and growth, reduced nutritional status, inability to control homeostasis, increased susceptibility to disease outbreak, injury to fish gill and fins, impairment and mortality.

Physico-chemical parameters determine or assess the water condition whether it is suitable for the support of aquatic live, for migration or death. Davies and Ansa [1], reported that all living organisms have tolerable limits of physico- chemical parameters in which they perform optimally. Thus, a sharp drop or increase within these limits will affect the body functions of an organism [11]. Sipaúba-Tavares, *et al.* [12], revealed that physico-chemical parameters like pH, alkalinity, water hardness and macronutrient concentrations determine which species or group of species thrive in a pond ecosystem.

Studies on water quality parameters of fish culture in plastic tanks include [13, 14] and other culture media include [1, 15-18]. This work therefore assessed the dynamics of some physico-chemical parameters of plastic fish tanks used for fish culture in two fish farms in Port Harcourt, Rivers State, Nigeria.

2. Materials and Methods

2.1. Study area

The study was carried out in Roone Fish Farm (Farm 1) and Hallelujah Fish Farm (Farm 2) in Port Harcourt, Rivers State, Nigeria. The region appears to experience heavy rainfall and short dry season every year. Temperatures throughout the year are relatively constant with slight variation from 25 ℃ – 30 ℃. The fish farms are located between latitudes 4.782^0N and longitudes 7.055^0E (Farm 1) and latitudes 4.839^0 N, longitudes 7.053^0 E (Farm 2). The research was conducted for a period of twelve months (October 2018 to September 2019) using two plastic fish tanks of 3m x 3m x 1.5m: outdoor without roof/shade and indoor/shaded roof tanks. The outdoor without roof/shade in Farm 1 and indoor/shaded roof in Farm 2.

2.2. Water Quality Analysis

Temperature (°C) was measured with a Celsius thermometer. Hydrogen ion concentration (pH), total dissolved solid (TDS), electrical conductivity (EC), and dissolved oxygen (DO) were measured in-situ using an Extech digital multiple water meter (model DO 700) while biological oxygen demand (BOD) was titrated using trimetric (Winkler's) method and total organic carbon was measured by Walkey Black method. A graduated.

2.3. Statistical Analysis

Water quality parameters were subjected to one-way analysis of variance (ANOVA) to test for significant difference at 0.05 level. The statistical analysis was done using Minitab version 16.0. The means were separated using Post hoc test with Turkey's HSD @ 95% probability.

3. Results

3.1. Physico-Chemical Parameters of Plastic Tanks Compared with Standard Values

The measured physico-chemical parameters of the plastic tanks in Farm 1 and farm 2 compared with standard values were presented in Table 1. Temperature (27.22 ℃), pH (6.79) and TDS (14.00 mg/L) in the plastic tank in Farm 1 were within the permissible values of the set standard for fish culture while the EC (23.00 µs/cm), turbidity (16.39 NTU), DO (4.95 mg/L), BOD (2.30 mg/L), depth (1.84 mg/L) and TOC (0.17 mg/L) were below the standard. For Farm 2, temperature (27.17 ℃), TDS (13.08 mg/L) and turbidity (60.36 NTU) in the plastic tank were within the allowable limits of the standard for fish culture while pH (4.36), EC (25.25 µs/cm), DO (4.41 mg/L), BOD (0.85 mg/L), depth (0.88 mg/L) and TOC (0.16 mg/L) were below the standard. However, the values of pH, turbidity, pH, BOD and depth showed significant differences ($p<0.05$) between the two farms while the other parameters revealed no significant difference ($p>0.05$) (Table 1).

Table-1. Physico-chemical parameters of plastic tanks used for fish culture (Mean ±SD)

Parameter	Fish Farm 1	Fish Farm 2	Standard
Temp (℃)	27.22 ± 1.50^a	27.17 ± 1.15^a	< 35 [19]
pH	6.79 ± 0.83^a	4.36 ± 0.91^b	6.0-9.0 [20]; 6.5-8.5 [21]
EC (µs/cm)	23.00 ± 56.55^a	25.25 ± 15.20^a	340-700 [22]
TDS (mg/L)	14.00 ± 58.10^a	13.08 ± 64.71^a	<500 [22]
Turbidity (NTU)	16.39 ± 9.53^b	60.36 ± 28.81^a	25-80 [23]
DO (mg/L)	4.95 ± 3.03^a	4.41 ± 2.10^a	5.0-9.0 [20];6.0 [21]
BOD (mg/L)	2.30 ± 0.97^a	0.85 ± 0.61^b	3.0 [20]; 3.0 NESREA [21]
Depth (m)	1.84 ± 0.40^a	0.88 ± 0.09^b	5-20 [20]
TOC (mg/L)	0.17 ± 0.18^a	0.16 ± 0.08^a	4 [24]

Mean with Different Superscript in the Same Column are Significant (P<0.05)

Keys: Temp-Temperature; pH-Hydrogen ion concentration; EC-Electrical conductivity; TDS-Total dissolved solids; DO-Dissolved oxygen; BOD-Biological oxygen demand; TOC- Total organic carbon

3.2. Variation of Physico-Chemical Parameters of the Plastic Tanks

The variations of temperature in both fish farms indicated similar trend as shown in Figure 1. The observed pH

in Fish Farm 1without shade or roof had higher pH than Fish Farm 2 with shade/roof as shown in Figure 2. Electrical conductivity and total dissolved solids in both outdoor and indoor operation systems indicated similarity in both fish farms as presented in Figure 3.While dissolved oxygen, biological oxygen demand (BOD) and total organic carbon (TOC) were presented in Figure 4.Though, dissolved oxygen and biological dissolved oxygen values were higher in Fish Farm 1 when compared to Fish Farm

2, but total organic carbon in both fish farms had similar patterns with no variations. Comparatively, the values of turbidity in Fish Farm 2 revealed higher margin than Fish Farm 1 (Figure 5). However, the water depth in Fish Farm 1 was higher than the water depth in Fish Farm 2 practiced in indoor system with shade or roof (Figure 6).

3. Discussion

The results of the physico-chemical parameters in the plastic tanks of the two fish farms revealed unpolluted culture system for fish to grow, interact and breed successfully. Temperature is one the most important factor for living organisms. In this study, temperature was considered normal for the growth of aquatic organisms. The insignificant differences in the values of temperature in the plastic tanks in both fish farms could be attributed to the weather conditions within Port Harcourt. The results agreed with the report of Davies and Ansa [1] and Davies, *et al.* [25] that climate and/or weather influence(s) the physico-chemical parameters of man-made culture system within Port Harcourt, Nigeria.

The recorded higher pH values in the outdoor system without shade or roof in Fish Farm 1 than in plastic tank with shade or roof in Fish Farm 2 might be attributed to higher density of photosynthetic phytoplankton in the plastic tank in Fish Farm 1 operated in an outdoor system without shade/roof. Values of pH in plastic tanks operated in an outdoor system without roof/shade in Farm 1 were in agreement with report of the studies of Davies, *et al.* [25] and Valsaraji, *et al.* [26] that recorded high pH values on days of intense photosynthetic activity. The observed low pH values in the plastic tank in Fish Farm 2 below the permissible limit of UNESCO/WHO/UNEP [20], indicated that the water was acidic for fish culture. This could be due to the restricted penetration of solar energy and diffusion of atmospheric oxygen because of the shade over the tank. The result of acidity could also be as a result of routine particles falling into the plastic tank in Fish Farm 2 and long-term change of water. The result also agreed with the findings of Davies [5] who reported water could be more acidic due to the combined effects of reduced sunshine and inflow of humic substances and organic matter.

The electrical conductivity of a water body is regarded as the potential to conduct electricity depending on the concentration of ions and temperature in the water system. The total weight of salts in water is a function of conductivity [27]. According to Verhuest [28], the productivity of water bodies including fishes are sign of conductivity. The result of electrical conductivity in this study was within the recommended standard and in line with the findings of the study of Davies and Ansa [1] that recorded higher values of electrical conductivity in fish culture system indicating productivity of the water body. Thus, the production of fish for aquaculture varies from species to species with the most appropriate conductivity. Furthermore, the result fell between the permissible limit of WHO [22] therefore, it is good for fish production practices.

The recorded significant turbidity, BOD and depth between the two plastic tanks might be attributed to the different locations. The observed values of turbidity were similar to those recorded by Davies, *et al.* [25]. Though, turbidity was higher in plastic tank in Farm 2 operated in an indoor/shade system which could be explained by the particulate matter that fell into the water from routine wood materials used in construction of the farm house. The concentrations of BOD in the plastic tanks in the two fish farms were within permissible limit of 3.0 mg/L [20].The findings agreed with the report from other culture system and standing water bodies in Zaria [29].

The recorded significant depth values in the plastic tanks in this study unveiled an increased water level during rainy period in plastic tank operated in Farm 1 than in the indoor system with roof/shade. It also revealed the impact of climatic temperature over the artificial culture systems. High temperature increases the degree of evaporation and metabolic activities within the cultures systems.

The observed insignificant DO values below the standard of UNESCO/WHO/UNEP [20] and NESREA [21] in the plastic tank in Farm 2 were contrary to the values reported by Davies, *et al.* [25]. TDS is regarded as the total load of dissolved substances in a water body. The observed TDS values below the standard permissible limit of $\leq$ 500 (WHO, 2011) might indicate that TDS in the plastic tanks have fewer particulate substances which could be attributed to rain, atmospheric deposit by wind and supplementary animal feed used by farmers. This report was similar to the findings of Ehigbonare and Ogunrinde [30] that supplementary feed in culture water increases TDS.

The total organic carbon (TOC) is the overall amount dissolved organic carbon compound present in aqueous solution or water bodies. The recorded values of total organic carbon concentrations were within the permissible limit of 4 mg/L for natural water [24]. However, the obtained values of total organic carbon might be linked to standing plant crops around the tanks and on the other hand from the wood particles falling directly into the surface water. This finding was in accordance with the work of Eswaran, *et al.* [31] and Batjes [32] that reported reservoirs act as a sink to total organic carbon in natural and artificial fish culture systems.

4. Conclusion and Recommendation

The physico-chemical parameters were most influenced by the different sample location and management. It can be concluded in this study that the physico-chemical parameters of the plastic tanks in Fish Farm 1 (outdoor Fish Farm) and Fish Farm 2 (indoor Fish Farm) are quite suitable for fish culture in Port Harcourt, Nigeria. Statistically, significant differences were also observed between the plastic tanks and farms. Based on the foregoing, it is clear that plastic tanks operated in an outdoor system without shade or roof is a factor in fish production and is best recommended.

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Figure-1. Variation of temperature of the plastic tanks used for fish culture

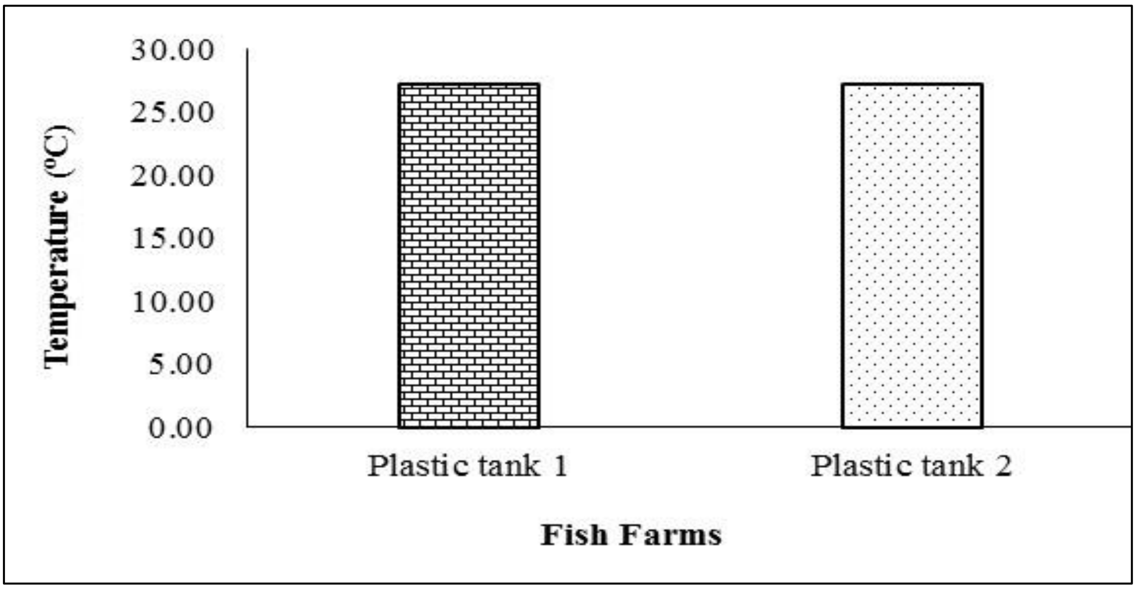

Figure-2. Variation of pH in the plastic tanks used for fish culture

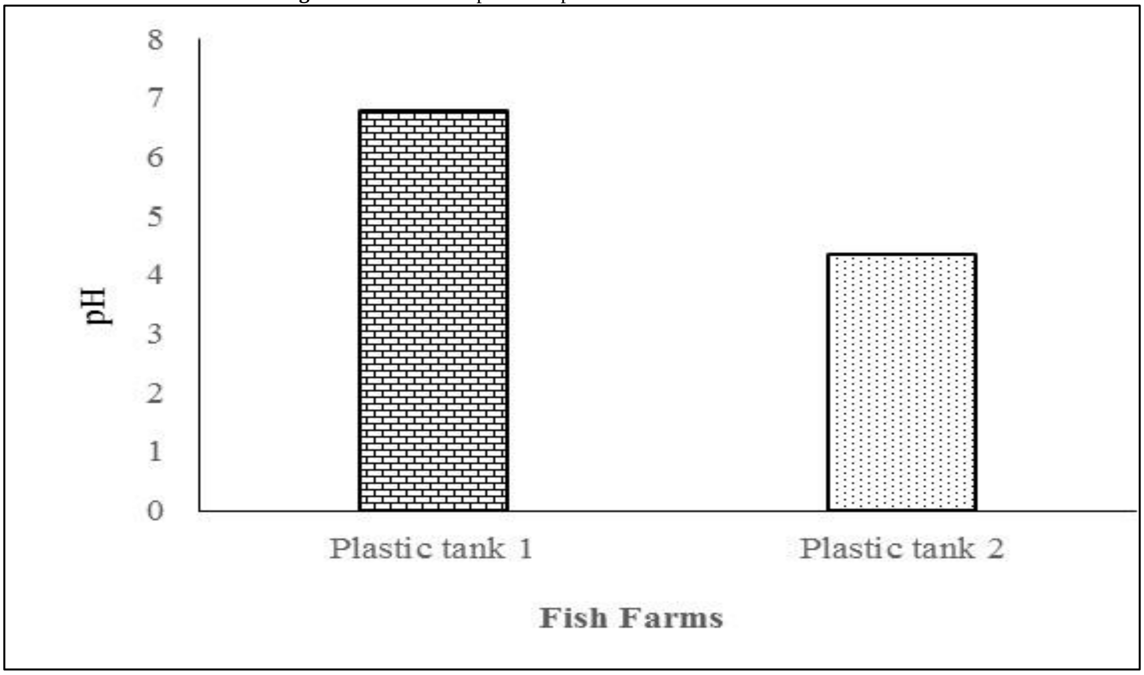

Figure-3. Variations of electrical conductivity and total dissolved solid in the plastic tanks used for fish

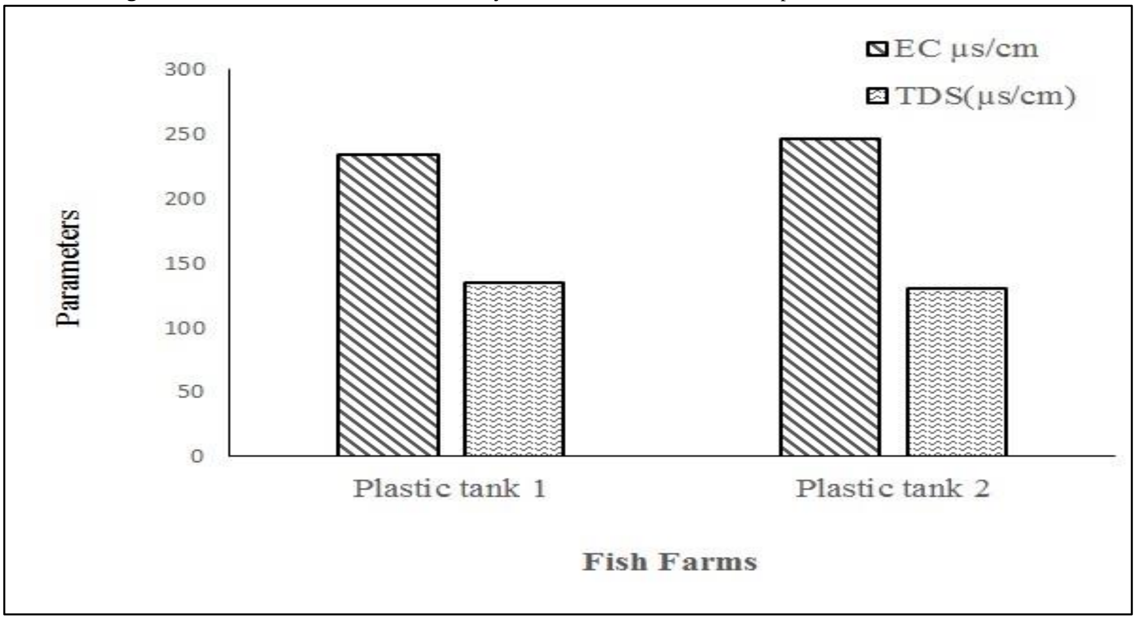

Figure-4. Variations of DO, BOD and TOC in the plastic tanks used for fish culture

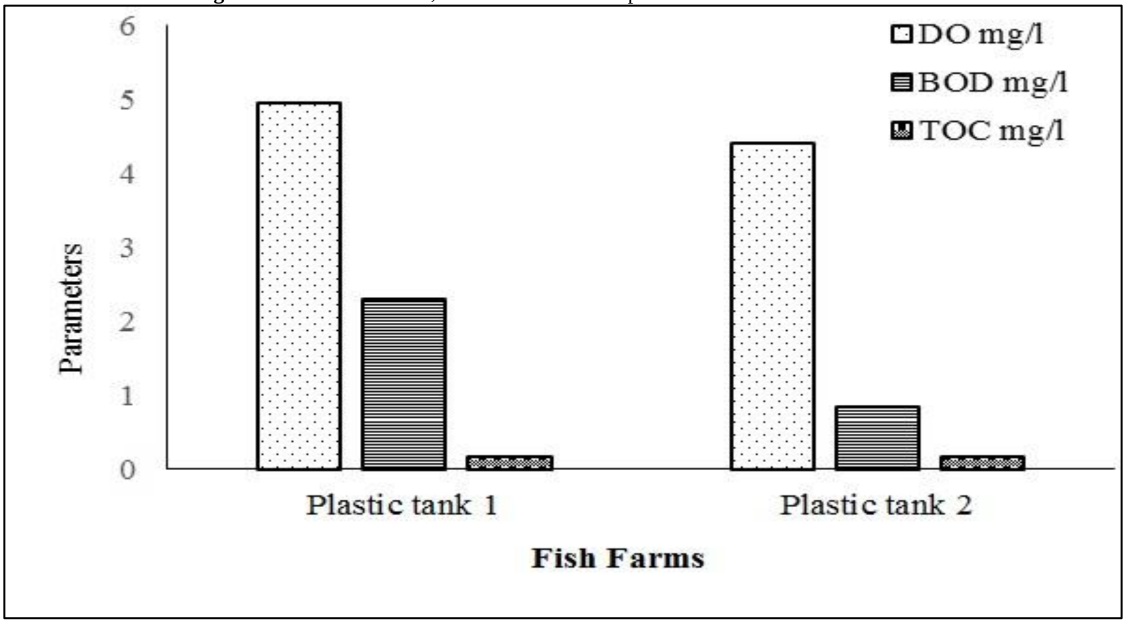

Figure-5. Variation of turbidity in the plastics tanks used for fish culture

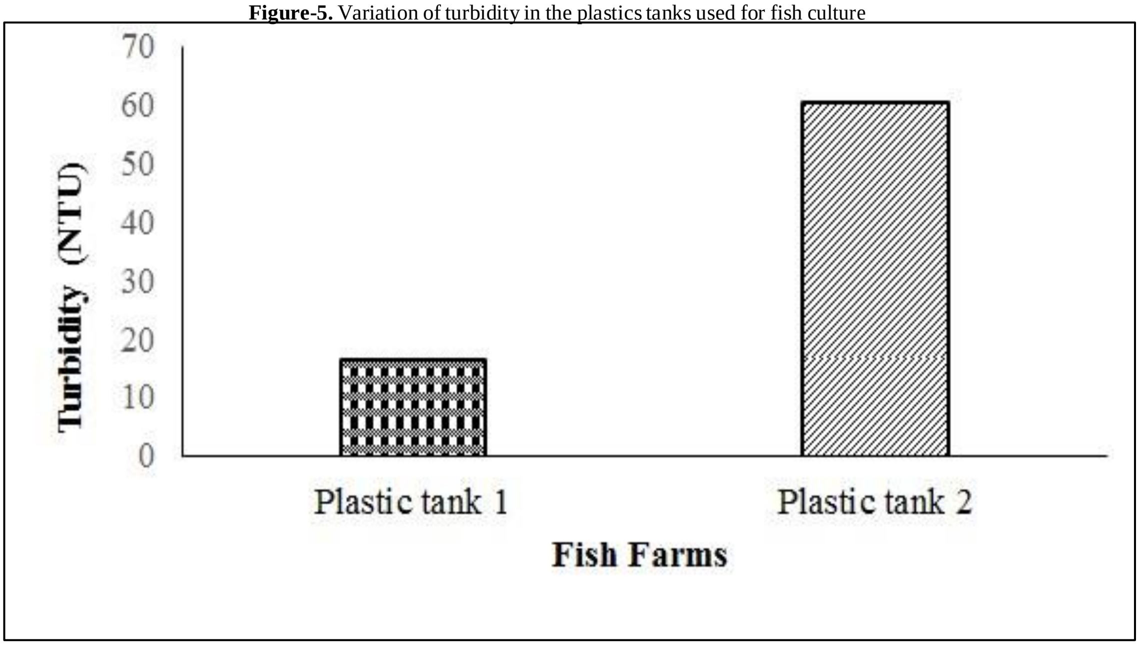

Figure-6. Variation of water depth in the plastic tanks used for fish culture