Physical and Chemical Variables of freshwater swamp ponds of Engenni, Ahoada-West, Niger Delta, Nigeria

Abstract

The Physical and chemical quality of natural water is essential for the life of aquatic organisms. This study is aimed at investigating the physical and chemical parameters of eight (8) local swamp ponds in the freshwater swamp of Engenni. Physical and chemical parameters of the freshwater swamp ponds were monitored over a period of three months (February-April 2019), During this period Temperature (ºC), Dissolved Oxygen (DO, mg/l), pH, Electrical Conductivity, (EC:µs/cm), Total dissolved solids, (TDS, mg/l), Salinity (‰), Turbidity (NTU) and Biochemical oxygen demand (BOD) were measured *insitu*. Temperature values did not vary significantly across stations, however DO values ranged between 0.55 ± 0.01mg/l and 0.95 ± 0.02mg/l, which was consistently lower than the 5mg/l prescribed to sustain fish health. pH values ranged from 6.17 ± 0.01 and 6.56 ± 0.01, indicating that the ponds were marginally acidic, values for EC (46.60 ± 0.10µs/cm and 156.57 ± 0.06µs/cm) and TDS (30.13 ± 0.12mg/l and 104.07mg/l ± 0.12mg/l) correlate as they were both highest and lowest in stations v and vii respectively. Salinity values of 0.02 ± 0.01‰ and 0.06 ± 0.0‰ across all stations was indicative of a typical freshwater environment. Turbidity was significantly higher ($P<0.05$) at station viii sampled stations. The result obtained from this research suggests that the swamp pond is capable of sustaining life in the aquatic ecosystem, but only fish species that are low oxygen tolerant can survive in swamp ponds.

Keywords: Physical and chemical, Freshwater, Swamps, Fisheries, Anoxia

1. INTRODUCTION

Freshwater ecosystem provides a wide range of use (i.e. ecosystem services) to people including domestic uses, industrial development, navigation, boating, fishing, dredging and wastes disposal. In the Niger Delta, the quest for fishery resources as the cheapest source of protein to support growing human populations in many riverine communities has led to the use of poison in the swamp ecosystem, such as Gammolin 20 [1], in order to increase catch with minimal efforts such poisons are non-specific in action and cause fatalities to both fin fishes, shell fishes and other aquatic flora and fauna as such they can have deleterious impacts to the wider ecosystems. The Physical and chemical quality of natural water is critical to the maintenance of aquatic biodiversity and its composition influences the ecological communities it can support. Commonly measured Environmental parameters include (pH, temperature, salinity, dissolved oxygen, biological oxygen demand, turbidity and transparency). These parameters are frequently used to detect any perturbation in the aquatic environment [2].

The presence of specific species and other aquatic organisms in any given ecosystem is the result of complex chemical make-up and ecological adaptations to these factors [3]. Additionally, these factors will vary over time and this dependent on the quality of the environment and its ability to buffer against perturbations such as the inflow of polluting substances. Good water quality is essential to the distribution of fishes [4]. Water the natural home of fish species and other aquatic lives has a complex chemistry and its constituent at a given period of time is dependent on biological, physical and chemical features of the environment. Natural water varies in composition and this is dependent on the quality of the environment, its high ability to dissolve substances is the determining factor. The deterioration of which are also dependent on the composition of aquatic vegetations and the substrate through which it flows [5]. Although; aquaculture practice can be a more sustainable alternative practice, it cannot totally substitute fishing in natural swamp ponds because a wide range of preference held by people in the Deltas that cannot be met within the constraints of normal aquaculture practice [1, 2].

Despite the reliance upon the Niger Delta swamps for fishing there is a dearth of information on the physical and chemical composition of the water they contain making it challenging to assess their ecosystem health. To date, the majority of studies across Nigeria have been on Physical and chemical parameters of surface water of rivers, lakes and creeks. Thus, this study presents novel information on the physical and chemical parameters of swamp ponds of Engenni, Ahoada-West, Niger Delta.

2. MATERIALS AND METHODS.

2.1 Study Area

The Engenni communities are located along the shoreline of the Orashi river which runs from Oguta in Imo state and terminates at Akpedan in central Abua in Abua/Odual Local Government Area of Rivers State where it empties into the brackish segment of Sombreiro river near Abonema Akuku-Toru Local Government Headquarters. It is a tributary to adjoining creeks like the Kolo creek and nearby lakes. The Engenni seasonal freshwater swamp is located within the Guinea-Congolian rain forest on the northern part of Niger Delta, virtually at the boundary between Rivers and Bayelsa States.

The eight studied swamp ponds had an average surface area of 20.3m^2(min.16.1m^2. max. 35m^2), and very relatively shallow, with an average depth of 3.6m (min.3.0m, max 4.0m) Most of the ponds were surrounded by warm and humid broad leaved forest, where buttress roots and sometimes burrows provides refugia where fish may aestivate. As a result of the broadleaved nature of the surrounding forest, all ponds are subject to seasonal leaf abscission from the surrounding trees which provide a source of allochthonous input. Tall trees (typically>12m) in the forest predominantly comprised of *Terminalia superba* (White Afara), *Elaeis guineensis* (Oil palm tree) under storey was dominated by Raphia palms (*Raphia vinifera*, *R. hookeri*), *Alchornea cordifolia* (Christmas tree), *Ficus exasperata* and *Bambusa vulgaris* (Indian bamboo), whilst the floor vegetation is predominantly comprised by ferns, grasses and forbs. The tree canopy surrounding station ii (Udoda) is especially dense such that twilight condition persist throughout the day

Commonly encountered macrophyte species are the free floating plant of the genera *Azolla sp*. and *Lemna sp*, and submerged oxygenator *ceratophyllum dermersum*; though this species was not recorded at station vii (Akinima) and viii (Joinkrama). *Pistia stratiotes* was also noted present at station I (Ikodi) and station ii (Udoda). Water colour tended to be associated with substrate type, where milkfish colour where associated with clayey substrate and brown water where the substrate was muddier. Station viii (Joinkrama 2) is especially dark as a result of large lake from which the ponds receives its water supply. Notable anthropogenic pressures upon the swamps in the Niger Delta are fishing, brewing of alcohol, palm wine tapings, hunting, logging fuel extracting, snail gathering and collection of other non- timber products. At station iii (Kunusha), these pressures have resulted in a more simplified two-storey forest structure.

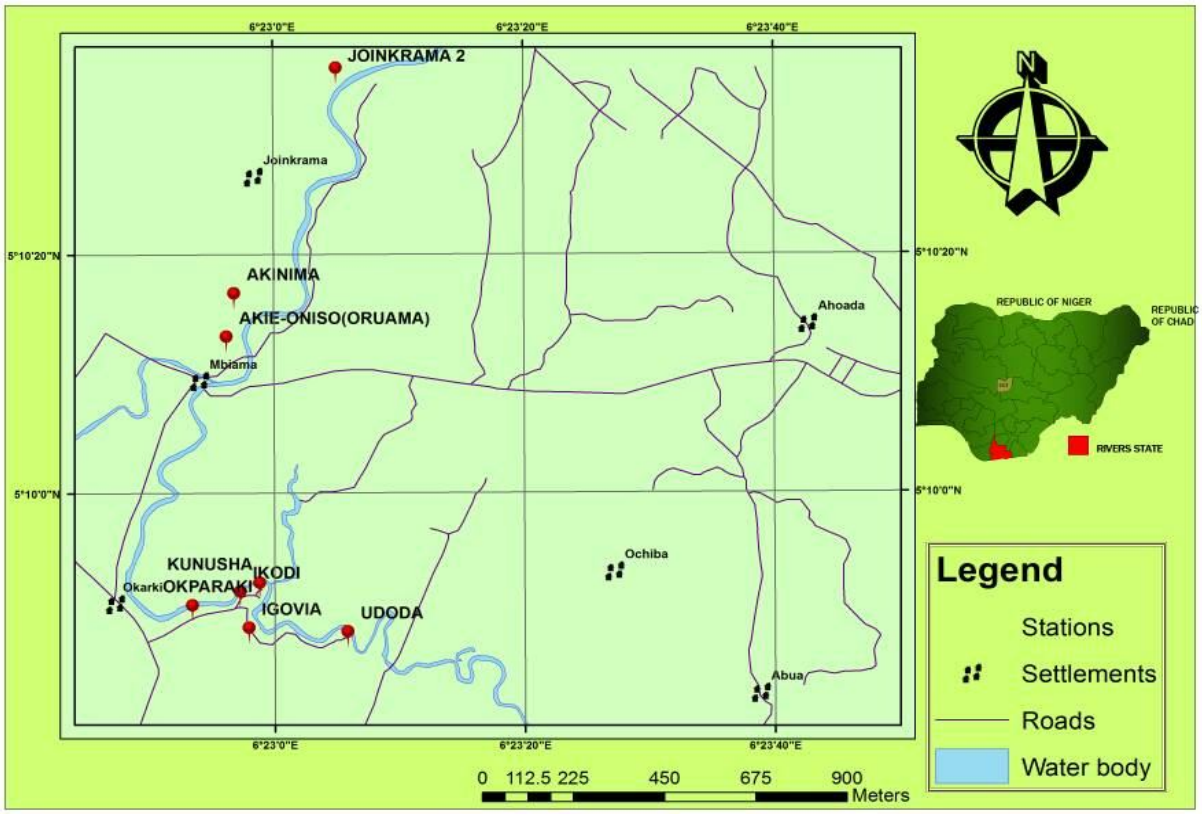

Fig. 1: Map showing the study area and stations in the lower Orashi, Niger Delta.

2.2 Sample Collection and Analysis

Sites were sampled monthly between February 2019 and April 2019, such that all sites were sampled in three occasions. The physical and chemical parameters that were measured *in situ* were temperature (ºC), pH, Conductivity (EC; µS/cm), total dissolved solids (TDS; mg/l), turbidity (NTU), and salinity (ppt) in triplicate using a multi-parameter checker (Extech model DO700). Dissolved oxygen (DO; mg/l) was determined using a modified Winkler-Azide method and Biochemical oxygen demand (BOD) was determined by the difference between DO of samples immediately. Laboratory analyses followed standard methods specified by APHA [6].

2.3 Morphometric Measurements of the Ponds

Measurements such as length and width of the various ponds in meters were taken using a calibrated tape. The areas of the ponds were determined by multiplying the length and the width while the depth was measured using a graduated pole, this was done before the de-watering period. The graduated pole was sent to the base of the pond and from the water mark the depth was recorded.

2.4 Statistical analysis

Triplicate measures of physical and chemical parameters were averaged. Mean separation of the physical and chemical parameters measured during the study period was done using Tukey's Pairwise [7]. All graphs were done using Microsoft Excel.

3. RESULTS

Mean DO values in the study ranged between min.0.55mg/l and max.0.95mg/l, whilst mean BOD values ranged between min. 3.28mg/l and max. 5.6mg/l (Table 1).

The mean DO values was highest in station i, ($P<0.05$), followed by station iv and respectively (Fig. 3), there was no significant difference between stations ii, iii and vi ($P>0.05$) and also between stations iv and v, just mean differences. But station i was significantly different from other stations ($P<0.05$) (Table 1).

BOD was significantly higher at stations i ($P<0.05$), followed by station iv (Fig. 9) , there was no significant difference between stations iii and iv, while significant difference ($P<0.05$) existed between station i, ii, iv, v, vii and viii (Table 1).

pH was significantly higher in station viii ($P<0.05$) (Fig. 4), followed by station iv, there was no significant difference between station v and vi ($P>0.05$), but station i, ii, iii, iv, vii and viii were significantly different ($P<0.05$) (Table 1).

The mean surface temperatures of the ponds were not significantly different($P>0.05$) just mean differences as they were within the regime of min. 27.17 ± 0.25ºC and max. 27.60ºC ± 0.10ºc (Table 1).

Conductivity (min.46.6µs/cm, max. 156.5µs/cm) and TDS (min. 30.1mg/l, max. 104.1mg/l) (Table 1), were highly correlated. Both were significantly higher (Turkey's $P<0.05$) in station v, while the lowest values were observed in station vii (Fig. 5 and 6).

The mean salinity values ranged between 0.02 ± 0.01‰. Salinity values were significantly higher ($P<0.05$) at stations i, ii, iii, and v respectively (Fig. 7), there was no significant difference between stations iv vi and viii ($P>0.05$), and also between stations vi, vii and viii, just mean differences (Table 1). The mean turbidity values recorded across stations ranged between min. 9.22 ± 0.02 NTU and max. 32.11 ± 0.01NTU, turbidity value was significantly higher in station viii ($P<0.05$), while the least was recorded in station ii (Fig. 8). There was significant difference ($P<0.05$) for mean turbidity values across stations (Table 1).

Table 1: Mean (± SD) values of physical and chemical parameters of the surface water of eight sampled swamp pond stations (February 2018 to April 2018).

	STATIONS							
	I	II	III	IV	V	VI	VII	VIII
Temperature	$27.57^{a} \pm 0.06$	$27.17^{b} \pm 0.25$	$27.60^{a} \pm 0.10$	$27.40^{ab} \pm 0.36$	$27.40^{ab} \pm 0.20$	$27.30^{ab} \pm 0.10$	$27.50^{a} \pm 0.17$	$27.57^{a} \pm 0.06$
(^{0}C)	27.51 - 27.63	27.42-26.92	27.5-27.7	27.04-27.76	27.2-27.6	27.2-27.4	27.33-27.67	27.51-27.63
DO (mg/l)	$0.95^{a} \pm 0.02$	$0.77^{c} \pm 0.03$	$0.77^{c} \pm 0.03$	$0.85^{b} \pm 0.01$	$0.85^{b} \pm 0.02$	$0.75^{c} \pm 0.01$	$0.63^{d} \pm 0.01$	$0.55^{e} \pm 0.01$
	0.93 - 0.97	0.74-0.80	0.74-0.80	0.84-0.86	0.83-0.87	0.74-0.76	0.62-0.64	0.54-0.56
pH	$6.36^{e} \pm 0.01$	$6.48^{c} \pm 0.01$	$6.32^{f} \pm 0.01$	$6.53^{b} \pm 0.01$	$6.41^{d} \pm 0.01$	$6.42^{d} \pm 0.01$	$6.17^{g} \pm 0.01$	$6.56^{a} \pm 0.01$
	6.35 - 6.37	6.47-6.49	6.31-6.33	6.32-6.54	6.40-6.42	6.41-6.43	6.16-6.18	6.56-6.57
Conductivity	$101.53^{e} \pm 0.15$	$110.53^{d} \pm 0.06$	$133.77^{b} \pm 0.06$	$113.10^{c} \pm 0.10$	$156.57^{a} \pm 0.06$	$85.37^{g} \pm 0.06$	$46.60^{h} \pm 0.10$	$93.10^{f} \pm 0.10$
(µs/cm)	101.38-101.68	110.47-110.59	133.71-133.83	113.0-113.2	156.51-156.63	85.31-85.43	46.5-46.7	93.0-93.2
TDS(mg/l)	$66.7^{e} \pm 0.06$	$72.80^{d} \pm 0.10$	$88.7^{b} \pm 0.06$	$75.47^{c} \pm 0.12$	$104.07^{a} \pm 0.12$	$56.33^{g} \pm 0.06$	$30.13^{h} \pm 0.12$	$61.50^{f} \pm 0.10$
	66.64-66.76	72.70-72.90	88.64-88.76	75.35-75.59	103.95-104.19	56.27-56.39	30.01-30.25	61.4-61.6
Salinity(‰)	$0.06^{a} \pm 0.01$	$0.06^{a} \pm 0.01$	$0.06^{a} \pm 0.01$	$0.05^{a} \pm 0.01$	$0.06^{a} \pm 0.01$	$0.03^{c} \pm 0.01$	$0.02^{d} \pm 0.01$	$0.04^{bc} \pm 0.01$
	0.05-0.07	0.05-0.07	0.05-0.07	0.04-0.06	0.05-0.07	0.02-0.04	0.01-0.03	0.03-0.05
Turbidity	$12.13^{d} \pm 0.02$	$9.22^{h} \pm 0.02$	$12.43^{c} \pm 0.01$	$12.64^{b} \pm 0.01$	$12.06^{e} \pm 0.02$	$10.04^{g} \pm 0.02$	$11.28^{f} \pm 0.01$	$32.11^{a} \pm 0.01$
(NTU)	12.11-12.15	9.20-9.24	12.42-12.44	12.63-12.65	12.04-12.08	10.02-10.06	11.27-11.29	32.10-32.12
BOD(mg/l)	$5.96^{a} \pm 0.02$	$5.46^{e} \pm 0.01$	$5.52^{d} \pm 0.01$	$5.90^{b} \pm 0.01$	$4.78^{f} \pm 0.01$	$5.52^{d} \pm 0.01$	$3.28^{g} \pm 0.01$	$5.74^{c} \pm 0.01$
	5.94-5.94	5.45-5.47	5.51-5.53	5.89-5.91	4.77-4.79	5.51-5.53	3.27-3.29	5.73-5.75

*Levels not connected by same letter across rows are significantly different (Tukey's Pairwise Comparison)

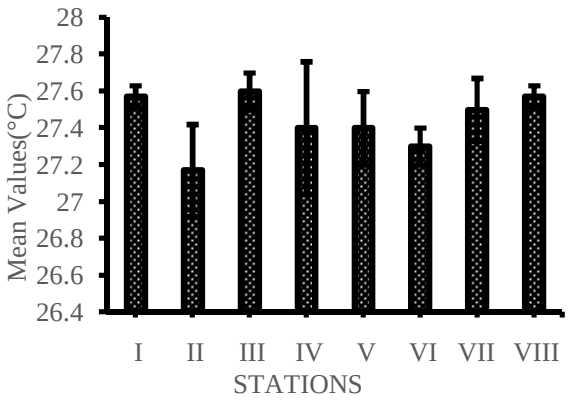

Fig 2: Mean Temperature (°C) Values in Swamp of Engenni, Ahoada-West, Niger Delta

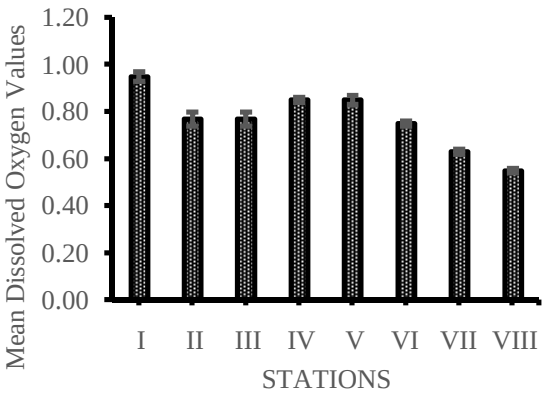

Fig 3: Mean Dissolved Oxygen(mg/l) Values in Swamp Ponds of Engenni

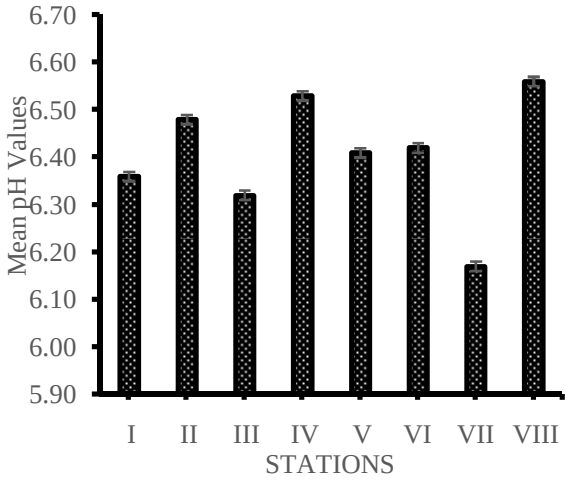

Fig 4:Mean pH values of Swamp Ponds in Engenni

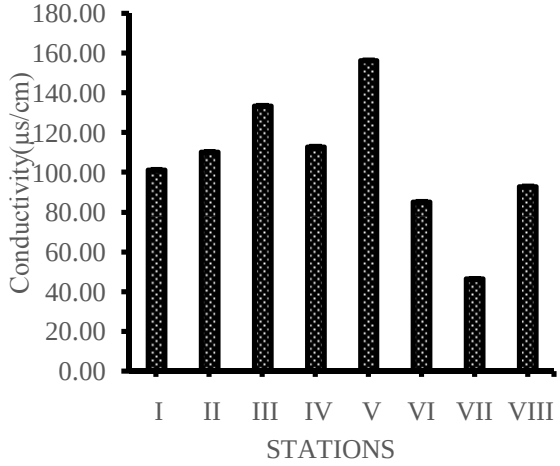

Fig 5:Mean Conductivity(µs/cm) Values of Swamp Ponds in Engenni

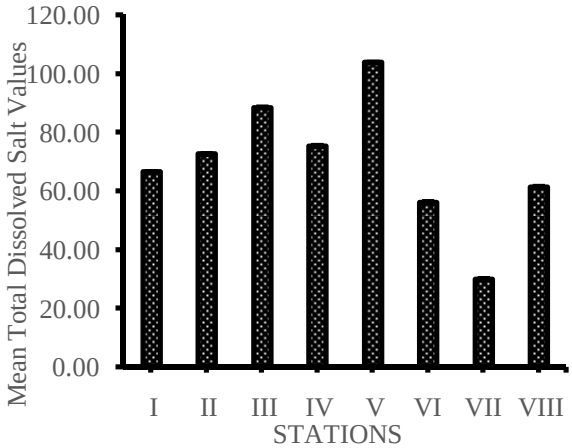

Fig 6: Mean Total Dissolved Salt Values of Swamp Ponds in Engenni

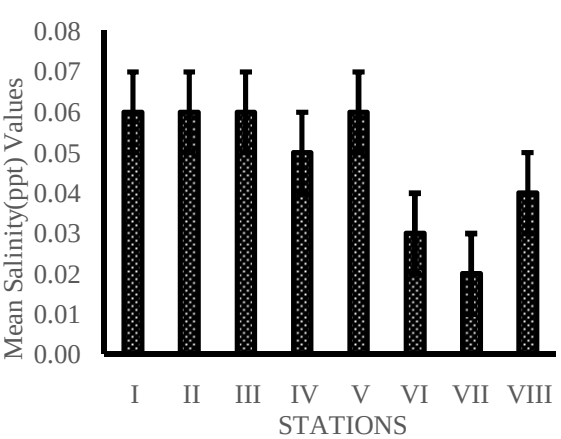

Fig 7: Mean Salinity(ppt) Values of Swamp Ponds in Engenni

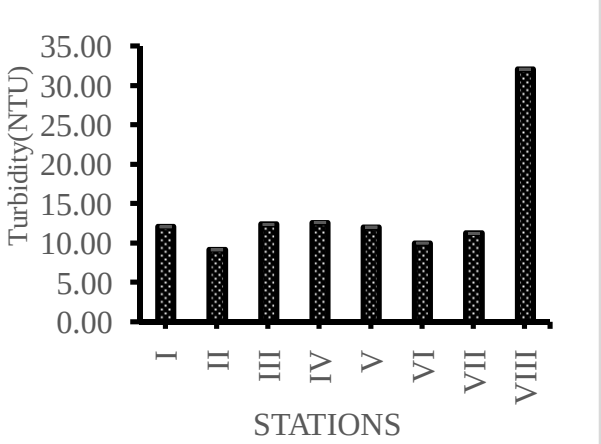

Fig 8:Mean Turbidity (NTU) Values in Swamp Ponds of Engenni

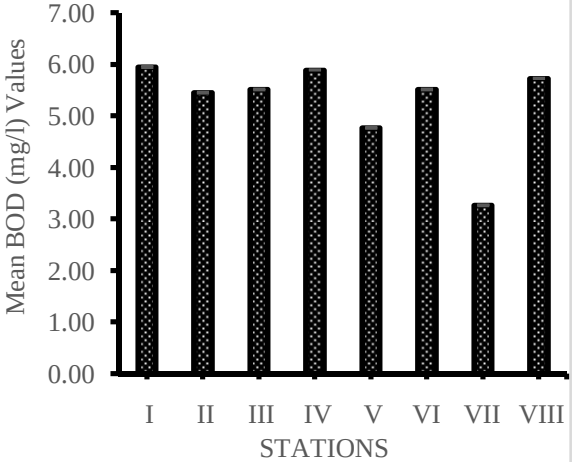

Fig 9: Mean Biochemical Oxygen Demand Values in Swamp Ponds of Engenni

4. DISCUSSION

Several factors influence the physical and chemical parameters of natural water bodies these factors are either caused by nature or anthropogenic activities. These factors were evident in the physical and chemical parameters of the water body studied. The surface temperature regimes of the various stations were consistent with other inland water bodies of the Niger delta. Ezekiel [8] had a mean surface temperature of min. 26.2 ± 0.54 to max. 28 ±0.53^{0}C in his studies in the floodplains of Odiokwu, Niger Delta. It also corroborates with the reports of Zabbey and Hart, [9], who reported mean temperatures of min. 25.6 ± 1.1^{0}C to max.30.8 ± 2.5^{0}C and Edoghotu *et al.* [5] that reported a mean temperature of min. 25^{0}C and max. 34^{0}C. The low temperatures of the ponds could be linked to the thick forest canopy provided by the trees measuring 14-16 meters that provided sheds to the station, thereby reducing the direct sunlight from reaching the stations. This is in conformity with the reports of Welcomme [4] who reported that water that flows under vegetation cover tends to have a lower temperature than those of an open habitat.

The pH value obtained in the stations indicated that the surface water of the stations were acidic and this corroborates favourably with the ranges of min. 6.0 ± 0.04 to max. 6.7 ± 0.05 recorded by Ezekiel [8] in the ponds of Odiokwu, Ahoada-West, Niger Delta and Davies *et al*. [10], that observed mean pH value of 6.07± 0.54 in the upper reaches of Orashi River. The acidity of the surface water of the swamp ponds is attributable to vegetation cover of the water shed which enhanced anoxic decomposition and releases gases like methane, ammonia and humic acid [4, 5]. The significant difference ($P<0.05$) recorded amongst some stations in the hydrogen ion concentration values may be linked to the influx of organic waste which depleted the dissolved oxygen content of the pond and rendered the swamp ponds acidic [10]. The pH value in this report is in alignment with findings of Scott [11] and RPI [12] in the Niger Delta environment. These pH values have been prescribed as suitable to sustain the lives of fishes in aquatic

ecosystem. Saxena [13] confirmed that most tropical freshwater fish prefer a pH value of 5.0 to 9.0.

The mean Conductivity value recorded in this study was lower than results of previous studies conducted in the Niger Delta. Edoghotu *et al.* [5] in Kugbo creek observed ranges of min.26.3µS/cm ± 52 to max.11767µS/cm ± 3512. Francis *et al.* [13] in the New Calabar river reported mean values of 578.19µS/cm. The value obtained in this study was however consistent with the TDS value obtained in this study; where TDS was highest EC was also highest, where TDS was lowest EC was also lowest, values in this study depicts freshwater environment. This assertion agrees with the report of Egborge [14] that classified waters with conductivity values of 40, 00µs/cm as marine, below 1000µs/cm as fresh water while in between the two as brackish. The increased EC values recorded in station v could be linked to the contribution of industrial effluents and the increased effect of soil erosion which was visibly noticed in the station. The dissolved oxygen values obtained from this study is typical of a lenthic water body. The values were at variance with the reports of Edoghotu *et al.* [5] that reported a mean DO value of 1.7mg/l in the dry months of February, and Ezekiel [8] that found mean DO of min. 5.7 ± 0.54 to max. 6.9 ± 0.42mg/l in the swamp ponds of Odiokwu. The anoxic condition noted in the swamp ponds of Engenni, Niger Delta, is caused by decaying plant and animal remains which harbours micro-organism that lower the dissolved oxygen content of the water.

The BOD range of min. 3.28 ± 0.01 and max. 5.96 ± 0.02mg/l observed in this study controverted the reports of Ezekiel [8], who reported a BOD value of min. 0.54 ± 0.03 to max. 0.64 ± 0.03mg/l and reports of CORDEC [15] who reported a BOD value of 1.98mg/l in Utukunu River Niger Delta. The disparity noted between this present study and the previous ones is attributable to the differences in organic matter content of the waters. The swamp ponds of Engenni is not properly aerated and full of remains of decaying plants and animal matter that reduce dissolved oxygen content of the water, the fishes still use up the already depleting dissolved oxygen during feeding thereby reducing the BOD. The BOD value obtained correlates with the DO values obtained in this study. This assertion agrees with the reports of Braide *et al*. [16] and Davies *et al*. [10] in their studies in Miniwaja stream in Eastern Niger Delta and upper Orashi River respectively.

The total dissolved solids value in the study was higher than the reports of Davies *et al*. [10] that recorded mean TDS value of 35.18 ± 4.48mg/l in their studies in upper Orashi Niger Delta, but lower than the values obtained in Kugbo creek by Edoghotu *et al.* [5] who reported ranges of 11mg/l to 809mg/l. The maximum value of 809mg/l was observed in the brackish segment of the creek, and this was attributed to the incursion of sea water in the brackish area. The results obtained is typical of fresh water body. Edoghotu *et al.* [5] reported that TDS values are usually higher in the marine environment than freshwater because of the salt content of the marine environment.

Salinity in the study area was expected as it was between the ranges of 0.02 ± 0.01ppt and 0.06 ± 0.01ppt in all the stations depicting a typical fresh water environment. The mean turbidity values recorded in this study was not surprising because the ponds are dependent on flooding which is

a natural phenomenon in the study area to get its stock, and usually during the flooding drains from wetland enter the ponds which leads to increase in suspended clayey particles in the water surface of the various stations The significantly higher ($P<0.05$) turbidity values recorded in station viii is attributable to the visible influx of water draining into the pond from a nearby lake that increased the clayey particles suspended in the surface water of the swamp pond.

5. CONCLUSION

The physical and chemical parameter of the swamp ponds of Engenni is capable of sustaining life in the aquatic ecosystem. However, it is recommended for the culture of fish species that are low oxygen tolerant or have auxillary breathing organ because of the anoxic condition that prevailed in the swamps

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