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Seasonal and spatial variations in physico-chemical parameters of water and proximate composition of *Macrobrachium macrobrachion* from Ologe lagoon and Badagry creek, Lagos, Nigeria

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ABSTRACT: In this study, seasonal and spatial variations in physicochemical parameters of water and proximate composition of *Macrobrachium macrobrachion* from Badagry Creek and Ologe Lagoon were examined. Samples of water and *M. macrobrachion* were collected from both stations on a monthly basis for six months. The physicochemical parameters monitored were pH, temperature, total suspended solids, total dissolved solids, total solids, total alkalinity, free carbondioxide, conductivity, salinity, dissolved oxygen, biochemical oxygen demand, ammonia and turbidity, while the proximate composition parameters were moisture content, crude protein, crude fibre, carbohydrate, crude lipids and ash. It was observed that alkalinity, salinity, dissolved oxygen, temperature and ammonia determined for both sample stations were within recommended limit of Food and Agricultural Organization, except pH for Badagry creek. There was no significant difference ($p > 0.05$) in seasonal variations of most physico-chemical parameters in both stations except for pH in Ologe lagoon, and electrical conductivity (EC), total dissolved solids (TDS) and total solids (TS) in both stations. Also, with the exception of EC, TDS and TS, there was no significant difference for spatial variation of physico-chemical parameters between the two stations. Moisture content, lipid and ash contents showed significant seasonal variation in Ologe lagoon, while crude protein and crude fibre recorded no significant difference. For Badagry creek, with the exception of moisture content, all other proximate composition parameters showed significant difference. However, there was no significant spatial variation in proximate composition between the prawns in Ologe lagoon and Badagry creek. There were gradual effects of season on water quality and proximate composition but these effects still support growth and survival of the prawn. However, regulatory measures should be put in place to protect these water bodies from direct/indirect human activities that can cause adverse damages.

Keywords: Badagry creek, *Macrobrachium macrobrachion*, Ologe lagoon, physico-chemical, variation.

INTRODUCTION

Nigeria has a land area of 960 km^2 with a continental shelf area of 37,934 km^2, coastline length of 853 km and Exclusive Economic Zone (EEZ) of 210,900 km^2 (Anyanwu et al., 2011). Lagos state is situated along the vast coastline which is endowed with marine, brackish and freshwaters of wide ecological zones and numerous fish species. The state has a vast network of lagoons, creeks, mangrove swamps and floodplains and one of such creeks is Badagry creek which runs across two national boundaries of Nigeria and Benin Republic. The creek receives untreated domestic sewage and agricultural wastes from surrounding towns and villages. Ologe lagoon is one of the four lagoons in Lagos, the others being Lagos lagoon, Epe lagoon and Lekki lagoon, and it sustains a thriving artisanal fisheries industry and also serves as a source of water for domestic and industrial use, transportation, logging and sand dredging. The lagoon is bordered by several fishing villages and an industrial town - Agbara Industrial Estate – which harbours several industries whose wastes constitute the major metal pollution by direct disposal into the Lagoon (Kumolu-Johnson et al., 2010). Both Ologe lagoon and Badagry creek are important for artisanal and commercial fisheries as well as transportation, recreation and domestic purposes. The people in these coastal communities also depend on these water bodies for livelihood.

One of the important shellfish species in Ologe lagoon and Badagry creek is *Macrobrachium macrobrachion*, a decapod crustacean belonging to the family Palaemonidae, which has been reported to have great aquaculture potentials (Jimoh et al*.,* 2012). *Macrobrachium* serves as a source of food and revenue generation to many people and countries across the world. However, according to Jimoh et al*.* (2012), there is a gradual but consistent decrease in the population of natural stocks of *Macrobrachium* in Badagry creek. This may be attributed to over-exploitation and, more importantly, to environmental degradation. This environmental degradation could be as a result of industrial effluents discharged into the water body, domestic and agricultural wastes and sand dredging activities.

According to Sharma and Singh (2016), water quality refers to the physical, chemical and biological characteristics of a water body. The quality of a water body largely depends on the interactions of various physicochemical factors (Momtaz et al*.*, 2010). The quality of the water determines the sustenance of the aquatic species and their safety for human consumption. Generally, water quality is determined using physicochemical parameters which have been reported to be greatly affected by pollution (Offem et al*.*, 2011; Iwuoha and Osuji, 2012; Matini et al*.*, 2012; Devi et al*.*, 2013; Tamrakar and Raj, 2013). Water pollution could be a result of discharge of domestic wastes, agricultural wastes and industrial effluents into the water. Seasonal variations in physicochemical parameters of water refer to the changes in the physicochemical parameters of the water as a result of changes in the season with resultant effect on the aquatic population. Crustaceans are highly sensitive to pollution (Bat et al., 2001; Guerra-Garcia and Garcia-Gomez, 2004), and their distributions are strongly influenced by the physico-chemical parameters (Sindermann, 1979). Varadharajan et al. (2013) reported that variations in the physico-chemical parameters, such as temperature, salinity, pH, dissolved oxygen and nutrients influence abundance and life cycles of crustaceans. Temperature was found to be the most critical environmental variable affecting availability and reproduction of freshwater prawn, *Macrobrachium birmanicum choprai* (Singh and Srivastava, 2006). Kingdom et al. (2013) reported that the abundance of *M. felicinum* was positively correlated with water level and total hardness, but negatively with pH and dissolved oxygen. Approximately 28% of the variation in *M. macrobrachion* was attributed to transparency, pH, total dissolved solids (TDS) and plankton abundance, while approximately 40% of the variation in *M. vollenhovenii* was attributed to TDS, water velocity and total hardness (Kingdom et al., 2013).

The proximate body composition including protein, moisture, fat, and ash are good indicators of physiological condition of an organism (Siva Reddy et al., 2013). The chemical composition and nutritional properties of aquatic crustaceans are important in their uses as sources of protein to significant proportion of the world population, particularly in developing countries where animal protein is expensive and beyond the reach of the poor man (Bello-Olusoji and Oke, 2005). However, proximate composition of crustaceans have been reported to vary with season, age and size of animal, stages of maturity, availability of food and feeding habit; and environmental factors, particularly, temperature, habitat salinity and rainfall pattern (Huang et al., 2005; Rosa and Nunea, 2005; Mridha et al., 2005; Ferdose and Hossain, 2011). Ukpatu and Udoh (2017) investigated the influence of environmental factors on the proximate composition of *Nematopalaemon hastatus* shrimp in Okoro River estuary, Nigeria and reported that proximate compositions of the shrimp were significantly affected by size, temporal and seasonal variations, while Siva-Reddy et al. (2013) reported that there was significant difference between males and females of *Macrobrachium rosenbergii* in case of proteins, moisture, fat and ash. Nasef (2016) reported that the nutritional values of muscle constituents of *Penaeus semisulcatus* were different from one season to the other, with positive weak correlation.

Thus, considering the ecological and economic importance of Ologe lagoon and Badagry creek, the anthropogenic activities within the areas and the possible effect on the biology of *M. macrobrachion,* this study aimed at assessing the effects of seasonal and spatial variations on physicochemical parameters of water and proximate composition of *M. macrobrachion* from Ologe lagoon and Badagry creek which will enable policy-makers to effectively manage and protect these water bodies from environmental pollution.

MATERIALS AND METHODS

This study was conducted for a period of six months from February 2017 - July 2017. February – April represented dry season while May – July represented rainy (wet) season. Prawn and water samples were collected monthly from two sampling stations - Ologe lagoon and Badagry creek. Data were generated on a monthly basis from these stations with respect to thirteen(13) physico-chemical parameters - pH, alkalinity, turbidity, salinity, dissolved oxygen, temperature, conductivity, total dissolved solids,

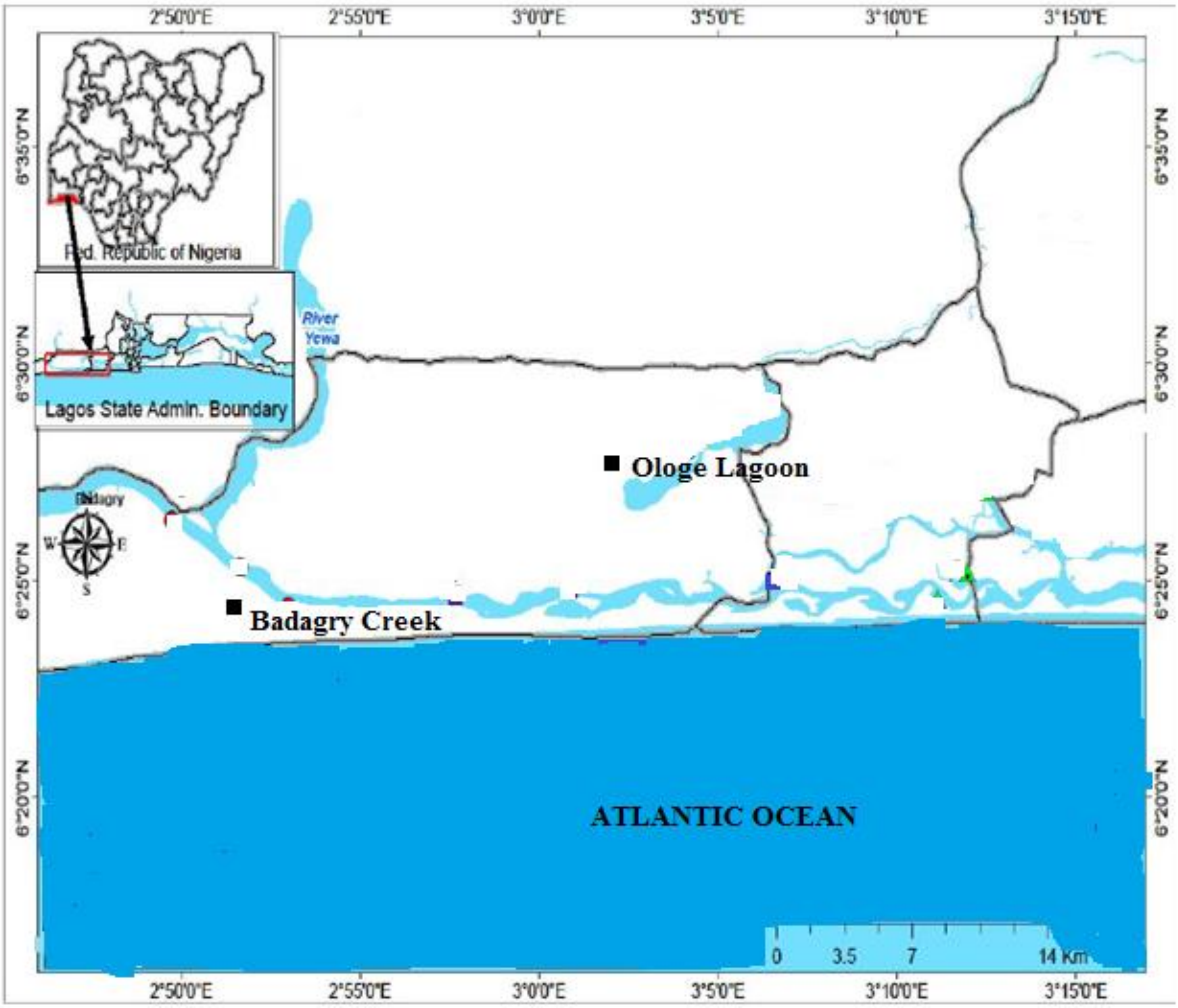

Figure 1. Map showing Badagry creek and OLoge lagoon.

total suspended solids, total solid, free carbondioxide, biochemical oxygen demand and ammonia, and proximate analysis of samples of *M. macrobrachion*.

Description of sampling sites

Ologe lagoon is located in the eastern part of Lagos State (Figure 1). It is a seasonal freshwater body with a surface area of about 64.5 km^2 (Kumolu-Johnson et al., 2010). It lies between latitude 6°27'N and 6°30'N and longitudes 3°02'E and 3°07'E. The lagoon opens up to the Atlantic ocean via Lagos harbour and Badagry creek. Ologe lagoon is deep in the centre but shallow at the edges with an average depth of 2.42 m and an average temperature of 30°C on a sunny day. Ologe lagoon is surrounded by several fishing villages and Agbara Industrial Estate which discharges its effluents into the lagoon.

Badagry creek with source from river Queme in the Republic of Benin to the west of Nigeria is located in Lagos state, southwest Nigeria (Jimoh et al., 2012). The creek is located on latitude 2°42´and 3°2´ N and longitude 6°23 and 6°28´E, and forms part of the continuous lagoon that stretches from Port Novo to Lagos (Akintola et al*.,* 2011). The creek empties directly into Ologe lagoon. The climate around the sampling sites is characterized by two seasons – rainy season (May – October) and dry season (November – April). The annual mean temperature is 27.20°C and relative humidity 83.01% (Salau, 2016).

Collection of water and prawn samples

Water samples were collected on a monthly basis for analyses of physico-chemical parameters from the two sampling stations using amber sampling bottles by dipping the bottles 15 cm below the water level at designated sampling stations. Prior to sample collection, all the plastic bottles were thoroughly washed with a 2% solution of Citranox, rinsed with tap water, rinsed with deionised water (DI), soaked in 5% nitric acid overnight and rinsed with DI again. The bottles were allowed to drain, dry and then stored in sealed plastic bags until use. The sampling bottles were labelled with dates and collection stations. Until analysis, collected water samples were stored in a cool cupboard temperature at 4^0C.

Prawn samples were collected monthly from each sampling station. The prawns were bought from the artisanal fishers at the landing site of Ologe lagoon (Oto jetty) and Badagry creek (Topo) and transported on ice to the Fisheries Laboratory of Lagos State University (LASU) for proper identification and preparation for proximate analysis. The prawn was identified using morphological characters reported by Holthius (1980). The prawns were then taken to College of Medicine of the University of Lagos for proximate analysis.

Physico-chemical analysis

Temperature and pH were determined, *in situ* using a combination pH electrode with temperature compensation. Total dissolved solid (TDS), electrical conductivity (EC) and salinity were determined using HACH multi-parameter conductivity/TDS/salinity meter (HQ40d). Total suspended solid (TSS) was determined by gravimetric method (Kazi et al*.*, 2009). Total solid was calculated from TSS and TDS. Total Alkalinity was determined by the burette titration method and dissolved oxygen (DO) was determined using a Clark-type amperometric DO meter while biochemical oxygen demand (BOD) was calculated by measuring DO before and after 5 days of incubation of 100 ml aliquot of the sample in the dark at 20ºC. The 5-day BOD (BOD_5) was then estimated as $DO_1 – DO_5$ (Huq and Alam, 2005). Turbidity was determined with a Turbidity meter (HACH 2100Q) while ammonia and free carbondioxide were determined by the salicylate colorimetric and base titration methods respectively.

Proximate analysis

Proximate composition of the prawn samples was determined using the method of Association of Official Analytical Chemists (2005).

Determination of moisture content

Samples were oven-dried to constant weight at 110ºC for 14 hours. Percentage moisture content was then calculated as:

$$\%\ \text{Moisture} = \frac{\text{W1} - \text{W2}}{\text{W1}} \times 100$$

Where W1 = Initial Weight of Sample and W2 = Final Weight of Sample.

Determination of ash content

Crucibles containing prawn samples were incinerated in a furnace set at 550ºC for 8 hours. The residue was weighed and percentage ash content was calculated as follows:

$$\%\ \text{Ash} = \frac{\text{Weight loss of Sample}}{\text{Initial Weight of Sample}} \times 100$$

Determination of crude fibre

The method as described by AOAC (2005) was used. Crude fibre content was then calculated as:

$$\%\ \text{Crude Fibre} = \frac{\text{Weight loss of Sample}}{\text{Initial Weight of Sample}} \times 100$$

Determination of Nitrogen and crude protein

Micro-Kjeldahl method as described by AOAC (2005) was used to determine the crude protein. The percentage of nitrogen per sample was calculated as:

$$\%\ \text{Nitrogen} = \frac{\text{Titre Sample} \times 0.1 \times 14 \times 250 \times 100}{\text{Weight of Sample} \times 1000 \times 25}$$

The percentage protein in the sample was then calculated by multiplying the % nitrogen by 6.25.

$$\%\ \text{Protein} = \%\ \text{Nitrogen} \times 6.25$$

Determination of lipid content

Lipid content of the prawn sample was estimated using Bligh and Dyer (1959) method. Lipid content was calculated as:

$$\%\ \text{Lipid} = \frac{\text{Weight of Residue}}{\text{Weight of Sample}} \times 100$$

Determination of Carbohydrate

The total carbohydrate content was determined by difference method. Sum of the percentage moisture, ash, lipid, crude protein and crude fiber was subtracted from 100%.

% Carbohydrate =100 – (% Moisture +% Ash +% Protein +% Lipid +% Fibre)

Table 1. Seasonal and spatial variations in physico-chemical parameters of Ologe lagoon and Badagry creek.

Parameters	Ologe Lagoon		Badagry Creek		Mean	
	Wet	Dry	Wet	Dry	Ologe lagoon	Badagry creek
pH (at 25°C)	6.79±0.31[a]	6.17±0.32[b]	5.51±0.96[c]	5.35±1.58[c]	6.48±0.45[e]	5.43±1.17[e]
Alkalinity (mg/l)	53.38±7.35[a]	60.33±20.81[a]	53.03±1.70[c]	43.2±10.68[c]	56.85±14.47[e]	48.12±8.71[e]
Turbidity (NTU)	13.75±4.15[a]	18.07±3.48[a]	14.79±8.97[c]	23.02±5.90[c]	15.91±4.16[e]	18.91±8.15[e]
Salinity (ppt)	0.16±0.10[a]	0.30±0.03[a]	0.15±0.04[c]	0.43±0.40[c]	0.23±0.10[e]	0.29±0.30[e]
Dissolved Oxygen (mg/l)	5.10±0.10[a]	4.03±0.10[a]	5.0±0.79[c]	4.03±0.90[c]	4.57±0.84[e]	4.52±0.93[e]
Temperature (°C)	26.13±0.00[a]	26.20±0.12[a]	25.53±0.416[c]	26.03±0.06[c]	26.17±0.08[e]	25.78±0.38[e]
Electrical conductivity	239.90±190.61[a]	515.67±100.20[b]	239.7±156.06[c]	829.33±689.18[d]	377.78±23.38[e]	534.52±51.39[f]
Total dissolved solids (mg/l)	135.33±10.65[a]	285.70±15.74[b]	136.30±14.54[c]	461.1±38.78[d]	210.52±11.01[e]	298.70±30.56[f]
Total suspended solids (mg/l)	33.13±3.86[a]	45.93±5.22[a]	30.90±3.50[c]	50.33±6.20[c]	39.53±4.04[e]	40.62±4.07[e]
Total solids (mg/l)	165.47±11.55[a]	330.93±8.32[b]	165.50±16.48[c]	511.43±35.74[d]	246.92±18.64[e]	338.47±30.89[f]
Free Carbondioxide (mg/l)	16.50±2.29[a]	23.96±3.37[a]	20.33±5.02[c]	22.12±6.22[c]	40.46±9.16[e]	42.45±9.91[e]
Biochemical Oxygen demand (mg/L)	11.33±1.04[a]	40.67±7.93[a]	21.67±2.21[c]	37.33±6.57[c]	26.0±4.40[e]	29.5±5.22[e]
Ammonia (mg/l)	0.10±0.02[a]	0.20±0.05[a]	0.13±0.02[c]	0.18±0.03[c]	0.15±0.03[e]	0.15±0.02[e]

Values are expressed as mean ± standard deviation; Values in the same row and with same superscript are not significantly different ($p > 0.05$).

Statistical analysis

Data generated were analysed using paired one-tail T- test at 5% significance level.

RESULTS AND DISCUSSION

Presented in Table 1 are the data for the seasonal and spatial variations in the physicochemical parameters of Ologe lagoon and Badagry creek. It was observed that pH for Ologe lagoon recorded higher value in wet season (6.79±0.31) than the dry season (6.17±0.32), and same for Badagry with 5.51±0.96 (wet season) and 5.35±1.58 (dry season). The mean value of pH for Badagry creek (5.43±1.17) and Ologe lagoon (6.48±0.45) were not within the recommended range of 6.5 to 8.5 for prawns and fish production (FAO, 2002). Most natural bodies have been reported to have a pH range of 5 to 10 (Tepe et al., 2005), and Etesin et al. (2013) reported that pH of water from Ikot river in both wet and dry seasons were within the WHO limit of 6.5 to 8.5. Akintola et al. (2011) and Ndimele and Kumolu-Johnson (2012) reported mean pH values of 8.97±1.37 and 7.65±0.079 for Badagry creek and Ologe lagoon, respectively. Thus, the pH has degraded with time due to anthropogenic activities with dire consequences for aquatic lives. Mean total alkalinity values for both Ologe lagoon (56.85±14.47 mg/l) and Badagry creek (48.12±8.71 mg/l) were both within recommended range of 25 to 60 (FAO, 2002). The mean values for turbidity in both stations were 15.91±4.16 (Ologe lagoon) and 18.91±8.15 (Badagry creek); these values are higher than the recommended value of 5 NTU (WHO, 2008). High turbidity values signify a high concentration of suspended solids (Ladipo et al., 2011). Thus, these higher values are indicative of an increasing level of wastes discharge into the water bodies. Salinity showed seasonal variation in both stations. It was higher in dry season and lower in wet season. This could be a result of dilution in wet season and concentration by evaporation during the dry season. The fluctuations can also be attributed to salt water intrusion. However, the salinity values for both stations are within the recommended limit of <10ppt (FAO, 2002).

Mean dissolved oxygen values for both stations are within recommended range of 3 to 7 mg/l (FAO, 2002). Dissolved oxygen varied seasonally, it was higher in wet season and lower in dry season for both stations. This is because dissolved oxygen decreases with increasing salinity and salinity was higher in dry season in both stations. The higher dissolved oxygen value could also be due to increased water flow and flooding associated with the wet season. During sampling periods, it was observed that there was an abundance of aquatic macrophytes (especially water hyacinth) on the

Table 2. Seasonal and spatial variations in proximate composition of *Macrobrachium vollenhovenii*from Ologe lagoon and Badagry creek.

Parameters	Ologe lagoon		Badagry creek		Mean	
	Wet	Dry	Wet	Dry	Ologe lagoon	Badagry creek
Moisture (%)	63.01±0.95[a]	61.89±0.43[b]	64.27±1.28[c]	64.03±0.22[c]	62.73±1.13[e]	64.14±0.83[e]
Crude lipid (%)	10.06±0.18[a]	7.36±0.26[b]	8.93±0.12[c]	6.25±0.58[d]	8.57±0.46[e]	7.59±0.32[e]
Ash (%)	0.68±0.06[a]	4.38±0.15[b]	0.48±0.01[c]	3.90±0.37[d]	2.53±0.03[e]	2.19±0.02[e]
Crude Carbohydrate (%)	7.92±0.17[a]	9.36±0.51[a]	10.38±0.19[c]	8.98±0.27[d]	8.49±0.34[e]	9.68±0.79[e]
Crude protein (%)	17.25±0.14[a]	16.40±1.36[a]	16.27±0.23[c]	15.49±0.21[d]	17.12±1.14[e]	16.23±0.47[e]
Crude fibre (%)	0.54±0.07[a]	0.59±0.18[a]	0.70±0.03[c]	0.34±0.09[d]	0.56±0.11[e]	0.13±0.01[e]

Values are expressed as mean ± standard deviation; Values in the same row and with same superscript are not significantly different (p > 0.05).

surface of the water which gradually withered away possibly as a result increasing salinity associated with the dry season. Temperature for both stations fell within recommended limit of 28 to 31°C (FAO, 2002). Temperature affects the rate of metabolic activities in organisms. Although higher values were recorded in the dry season than the wet season, as reported by Etesin et al*.* (2013) and Makwe and Chup (2013), the difference between seasons in both stations was not significant. Electrical conductivity (EC) values of 377.78±23.38 and 534.52±51.39 were recorded for Ologe lagoon and Badagry creek respectively. Higher values of EC were recorded during the dry season than the wet season. This is in agreement with the findings of Allison (2006) and Kingdom et al. (2013). Although these values are within the recommended <700 µmhos/cm (WWB, 2009; Ezzat et al*.*, 2012), the slightly high values can be attributed to the effects of evaporation which is more pronounced in the dry season.

Mean value of total dissolved solids (TDS) for Ologe lagoon (210.52±11.01 mg/l) and Badagry creek (298.70±30.56mg/l) were within recommended limit of 1000 mg/l (WHO, 2008). The values were higher in the dry than the rainy season, as reported by Ladipo et al. (2011). The mean values for total suspended solids (TSS) were 39.53±4.04 mg/l and 40.62±4.07 mg/l for Ologe lagoon and Badagry creek respectively. Similar to the seasonal variations in the values of TDS, the TSS recorded higher values in the dry than the rainy season. These TSS values are higher than the WHO (2008) recommended limit of 30 mg/l for drinking water, and might signify high anthropogenic activities around the water bodies. According to Chagas and Suzuki (2005), high TSS causes water to heat up faster and consequently might adversely affect aquatic life. Mean values for free carbondioxide for the both stations were 40.46±9.16 mg/l (Ologe lagoon) and 42.45±9.91 mg/l (Badagry creek). Akintola et al*.* (2011) reported values for free carbondioxide (CO_2) to be within the range of 0.80 to 10.00mg/l in Badagry creek, and Micheal (1992) reported that free CO_2 concentration less than 10.00 mg/l are usually tolerated by fish if dissolved oxygen concentrations are near saturation, but values above 10.00 mg/l are known to cause mineral deposits within kidney tubules, collecting ducts and ureters. Thus, the recorded values of free CO_2 appear was high. Biochemical Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen removed from water by aerobic bacteria for their metabolic requirements during the breakdown of organic matter (Chapman, 1996). Higher values of BOD were recorded during the dry season and this may be due to higher rate of decomposition of organic matter at higher temperatures and less water current (Sanap et al*.*, 2006).

With the exception of EC, TDS and TS, there was no significant difference in the spatial variation between Ologe lagoon and Badagry creek for all the other parameters. This is possibly because, although Ologe lagoon receives industrial effluents from Agbara Industrial Estate, the point (Oto jetty) from which samples were collected along the lagoon was relatively far from the effluent discharge points. TDS and EC varied spatially between the two stations with higher values in Badagry. This can be attributed to greater human activities along the Badagry creek and influence of the marine environment as a result of closeness of Badagry creek to the sea.

Proximate composition

Proximate composition provides information about the nutritive value of an organism and it is influenced by morphological and environmental factors such as sex, size and age as well as season of collection of organisms (Huang et al., 2005; Rosa and Nunea, 2005; Mridah et al., 2005; Ferdose and Hossain, 2011). From the results of seasonal variation in proximate composition of *M. macrobrachion* (Table 2), it was observed that a higher value for moisture content was recorded in wet season than in dry season. This is probably as a result of abundance of rainfall in wet season. Ehigiator and Oterai (2012) reported moisture content for *M. vollenhovenii* to be 10.64±0.11%. Islam et al*.* (2017) studied comparative analysis of wild and cultured prawn (*M. rosenbergii*), and reported moisture content for wild prawn as 71.44±1.43%. Saravana-Bhavan et al*.* (2010) also reported moisture content in the body of adult *M. rosenbergii* as 76.4 and

75.5% from two different natural climes. These reported values are slightly higher than the values recorded in this study; however, Bassey et al. (2011) reported that low moisture content in prawn increases the shelf- life. Moisture content, ash and lipid showed significant seasonal variation (p>0.05) while no significant seasonal variation was recorded for crude protein, crude fibre and crude carbohydrate in prawns of Ologe lagoon. Crude lipid, ash, crude carbohydrate, crude protein and crude fibre showed significant seasonal variation (p>0.05) while moisture showed no significant seasonal variation for prawns in Badagry creek. Crude lipid had higher value in wet season (10.06±0.18%) than in dry season (7.36±0.26%) for Ologe lagoon, and also 8.93±0.12% (wet season) and 6.25±0.58% (dry season) for Badagry creek. This agrees with the findings of Azim et al. (2012) who reported that lipid percentage decreases in the summer and slightly increases in the monsoon. The mean value for crude lipid for Ologe lagoon and Badagry creek were 8.57±0.46% and 7.59±0.32% respectively which compared favourably with that of Ehigiator and Oterai (2012). Low lipid content is an indication that the prawn would not be subjected to rancidity (Deekae and Idoniboye, 1995). Crude protein - 17.12±1.14 and 16.23±0.47% - for Ologe lagoon and Badagry creek respectively was the highest value amongst all the nutrients in the prawn, and this agreed with the results of the study by Ehigiator and Oterai (2012). Portella et al. (2013) also reported protein contents of 21.5 and 18.5% in *M. amazonicum* and *M. rosenbergii* respectively. The high protein value recorded in this study is an indication that the prawn is a good source of protein. Slightly higher values of crude protein were recorded in the wet than the dry season; however, the difference was not significant.

The carbohydrate contents for *M. macrobrachion* from Ologe lagoon and Badagry creek were 8.49±0.34 and 9.68±0.79% respectively. This agreed with the findings of Reddy et al. (2008) that reported that the carbohydrate content of cultured and frozen *M. rosenbergii* were 5.02 and 8.34% respectively. The mean ash content for Ologe lagoon and Badagry creek were 2.53±0.03% and 2.19±0.02% respectively. Although these values are close to the value (4.06%) reported for *Penaeus semisulcatus* (Diler and Ata, 2003), they are however lower than 10.28±0.30% reported for ash by Ehigiator and Oterai (2012). Higher values of ash were recorded in the dry season. The level of ash is an indicator of the mineral content of the organism. The mean crude fibre content for both stations were 0.56±0.11% (Ologe lagoon) and 0.13±0.01% (Badagry creek). The mean value for Ologe lagoon was similar to 0.54±0.02% reported by Ehigiator and Oterai (2012) while that of Badagry creek was lower. Jike–Wai and Deekae (2000) reported that all animal products contain lower fibre content than plants. There was no significant difference for spatial variation in proximate composition between the prawns in Ologe lagoon and Badagry creek. This ought not to be as there was effluent discharged into Ologe lagoon and human activities in Badagry creek but the effects of these activities decrease from the points of discharge to the point where samples were collected.

Conclusion and recommendations

With the exception of EC, TDS and TS, the physico-chemical parameters of Ologe lagoon and Badagry creek did not show significant seasonal and spatial variations, though pH showed seasonal variation in Ologe lagoon. The values of these parameters were within the recommended level for water and the survival of *Macrobrachium macrobrachion*. Although moisture content, crude lipid and ash showed significant seasonal variation, there was no significant spatial variation in all the proximate composition parameters between both stations. However, there is need for constant regulation and monitoring of these water bodies in order to control the water quality which will affect the growth, survival and reproduction of organisms and their proximate parameters. Also, there is need for regular monitoring of industrial effluents and domestic wastes discharged into these water bodies to promptly detect sudden increases and take necessary steps to prevent its harmful effects on aquatic organisms. Furthermore, awareness programmes should be carried out by the Government and researchers to educate inhabitants of surrounding fishing communities on the effects of human activities on aquatic life.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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