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Assessment of effect of fish feeding practices on the water quality of some fish ponds in Ekiti State Fish Farm, Ado Ekiti, Nigeria

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Abstract
The present study was aimed to access the effect of fish feeding practices on the water quality of some fish ponds in Ekiti State Fish Farm, Ado Ekiti, Nigeria. Water samples for physico-chemical parameters were collect fortnightly, from the selected ponds and reservoir for a period of six month. Proximate composition of the fish diets (Coppens, Vital and CHI) used were also carried out using standard methods. Proximate analyzed showed that CHI feed had the lowest lipid and crude protein content, the highest crude protein and lipid content was recorded for Coppens feed. Pond 2 was found to have the mean lowest dissolved oxygen content while pH total alkalinity and acidity, conductivity, TOC, OM, BOD, Ca^{2+}, Mg^{2+}, NO_3^- and SO_4^{2} contents were significantly higher (p< 0.05) in pond 2 than other stations. The study concluded that feed quality and feeding frequency negatively impacted the water quality of the fish ponds.

Keywords: Feeding Practices, Fish pond, Physiochemical parameter, Water quality

Introduction

Fish, which constitute one of the cheapest sources of animal protein is generally appreciated as one of the healthiest source of protein because it has amino acid compositions that are higher in cysteine than most other source of animal protein [1]. Fish production in aquaculture is now on the increase as a result of high demand of fish food and over exploitation of fishes in the wild. However, for higher growth rate and greater yield in fish farming, supplementary feeding and pond fertilization has implicated to contribute significant [2]. Therefore, sustainability of aquaculture depends on supplementary feed source and management [3]. However reported that feed quality and frequency of feeding are two important factors contributing to high nutrient inputs into fish pond. Overfeeding or poor feed utilization by the fishes could also leads to nutrient enrichment of the fish pond with concomitant water quality changes, these might increase algal production and degraded habitat which could affect fish abundances and the culture system [4]. Therefore, feeding practices must be developed to minimize feed wastage and deterioration of water quality. Water is an essential component of the earth [5]. Water quality refers to the chemical, physical, and biological characteristic of water [6]. Determinants of optimum water quality for aquatic biota in a water body includes: adequate level of dissolved oxygen, hardness, turbidity, alkalinity, nutrients, and temperature [7]. Conversely, other parameters like biological oxygen demand and chemical oxygen demand indicate the pollution level of a given water body [7]. Water quality is determined by various physico-chemical and biological factors, which directly or indirectly affect its quality and consequently its suitability for production of fish and other aquatic animals [8]. Ekiti State fish farm which is one of commercial fish farm in the Ekiti State, Nigeria has several earthen ponds stocked with different fish species which are being fed different diets. Evaluating and providing information on the effect of feed quality, feeding, practices, and the frequency of feeding of fishes in Ekiti State fish farm on the quality of water in ponds is essential., Hence this study was aimed to access the effect of fish feeding practices on the water quality of some fish ponds in Ekiti State Fish Farm, Ado Ekiti, Nigeria.

Materials and Methods
Study Area
This study was carried out in Ekiti state government fish farm managed by the fisheries division, Ministry of Agriculture and Natural Resources, Ado Ekiti, Ekiti State, Nigeria. The state is situated entirely within the tropics and is located between longitudes $4^0 45^1$ and $5^0 45^1$ east of the Greenwich Meridian and latitudes $07^0 5^1$ and $08^0 55^1$ north of the equator. The investigated ponds in the study site are located within the Latitudes $07^0 37'$ 54.6''N to $07^0 37'$55.9''N and Longitudes $05^0 12'$35.2''E to $05^0 12'$36.8''E, while the land elevation is within 425 m to 431 m above sea level (Fig 1).

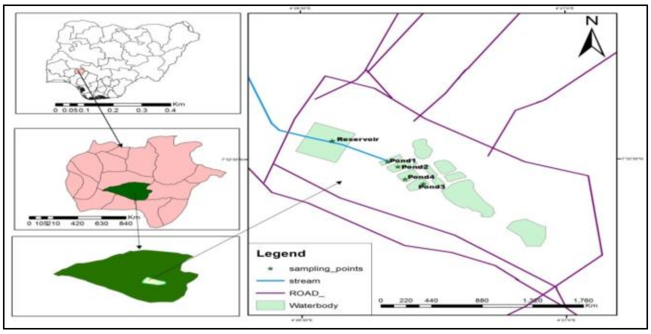

Fig 1: (1) Map of Nigeria showing Ekiti state, (2) Map of Ekiti state showing Ado-Ekiti local government, (3) Map of Ado-Ekiti local government showing the sampling locations, (4) The sampled ponds in relation to other pond in the fish farm.

Evaluation of the Fish Feeding Practices adopted in the Farm
Structured questionnaires were administered to three officers in the Department of Aquaculture, Ekiti State Ministry of Agriculture to ascertain the pond condition, stocking density and feeding practices adopted in the farm. The following important questions were addressed in the questionnaire: type, size and depth of the ponds; type, age and number of fish stocked; feeding practices used and water supply source.

Proximate composition of feed
The protein, lipid, carbohydrate, ash content, ether extract and the moisture contents of the commercial feeds fed to the fishes were analysed according to the methods [9].

Selection and description of the sampled ponds
Four ponds designated (P1, P2, P3 and P4) were selected out of the stocked ponds based on the types of feeds used and the feeding practice being adopted on the farm. The water conservation reservoir (S1) which supplied water to the ponds was selected as the control. Each of the selected earthen pond which was rectangular in shape measured about 400 m^2 with a depth of about 0.8 m. Each pond was stocked with juveniles of the African catfish, *Clarias gariepinus*.

Sampling procedure and field determinations
Water samples for physico-chemical parameters were collected fortnightly, from the selected ponds and the reservoir for a period of six month between September 2014 and February 2015. An improvised water sampler with 2 liter capacity was used for the sampling. Water temperature (using mercury in glass thermometer), pH (using pH meter), were determined on the field *in situ.* Samples for dissolved oxygen (DO) and five-day biochemical oxygen demand (BOD_5) were collected in oxygen bottles (250 ml reagent bottles). Dissolved oxygen samples were fixed on the field immediately on the collection with Winkler's reagents A and B. BOD_5 samples were collected in black reagent bottles, wrapped in a black nylon and kept in dark cupboard at room temperature (about 27±2 ^{0}C) for five days.

Analyses of physico-chemical parameters of water quality
Total dissolved solids (TDS)
The TDS was estimated gravimetrically. The dissolved substance was removed by filtering 100 ml of water samples through a 0.45 µm millipore membrane filter under suction pressure. The filtrate was dried to constant weight at 105±2 ^{0}C [10].

Conductivity
Conductivity meter was used to determine the electrical conductance of water. A small volume of the sample was poured into a container and the electrode of the conductivity meter was immersed in it at a room temperature. Readings were subsequently taken. The electrode was pre-rinsed with distilled water before and after each measurement.

Turbidity
Nephlometric method was used to determine water turbidity. A turbidimeter (Jenway 6501) was used to measure the turbidity of each sample. The wavelength of the equipment was set at 540 nm and distilled water was use as blank to adjust the light transmittance to 100. Water sample were filled into a colorimeter curvet and transmittance measure at a wavelength of 540 nm [10].

Colour (True and Apparent)
Colorimeter method was used for colour determination. A (Spectronic Instrument 20 D+) colorimeter was used to measure the true and apparent colour of each sample. The wavelength was set at 430 nm and distilled water was use as blank to adjust the light transmittance to 100. Water were filled into the colorimeter curvet and transmittance measured at wavelength of 430 nm. For true colour, the water samples were filtered using Whatmann filter paper before measurement [10].

Alkalinity
Acid-base titration method was used to determine the water alkalinity. Fifty (50) ml of the water sample was measured into a 250ml Erlenmeyer flask and 5 drops of mixed indicator (bromocresol green and methyl red) was added, solution turned light blue and the solution was titrated with 0.02N sulphuric acid (H_2SO_4) until colour changes to pink [10].

Total acidity
Total acidity was determined by acid-base titration of water sample with standard calcium carbonate solution (0.2N $CaCO_3$) using phenopthaline indicator. Fifty (50) ml of the water sample was measured into a 250 ml Erlenmeyer flask and 5 drops of indicator was added, the solution which turned colourless and the solution was titrated with 0.2N Calcium carbonate until colour changes to pink [10].

Calcium ion concentration
Complexiometric method was used to determine the level of Ca^{2+} in the sample. Fifty (50) ml of water sample was measured into 250 ml Erlenmeyer flask and 5 ml of 0.1N NaOH buffer was added to adjust pH to 10 and 0.2 g of calcon indicator was added using a spatula. The solution

which turned purple was then titrated against 0.0141 N Ethylene-Diamine Tetra-Acetic acid (EDTA), until blue colour end point was observed [10].

Magnesium ion concentration
Complexiometric titration method was also used for the determination. Calcium and magnesium levels were determined so as to get the concentration of magnesium in the water sample. Fifty (50) ml of the sample was measured into a 250 ml Erlenmeyer flask and 2 ml of calcium and magnesium buffer was added. Calcium magnesium indicator (0.2 g Eriochrome blue black) (0.2) g was also added using spatula and the solution which turned purple was then heated for 2 minutes and titrated against 0.0141 N ethylene-diamine tetra-acetic acid (EDTA), until blue colour end point was observed. The difference in the value of calcium determined and that of calcium and magnesium gives the concentrated of magnesium in water sample [10].

Potassium ion concentration
Flame emission spectrophotometer (FES) was used for K^+ determination. Distilled water used to set the light transmittance of the FES to 100 at 769 nm wavelength. Ten (10) ml of water sample was then aspirated into the flame photometer and the intensity emitted radiation was compared with that calibrated graph of standard solution of KCl to determine the K^+ concentration [11].

Sulphate ion concentration
Turbidometric method was used to determine the SO_4^{2-} level. Twenty five (25) ml of the sample was measured into a sterile specimen bottle and 5 ml of glycerol-alcohol and 5 ml NaOH-HCl was added respectively. The solution was then shaken vigorously and a small amount was introduce into a cuvette and turbidity was measured at 430 nm using a Jenway 6501 turbidity meter, 0.02 g of Barium Chloride ($BaCl_2$) was then added to the solution in the specimen and shake bottle using automated shaker for 15 minutes, after which absorbance was measured at the same wavelength. The concentration of the sulphate ion present in the water sample was obtained as a difference in the value of turbidity before adding $BaCl_2$ [10].

Nitrate (NO_3^{2-})
This was estimated colorimetrically by using 0.2 NaOH, hydrazine sulphate and sulphamilamide reagent and with green filter. To 5 ml of water samples measured in a test tube, 1 ml of NaOH solution, 5 ml of 80% H_2SO_4, and 5 drops of Brucine-Sulphanilic acid solution was added and swirled to mix thoroughly. The solution was then placed in a rack of tubes in a well stirred boiling water bath that maintained a temperature of not less than 95 °C for 20 minutes. Thereafter, the sample was immersed in a cold water bath to allow for cooling. The sample was then turned into cuvette for nitrate's absorbance reading in a Jenway colorimetric meter at wavelength of 430 nm [12]

Total organic carbon and organic matter (TOC and OM)
Chromic acid digestion was used for determination of TOC and OM content. 100 ml of sample was measured into a 250 ml Erlenmeyer flask, 10ml of potassium dichromate ($K_2Cr_2O_7$) solution and 20 ml of concentrated H_2SO_4 was added respectively. The solution which turned yellow was left for 24 hours to allow for proper digestion of the organic content. To the digest, 100 ml of distilled water and 5 ml or Orthophosphoric acid was added to initiate further breakdown reaction. Ten (10) drops of Barium Diphenyl Amine Sulphonate indicator was then added which made the solution to turn blue-black. The solution was titrated against 0.1N Ferrous Ammonium Sulphate (FAS) until a light green colour end point was observed [11, 12].

Statistical Analysis
The data collected were subjected to one- way analysis of variance (ANOVA) using SPSS version 17.00 to determine differences between mean values. Significant differences were considered to be significant at $p < 0.05$ and $p < 0.01$ levels.

Results
Feeding practices in the fish farm
From the information gathered from the questionnaire, inconjuntion with the observed operational practices during the period of study, three (3) types of commercial pelletized feeds: Coppens (manufactured in Netherland), Vital feed (manufactured in Nigeria) and CHI feed (manufactured in Netherland) were commonly used to feed the fishes. Feeding was done twice a day at exactly 7:00 am in the mornings and 5: 00 pm in the evenings. According to the respondents, ration allotment were done according to the fish body weights. The respondent also confirmed that the different commercial feeds were mixed together to feed the fishes. During the sample collection, it was observed that the workers used a broadcasting feeding system. It was also observed that after feeding the fishes, the uneaten feeds on the surface of the water were always left for the fishes to feed on when they are less satiated. The respondents reported that in ponds 1 and 3 Coppens and Vital feeds in equal proportions were used while in pond 2 and 4, a mixture of Coppens and Chi feeds were employed in feeding the fishes.

Proximate composition of the commercial feeds
Comparative analyses of the proximate constituents of the commercial feeds are shown in Table 1. The analysis showed that the moisture, ash and crude fiber components of the three commercial diets fed were not significantly different ($p > 0.05$) from each other. However, the analyses revealed that the lipid, crude protein and N.F.E. content of the three diets were statistically different ($p < 0.05$). The result showed that protein content of the CHI feed was the lowest in all the 3 feeds used during the period of sampling while the highest value of crude protein was recorded in coppens feed during the period of sampling.

Table 1: Mean proximate composition of feeds samples used in Ekiti state fish farm during the period of study

(%) Composition	Coppens		Vital		CHI	
	Determination	Manufacture specification	Determination	Manufacture specification	Determination	Manufacture specification
Moisture	6.71±1.00	-	7.46±2.05	12.00	7.26±1.00	9.0
Ash	7.14±1.05	10.4	7.89±1.03	-	5.65±2.50	2.50
Crude fibre	0.69±0.90	1.60	1.49±0.65	2.80	1.45±0.90	2.50

Crude lipid	8.42±2.05	15.00	10.92±0.65	11.00	8.03±1.65	12.00
Crude protein	45.94±1.56	56.00	43.75±1.03	45.00	39.38±2.00	45.00
Nitrogen free extract	36.10±2.00	-	28.49±1.85	-	38.23±3.03	-

Monthly variation in physical properties of culture water

The mean monthly variation in the temperature of water collected from the reservoir and the sampled fish ponds is shown in Fig 2, the mean temperature was shown to vary between 24.46 ± 0.32 °C (pond 4; January 2015) and 26.79 ±0.32 °C (pond 2; October, 2014), there was no significant difference ($p < 0.05$) in the mean temperature of cultured water during the period of study (Table 1). Turbidity of water collected from the reservoir and the sampled fish ponds is shown in Fig 3. Analyses showed that the turbidity level increased progressively between September 2014 and January 2015 before a slight fall in February 2015 in Pond 2. Comparative analyses of the mean turbidity levels between the reservoir and the ponds (Table 2) showed there was significant difference ($p < 0.05$) in the turbidity of water in the various ponds. In the fish ponds sampled, the apparent colour of water decreased progressively from September 2014 to February 2015 (Fig. 4). Apart from pond 2 where lower water true colour was recorded irrespective of the month of sampling, the true colour of water in the reservoir, pond 1 and 3 varied within narrow amplitude (Fig. 5).

Table 2: Post-Hoc Multiple Comparison (Duncan) to compare physical parameters of the reservoir and the sampled fish ponds

	Reservoir	**Pond 1**	**Pond 2**	**Pond 3**	**Pond 4**
Parameters	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D
Temperature (^{0}C)	25.81±1.03^a	26.10±0.77^a	26.51±0.59^a	25.0±0.97^a	26.53±0.56^a
Turbidity (NTU)	21.36±30.28^a	75.42±56.8^b	185.92±66.58^b	78.47±28.59^b	147.58±36.65^b
Apparent colour (Pt.Co)	91.18±4.09^a	62.63±17.5^b	37.63±18.07^c	76.18±6.89^a	47.09±14.29 ^{c}
True colour (Pt.Co)	95.54±1.96^a	85.27±9.07^{ab}	63.36±17.93^c	90.81±2.31^a	77.90±12.23^{ab}

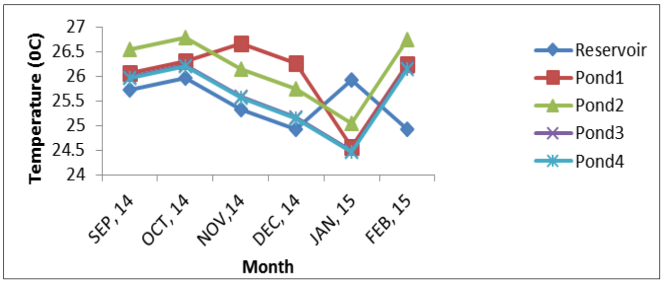

Fig 2: Mean monthly variation in the water temperature of water during the period of study

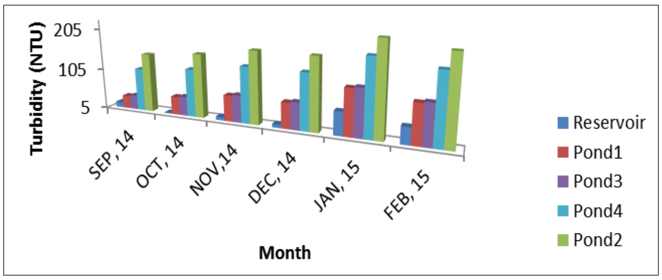

Fig 3: Mean monthly variation in the turbidity of water in the different studied culture media

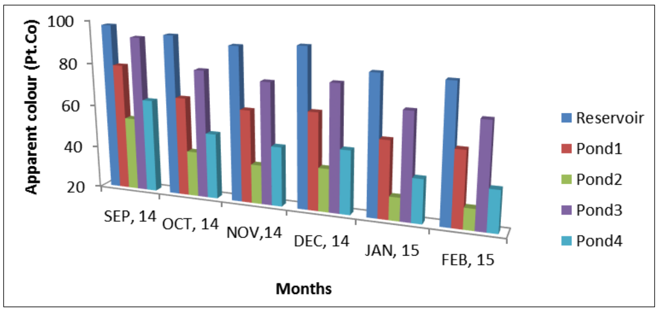

Fig 4: The monthly mean apparent colour of water in the reservoir and the studied fish ponds

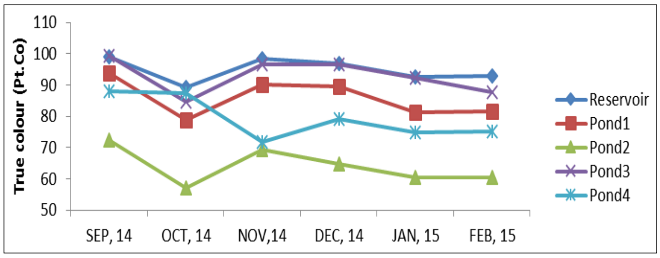

Fig 5: The mean monthly variation in the true colour of water in the reservoir and the fish ponds studied.

Monthly variation in chemical properties of culture water

The monthly variation in the mean pH of water samples collected from the reservoir and the studied fish ponds is shown in (Fig. 6), however pH analyses on pond 2 and 4 were significantly different ($p < 0.05$) when compared with those of the other ponds and the reservoir (Table 3). The lowest conductivity value was recorded in the reservoir samples irrespective of the month of collection (Fig. 7). In Table 3, pond 2 water sample was found to be significantly different ($p < 0.05$) than the reservoir and those of other ponds samples. Analyses showed that the TDS values in the reservoir, pond 1, 3 and 4 had a bi-modal pattern with peaks in September 2014 and February 2015 (Fig.8). Acidity of the reservoir and the fish pond was also found to increase progressively in succeeding months from September to November, likewise between December 2014 and January 2015 before a gradual decline between January and February 2015 only in pond 2 (Fig. 9). Apart from the month of October 2014, water in pond 2 was found to have the highest acidity during the period of study (Fig. 9). In September 2014, the water alkalinity in the fish ponds was significantly higher than that of reservoir water. In October 2014, the mean alkalinity level (135.00 ± 52.33 mg/L$CaCO_3$) was significantly higher in pond 4 than in other fish ponds and the reservoir (Fig. 10) Comparative analyses in Table 3 showed that pond 2 was significantly higher ($p < 0.05$) than the reservoir and those other ponds. The level of the dissolved oxygen in the reservoir water was relatively high during the period of study varying between 8.50 ± 0.42 mg/L (January, 2015) and 11.20

± 2.26 mg/L (October 2014) (Fig. 11). The results showed that between September and November 2014, a relatively low biological oxygen demand values were recorded for the reservoir and the selected fish pond water samples (Fig. 12), however the reservoir had significantly (p < 0.05) lower BOD_5 than other ponds (Table 3). The monthly variation in the organic matter content (Fig. 13) and total organic carbon (Fig. 14) followed the same trend the organic matter and total organic carbon levels were significantly higher (p < 0.05) in the fish ponds than in the reservoir.

Table 3: Post-Hoc Multiple Comparison (Duncan) to compare chemical parameters of the reservoir and the sampled ponds.

Parameters	Reservoir Mean±S.D	Pond1 Mean±S.D	Pond2 Mean±S.D	Pond3 Mean±S.D	Pond4 Mean±S.D
Total alkalinity (mg/LCaCO$_3$)	67.45±24.07^{b}	96.54±34.92^{a}	173.63±55.49^{c}	90.18±35.44^{a}	117.63±32.38^{b}
Total acidity (mg/LCaCO$_3$)	19.25±9.02^{a}	43.18±18.80^{b}	91.63±38.45^{bc}	32.63±7.68^{a}	44.36±15.66^{b}
pH	6.94±0.29^{a}	6.89±0.31^{a}	7.27±0.33^{b}	6.89±0.44^{a}	7.02±0.544^{b}
TDS Ppm	103.51±31.47^{a}	139.63±18.33^{ac}	311.64±74.65^{b}	138.12±49.5^{ac}	155.31±53.2^{c}
Conductivity (μsmc^{-1})	165.43±11^{c}	233.78±38.80^{a}	529.27±142.54^{c}	229.92±66.68^{a}	260.05±67.80^{a}
DO (mg/L)	9.32±1.41	3.96±1.59^{a}	2.67±3.14 ^{a}	6.54±3.14	4.33±1.28 ^{a}
BOD (mg/L)	3.63±1.22	5.51±2.34	12.42±7.23	4.06±0.50	7.36±2.84
TOC (mg/L)	2.67±0.81^{c}	5.04±1.52^{b}	8.64±2.51^{c}	4.21±1.21^{b}	7.27±1.55^{b}
Organic matter (mg/L)	4.61±1.39^{c}	8.67±2.67^{b}	14.86±4.35^{c}	7.26±2.09^{b}	12.54±2.67^{b}
Nitrate (mg/L)	5.42±0.64^{a}	5.99±0.44^{a}	7.63±1.65^{a}	6.06±0.50^{a}	7.36±0.92^{b}
Sulphate (mg/L)	1.33±1.42^{c}	4.33±1.66^{c}	8.40±3.07^{b}	7.06±2.78^{b}	10.79±2.13^{c}
Calcium (mg/L)	24.80±6.06^{a}	27.59±4.97^{b}	39.15±11.2^{bc}	25.13±3.00^{a}	28.29±5.61^{b}
Magnesium (mg/L)	4.38±2.57^{a}	4.49±2.38^{a}	9.37±5.95^{b}	4.73±2.47^{a}	4.76±2.28^{a}
Potassium (mg/L)	0.103±0.02^{a}	0.148±0.05^{a}	0.250±0.04^{a}	0.145±0.02^{a}	0.220±0.03^{a}

The result showed that the organic matter and total organic carbon contents were significantly higher in water samples collected from pond 2 and 4 than those of samples collected from the reservoir and ponds 1 and 3 respectively in the months of September and October 2014 and January 2015. Between the months of November 2014 and February 2015, a sharp rise in level of calcium ion was recorded in pond 2 while in ponds 4, the Ca^{2+} concentration showed a slightly progressive increment between November 2014 and February 2015 (Fig. 15). Analyses showed that in September 2014 the level of magnesium ion was significantly higher in ponds 2 and 4 while in November, 2014 the level of the magnesium was significant only in ponds 2 and 4 (Fig. 16), moreover magnesium ion concentration showed that there were no significant difference (p > 0.05) between reservoir and the ponds apart from pond 2 which was statistically higher (p < 0.05) than other sample ponds and the reservoir (Table 3). Irrespective of the month, the reservoir had the lowest level of potassium ion while the highest potassium ion concentration was recorded in pond 2 followed by pond 4 (Fig. 17). Analyses showed that in the month of September 2014 and February 2015, the level of nitrate in pond 2 and 4 were found to be significantly higher than all the other studied ponds and the reservoir (figure 18). Irrespective of the month of sampling, water in the reservoir had the lowest concentration of sulphate while the highest sulphate value was recorded in pond 4 (Fig. 19).

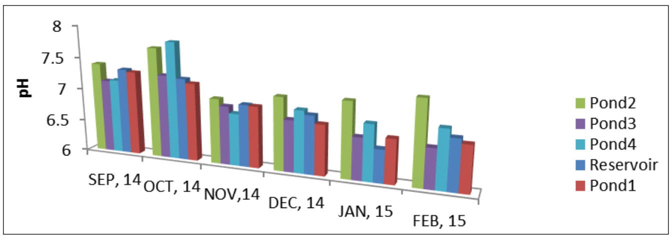

Fig 6: The monthly variation in means of pH of water samples collected from the reservoir and the sampled fish ponds.

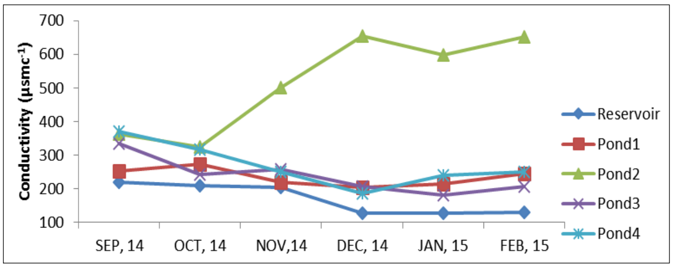

Fig 7: The monthly variation in the mean conductivity of water samples collected from the reservoir and the studied fish ponds.

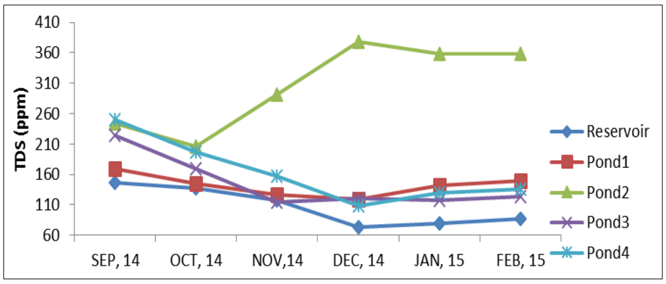

Fig 8: The monthly variation in the mean of total dissolved solid content of the reservoir and the fish ponds during the period of study.

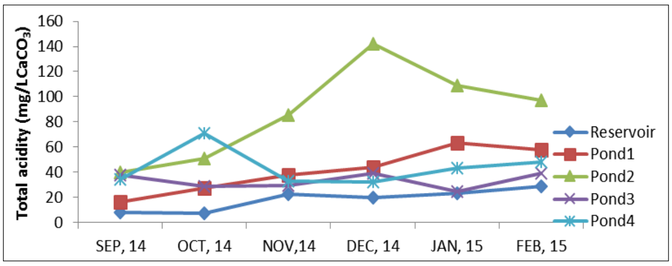

Fig 9: Monthly variation in the mean total acidity of the reservoir and the fish pond water.

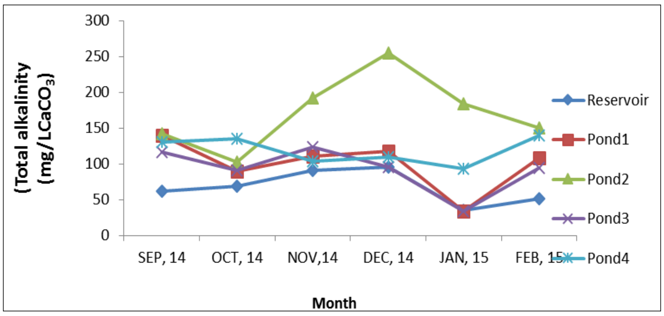

Fig 10: Monthly variation in the mean total alkalinity of water from reservoir and the sampled fish ponds.

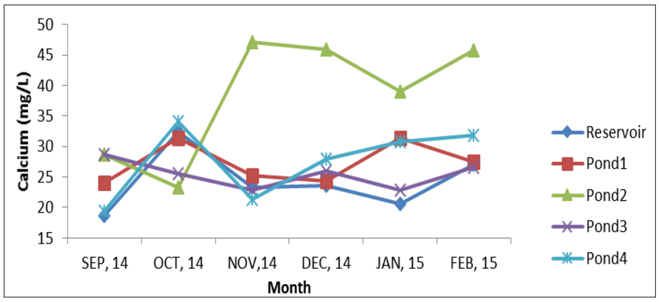

Fig 15: Monthly variation in the mean of calcium ion content of the reservoir and the fish pond water samples during the period of study.

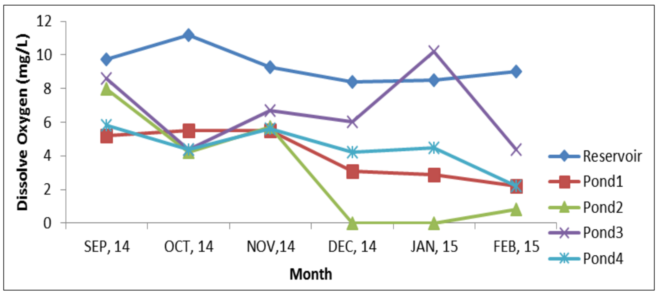

Fig 11: The monthly variation in the mean of dissolved oxygen level of the reservoir and the fish ponds during the period of study.

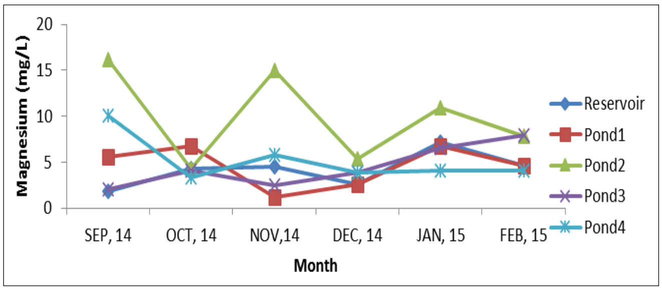

Fig 16: Monthly variation in the mean magnesium ion content of water samples collected from the reservoir and the studied fish ponds.

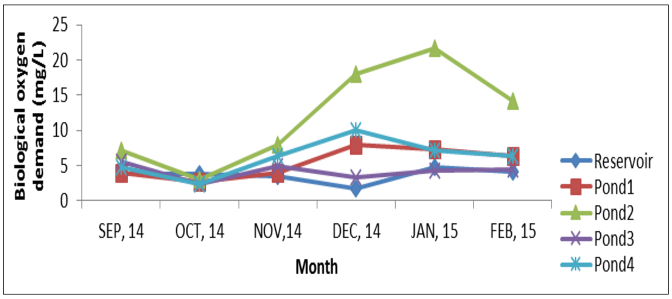

Fig 12: The monthly variation in the mean biological oxygen demand of water samples collected from the reservoir and the studied fish ponds.

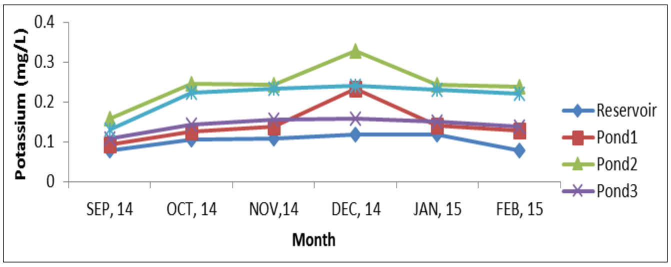

Fig 17: Monthly variation in the mean potassium ion concentration in water samples collected from the reservoir and the studied fish ponds.

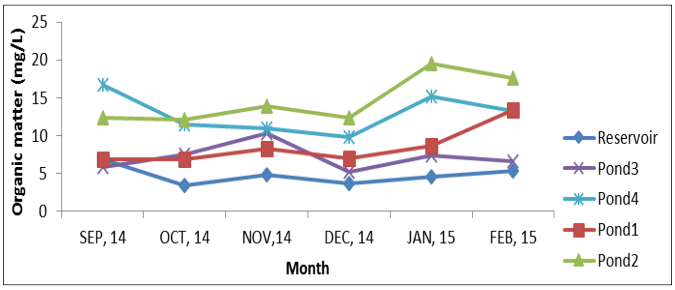

Fig 13: The mean monthly variation in the organic matter content of water in the reservoir and the fish ponds studied.

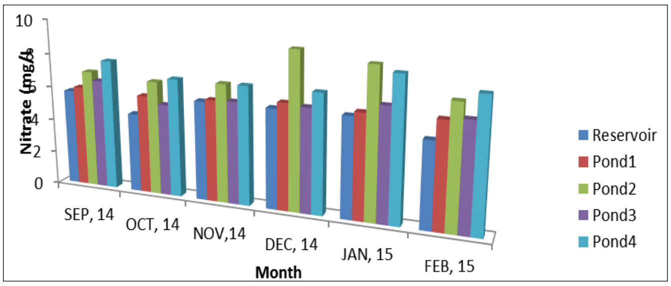

Fig 18: Monthly variation in the mean nitrate concentration in water samples collected from the reservoir and the studied fish ponds.

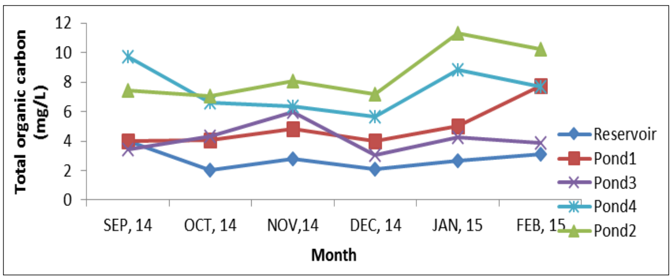

Fig 14: Mean monthly variation in the total organic carbon content of water in the reservoir and the fish ponds studied.

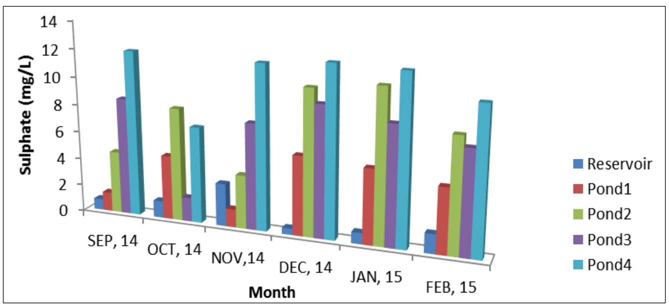

Fig 19: Monthly variation in the mean sulphate ion content of water samples collected from the reservoir and the studied fish ponds.

Discussion

The feeding practices adopted in the Ekiti state fish farms significantly impacted the water quality of the culture ponds. In most instances, the nutrient levels of water in the culture ponds were significantly elevated by the feeding practice adopted. Other factors which might have led to the impaired of the water quality parameters in the culture ponds compared to the reservoir water include the release of excretory products from metabolic activities of the cultured fishes [13]. Also microbial decomposition of uneaten feeds and faecal matters, which leads to mineralization and release of nutrient into the water of the culture will ensure additional nutrient input into the systems [14]. The type and quality of nutrient in the commercial feeds fed to the fishes is equally important where ingredients are not properly bound with an adequate binder, there is tendency for the nutrients in the feed to leach into water before the feed is consumed by fish. Diets formulated with protein sources of low biological value have been shown to exhibit high content of non-protein nitrogen, which causes an imbalance in amino acid ratio [15]. Feeding such a low biological protein diet to fish will lead to increase in metabolic excretion, with a consequently negative effect on the water quality [15, 16]. The sudden rise of water temperature in the reservoir in January 2015 could be attributed to seasonal variation which probably affects the ambient temperature. Also reduction in the depth of the water in the pond during these period implied that, light rays could penetrate through the water column hence the water would be easily heated to higher temperatures [17]. The increase in the values of turbidity during the period of study was probably due to the feeding practice adopted in the farm. The fine silt particles faecal matters and particles of uneaten food which are raised in a flux during scrambling for food during feeding are most likely going to remain suspended in water. [18] suggested that clay turbidity in water up to 30 NTU or higher may prevent development of plankton blooms, while turbidity values below 30 cm generally are adequate for good fish production [19]. The pH values in all the ponds and the reservoir in September and October 2014 were acidic and became slightly alkaline from November 2014 to February 2015. This could be attributed to acidic condition by higher precipitation between September and October 2015 and reduction in the precipitation during dry season makes the water alkaline in the subsequent months [20, 19]. The conductivity values of the reservoir and all the ponds were not exceeding the tolerance limit of aquatic life [21]. Although, during the study period mean conductivity were higher in all the ponds which could be attributed to rise in the level of uneaten feeds dissolved in the water. The high value of total dissolved solid observed in September could be attributed to weathering intensity and the increased amount of ground water recharge. It could also be due to overfeeding and increasing level of uneaten feeds that dissolved in the water. However, all through the months during the study period, the TDS values are within the 1000mg/L recommended tolerance limits [22]. The high value of acidity observed in the reservoir and the ponds between Septembers to November could be attributed to agricultural activities around the culture farm resulting in runoff of herbicide residue into the ponds and could also be due to introduction of allocthonos material such as the type of feed used in feeding the fishes [23]. Rise in the mean total alkalinity values observed in the reservoir and all the ponds between November 2014 and February 2015 could be attributed to reduction in amount of precipitation fell causing the water to be alkaline. However, in all the months of the study period, the total alkalinity values are within the [24] limit for unpolluted pond. Dissolved oxygen of the reservoir and all the ponds were lower between December 2014 and February 2015 which could be attributed to oxidation of humic compounds available for decomposition and wind velocity that seemed lower thus reducing the movement of the water by wind action [25]. However, dissolved oxygen values in the reservoir were higher but lower in the ponds respectively than those reported by [26] on Calabar river and Ogun river, respectively. Increment in BOD level in all the ponds during the present study could be attributed to high amount biodegradable organic matter resulting from the rise in the level of uneaten feeds that dissolved in the water. It could also be due to fallen debris and faecal products of the fishes. The findings of [27] and [28] agreed with the result of this study. High Level of TOC and OM observed in all the months of the study in the respective ponds could be attributed to overfeeding and increasing level of uneaten feeds that dissolved in the water [18]. The high value of nitrate in the reservoir and the ponds could be attribute to the period of the season because nitrates level in water are usually built up during dry seasons. The high level of nitrate observed during this study is in agreement with [29] who concluded that nitrates are usually built up during dry seasons and that high levels of nitrates are only observed during early rainy seasons. The concentration of sulphates observed in the reservoir and all the ponds were in tolerable range and are within [30] tolerance limit (42.46 – 57.36 mg/L). Irrespective of the month of sampling, water in the reservoir had the lowest level of potassium ion while the highest potassium ion concentration was recorded in the all the ponds, this could be attributed to overfeeding and increasing level of uneaten feeds that dissolved in the water [31] (Boyd, 1979). The values of calcium and magnesium observed in the reservoir and the pond during the study period agreed with recommended range for free calcium and magnesium in culture waters [20]. In this present investigation, it was observed that the maximum and minimum parameters were not at the level of pollution. In this present investigation, it was found that the maximum and minimum parameters were not at the level of pollution. Although in pond 1, 2 and 4, most of the determine parameters were slightly higher in comparison with pond 3 and the reservoir that supplied water for all the ponds. This may be due to the rate at which the fishes are been fed, the type of feed been used and the adopted practice at those ponds mentioned. Conclusively, in this study the water quality in terms of its physico-chemical parameters of Ekiti state fish farm ponds were within the recommended values of World Health Organization (WHO) and American Public Health Association (APHA) standard for fish pond except turbidity, total alkalinity, total acidity, biological oxygen demand and dissolved oxygen which were slightly above and below the acceptable limit in some of the pond. However, feeding practices in the farm influenced the resultant physico-chemical properties of the water.

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