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Fecundity studies of the African catfish *Clarias gariepinus* (Burchell, 1822) fed Coppens feed and Unical aqua feed in circular concrete tanks

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ABSTRACT

Objective: To determine and compare the fecundity of *Clarias gariepinus* (*C. gariepinus*) fed with Unical aqua feed and Coppens feeds in concrete tanks, including the nature of relationship that exist between fecundity and morphometric indices of fish such as total length and total weight.

Methods: An experiment was conducted for 6 months in the fish farm of University of Calabar with two triplicate groups of 50 *C. gariepinus* post-fingerlings. The experimental fish weighing (0.50 ± 0.02) kg were stocked in concrete tanks (circular) of 16.63 m^2 area. The tanks were labelled A_1, A_2, A_3, B_1, B_2 and B_3. Fish in tank A_1, A_2 and A_3 were fed with Coppens feed and fish in tanks B_1, B_2 and B_3 were fed with Unical aqua feed. Feeding was done twice daily (9:00 and 16:00) at 3% of their body weight.

Results: Mean fecundity of *C. gariepinus* fed with Unical aqua feed (68 366.67 ± 15 966. 29) eggs varied significantly ($P < 0.05$) from *C. gariepinus* fed with Coppens feed (61 833.83 ± 11 692.31) eggs. A linear relationship was observed between fecundity and biometric indices (total length, total weight and ovary weight) of *C. gariepinus* fed with the two feeds. Food conversion efficiency of *C. gariepinus* fed with Coppens feed (50.94% ± 0.91%) was insignificantly higher ($P > 0.05$) than *C. gariepinus* fed with Unical aqua feed (50.37% ± 1.29 %). Water quality parameters including ammonia (mg/L), pH, water temperature (°C) and dissolved oxygen (mg/L) fell within the recommended range for the culture of fresh water fish.

Conclusions: Fecundity of *C. gariepinus* reared in concrete tank was significantly influenced by the experimental feed. Therefore, on the bases of affordability and availability to farmers, Unical aqua feed is more economical and is recommended as a cost-effective cultivation of female *C. gariepinus* broodstock.

1. Introduction

The African catfish [*Clarias gariepinus* (*C. gariepinus*)] which belongs to the Clariidae family continues to remain the most popular fish species in the Nigerian aquaculture. This could be due to several favorable physical, biological and socioeconomic characteristics exhibited by this species. Such characteristics include size, fast growth rate, high fecundity, fast gonadal development, disease resistance, ease of artificial breeding, high stocking densities under culture conditions, ability to tolerate a varying range of environmental conditions, acceptability of artificial feed, good taste, high quality meat and high market value[1]. Current statistics given by Food and Agriculture Organization indicates that apart from playing a significant role in hunger elimination, health promotion and poverty reduction, fisheries and aquaculture are also a source of wealth especially in developing countries such as Nigeria[2]. However, the growth rate of fisheries and aquaculture sector in Nigeria has been slow because of major challenges such as the availability of a cheap but high quality feed. This has led to the search for alternative and cheaper fish feed that will supply all the nutrients required by fish for optimal growth. Fecundity is an index which measures the number of eggs carried by a gravid female fish or shrimp[3]. During selection of species for aquaculture, fecundity is one of the important characteristics considered by scientists[4]. Fecundity is also used to evaluate the performance of aquaculture feed especially when a new feed is benchmarked. Aquafeed is

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known to influence fecundity and gonadal development in both shell and fin fishes[5-7]. Unical aqua feed is a new feed produced by the University of Calabar fish feed mill. Through the sponsorship of the Education Trust Fund, the feed mill was successfully acquired and installed in 2010 with the aim of providing high quality fish feed at an affordable rate to both extensive and commercial fish farmers in the South-South geopolitical zone in Nigeria. Comparative studies have been carried out on Unical aqua feed with other imported feed such as Coppens with respect to growth performance of *C. gariepinus*, egg and sperm quality of *C. gariepinus*, fecundity of *C. gariepinus* in earthen pond, gonad gross morphology and gonadosomatic index of *C. gariepinus*[6-9]. Meanwhile, no study have been reported on the fecundity of *C. gariepinus* fed with Unical Aqua feed and Coppens feed in concrete tanks. Therefore, this study was carried out to evaluate and compare the fecundity of *C. gariepinus* fed with Unical aqua feed and Coppens feeds in concrete tanks, including the nature of relationship that exist between fecundity and fish morphometric indices such as total length (TL) and total weight.

2. Materials and methods

2.1. Study area

This study was conducted at the Institute of Oceanography, Fish Farm Hatchery Complex, University of Calabar, geographically located at latitude of 4°55.9" N and longitude of 8°26" E.

2.2. Experimental design

This study was conducted for 6 months using three Education Trust Fund concrete tanks (circular) of 16.63 m^2 area. The tanks were divided into two equal parts using tarpaulin and hard wood to obtain six experimental units (A_1, A_2, A_3, B_1, B_2 and B_3) to abet triplication. Each of the tanks was filled with water to a volume of 8.32 m^3. The six tanks were stocked with 300 post-fingerlings of *C. gariepinus* collected from the Hatchery Complex of the University of Calabar fish farm. The post-fingerlings had a mean bulk weight of (0.50 ± 0.00) kg (*i.e.* 10 g for each post-fingerling). After stocking, the fish were allowed to acclimate for 7 days before the start of the experiment. During the acclimation period, feeding was done twice daily to the level of satiation. The start of trial brfore 24 h, the experimental fish were starved after which the average initial biometric parameters in each experimental unit including the wet body weight were measured.

The wet body weight was weighed to the nearest gram according to the method of Eyo and Ekanem using a METLAR MT-5000D electronic balance[10]. Coppens feed was fed to fish in units A_1, A_2 and A_3 while Unical aqua feed was fed to fish in units B_1, B_2 and B_3 at 3% of their body weight twice daily between 9:00 and 16:00. The final weight was measured at the end of the experiment in each of the experimental units. At the end of feeding trial, a total of 120 gravid females were collected from the two experimental treatments (60 from Coppens feed and 60 from Unical aqua feed) and used for fecundity studies. Water quality parameters including pH, dissolved oxygen (DO), ammonia and temperature were measured on weekly basis using standard meters and kits according to the method of Eyo *et al*.[11]. pH was measured using Hanna pHep pocket-sized pH meter, DO was measured using DO meter, ammonia was measured colorimetrically using ammonia test kit and temperature was measured using mercury-in-glass thermometer.

2.3. Composition of Coppens and Unical aqua feed

Coppens feed (42% cp) produced by Coppens International was composed of several grains, Ca, marine fish meal, lysine, refined fish oil, methionine, $CuSO_4$, Se and P. Unical aqua feed produced by fish meal feed of the University of Calabar was composed of corn powder, industrial fish meal, soybean meal, groundnut cake, lysine, bone meal, methionine, wheat flour, molasses, NaCl and vitamin premix.

2.4. Proximate analysis of Coppens feed and Unical aqua feed

Proximate analysis of the dry matter of Coppens feed and Unical aqua feed was done in Biochemistry Department, University of Calabar[12].

2.5. Fecundity estimation

Fecundity was determined according to Eyo *et al*. as the product of the number of eggs in 1 g of the egg-mass and total weight of the ovary[1]. For each gravid fish sample, morphometric measurements [TL (cm) and total weight (g)] were taken before eggs were removed. The eggs were removed by dissecting the fish abdomen with a sharp scissors. The eggs were collected and washed in distilled water before weighing to the nearest 0.1 g. The collected eggs were preserved in Gilson fluid for 48 h for easy separation of the eggs from the ovarian tissues before estimation. The diameters of 30 eggs per fish were measured according to protocols outlined by Mesa *et al*. using a stereomicroscope with an ocular micrometer eye piece[13].

2.6. Feed consumption and food conversion efficiency calculation

Food conversion efficiency (FCE) was calculated as follows[14]:

FCE = Weight gain (g) / Feed consumed (g) × 100

where food consumed was calculated as follows:

Food consumed = 3% × Body weight × Number of days

2.7. Statistical analysis

Data were screened using *t*-test analysis to obtain the fecundity of fish in the two experimental diets with the significant aid of Predictive Analytical Software version 18.0. Probability level of $P < 0.05$ was considered significant. Also, the type of relationship that existed between fecundity and morphometric indices of fish fed with the two experimental diets was established using correlation and linear regression model with the aid of Predictive Analytical Software version 18.0.

3. Results

3.1. Proximate composition of the dry matter of Unical aqua and Coppens feeds (mg/100 g)

Result obtained from the mean proximate composition of the dry matter of Unical aqua and Coppens feeds (mg/100 g) showed that Unical aqua feed had a higher moisture content (9.53 ± 0.15) than Coppens feed (8.23 ± 0.07). Similarly, mean fat content of Unical aqua feed (12.03 ± 0.02) was also higher than mean fat content of Coppens feed (11.57 ± 0.15). Unical aqua feed also had a higher crude protein content (43.30 ± 0.23) than Coppens feed (42.94 ± 1.34). Unical aqua feed had a lower mean crude fibre content (3.34 ± 0.10) than Coppens feed (3.53 ± 0.31). Similarly, Unical aqua feed also had a mean ash content (9.03 ± 0.20) than Coppens feed (9.42 ± 0.04). Mean carbohydrate content was lower in Unical feed (22.77 ± 1.27) than Coppens feed (24.31 ± 2.10). Figure 1 shows the mean proximate composition of the dry matter of Coppens and Unical aqua feed.

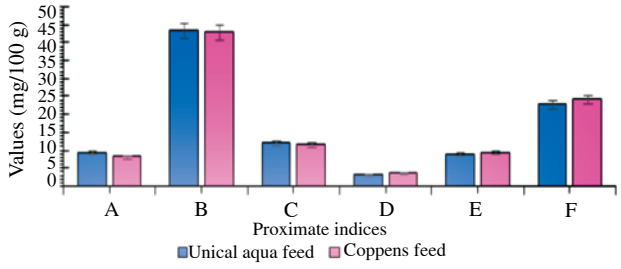

Figure 1. Mean proximate composition of the dry matter of Coppens and Unical aqua feeds.

A: Mean moisture content; B: Mean crude protein content; C: Mean fat content; D: Mean crude fibre content; E: Mean ash content; F: Mean carbohydrate.

3.2. Food utilization of C. gariepinus fed with Coppens and Unical aqua feed

Food utilization of fish fed with Coppens and Unical aqua feed was evaluated using food consumed and FCE showed that the experimental fish significantly ($P < 0.05$) consumed more Coppens feed food [(55.69 ± 5.09) kg] compared to Unical aqua feed [(48.84 ± 5.07) kg]. FCE was not significantly different ($P > 0.05$) in fish fed with Coppens feed (50.94% ± 0.91%) compared to fish fed Unical aqua feed (50.37% ± 1.29%).

3.3. Mean fecundity of C. gariepinus fed with Coppens feed and Unical aqua feed in concrete tank

Mean fecundity of *C. gariepinus* fed with Unical aqua feed was observed to range from 50 400 eggs for fish with TL (41.8 cm), total weight (486 g), ovary weight (OW) (72 g) and mean egg diameter (MED) (1.28 mm) to 103 600 eggs for fish with TL (48.5 cm), total weight (762 g), OW (148 g) and MED (1.53 mm) with mean of 68 366.67 ± 15 966.29 eggs. For fish fed with Coppens aqua feed, fecundity ranged from 42 000 eggs for fish with TL (46.3 cm), total weight (620 g), OW (60 g) and MED (1.52 mm) to 81 200 eggs for fish with TL (46.0 cm), total weight (664 g), OW (116 g) and MED (1.33 mm) with mean of 61 833.33 ± 11 692.31 eggs. There was no significantly different ($P > 0.05$) in the fecundity and MED of *C. gariepinus* fed with Coppens feed and Unical aqua feed.

3.4. Correlation and regression analysis for fecundity and biometric parameters of C. gariepinus fed with Unical aqua feed and Coppens feed

A linear relationship was obtained from fecundity of *C. gariepinus* fed with Unical and Coppens feeds and all the biometric parameters (TL, female body weight, OW and MED). For female *C. gariepinus* fed with Unical aqua feed, correlation coefficient (r) indicated a positive significant relationship ($P < 0.05$) between fecundity and all the biometric parameters including TL, female body weight, OW and MED (Table 1). For female *C. gariepinus* fed with Coppens feed, correlation coefficient (r) indicated a negative non-significant relationship ($P > 0.05$) between fecundity and all the biometric parameters including TL, female body weight, OW and MED (Table 2).

Table 1

Values of coefficient of correlation (r), regression coefficient (b) and intercept (a) in relationship between fecundity and biometric (F/FBW, F/TL, F/OW and F/MED) for female *C. gariepinus* fed with Unical aqua feed ($y = a + bx$ and $y = bx$).

Ordinate	Abscissa	a	b	r	r^2	Significance of r at 5% level
Fecundity	FBW (g)	383.89	111.0	0.7792	0.6072	Significant
Fecundity	TL (cm)	218 843.00	6524.2	0.8438	0.7120	Significant
Fecundity	OW (g)	-	700.0	1.0000	1.0000	Significant
Fecundity	MED (mm)	136 377.00	146 828.0	0.7571	0.5732	Significant

Pearson's product-moment correlation value for $df = 58$ was 0.6664 at $P = 0.05$.

Table 2
Values of coefficient of correlation (r), regression coefficient (b) and intercept (a) in relationship between fecundity and biometric (F/FBW, F/TL, F/OW and F/MED) for female *C. gariepinus* fed with Coppens feed ($y = a + bx$ and $y = bx$).

Ordinate	Abscissa	a	b	r	r^2	Significance of r at 5% level
Fecundity	FBW	67 525	8.3	0.064 1	0.004 2	Not significant
Fecundity	TL (cm)	109 741	1 090.2	0.367 4	0.135 0	Not significant
Fecundity	OW (g)	-	700.0	1.000 0	1.000 0	Significant
Fecundity	MED (mm)	170 229	77 241.0	0.562 5	0.316 4	Not significant

Pearson's product-moment correlation value for $df = 58$ was 0.666 4 at $P = 0.05$.

3.5. Mean physico-chemical parameters of circular concrete tanks

Mean physico-chemical parameters of circular concrete tanks used in this study was shown in Table 3. Values obtained from mean pH ranged from 6.54 ± 0.03 to 7.31 ± 0.08 in concrete tanks fed with Unical aqua feed, whereas in concrete tanks fed Coppens feed, mean pH value ranged from 6.87 ± 0.07 to 7.24 ± 0.17. Values obtained from mean DO in tanks fed with Unical aqua feed ranged from (4.83 ± 0.35) mg/L to (5.87 ± 0.23) mg/L and in tanks fed with Coppens feed, values of mean DO (mg/L) ranged from (4.97 ± 0.21) mg/L to (5.57 ± 0.11) mg/L. Mean water temperature ranged from (30.04 ± 0.44) ˚C to (31.30 ± 0.17) ˚C in tanks fed with Unical feed and (29.73 ± 0.84) ˚C to (30.93 ± 0.49) ˚C in tanks fed with Coppens feed. In tanks fed with Unical feed, mean ammonia level was observed to ranged between (0.00 ± 0.00) mg/L to (0.05 ± 0.01) mg/L and in tanks fed Coppens feed, mean ammonia level ranged between (0.00 ± 0.00) mg/L to (0.04 ± 0.06) mg/L. The result of t-test revealed that there was significant difference ($P > 0.05$) in the mean physico-chemical parameters of circular concrete tanks fed with the two experimental diets.

4. Discussion

Fecundity defined as the number of eggs carried by a gravid female fish is a very important aspect of fish culture since it is concerned with the average reproductive characteristics of fish. Findings from this study have showed that fecundity and egg size in *C. gariepinus* can be influenced by feed. Results of the present investigation clearly indicate that fecundity (number of eggs) of *C. gariepinus* fed with Unical aqua feed varied significantly ($P < 0.05$) from *C. gariepinus* fed with Coppens feed. Equal size of fish in this study was found to have different OW and fecundity. This agrees with Musa and Bhuiyan who reported similar observation on the fecundity of *Mystus bleekeri* from the River Padma near Rajshahi City[15]. The significant variation ($P < 0.05$) observed in the fecundity of fish fed with the two diets may be due to the differences in the nutrient compositions of the two diets. However, proximate composition of the two experimental diets showed significant ($P < 0.05$) differences in all the proximate indices except crude protein content which was insignificant ($P > 0.05$) in the two diets. Also, proper feed utilization could be responsible for growth of ovaries and increase in number of eggs found in the ovaries of *C. gariepinus* in this study. FCE did not show any significantly difference ($P > 0.05$) in fish fed with Coppens feed and Unical aqua feed. Based on some reports, FCE of fish fed with Coppens (50.94% ± 0.91%) and Unical aqua feeds (50.37% ± 1.29%) falls within the range (above 50%) considered as good growth in aquaculture[7,9,16]. Fecundity and OW of *C. gariepinus* were not found to be affected by body size in fish fed with Unical and Coppens feeds as evident in larger females who have not the highest OW and fecundity. Interestingly, OW of 148 g was found in female fish fed with Unical aqua feed with body weight of 762 g and fecundity of 103 300 eggs while fish weighing 832 g (highest body weight) were OW of 132 g and fecundity of 78 400 eggs. Similarly, fish fed with Coppens feed also showed the same result where fish weighing 763 g had the highest OW of 116 g and fecundity of 81 200 eggs whereas fish with the highest body weight of 843 g had OW of 94 g and fecundity of 65 800 eggs. Extrinsic factors such as environment and food supply have been reported to affect fish fecundity[17,18]. Findings of this study show that the differences observed in the fecundity of *C. gariepinus* fed with the two diets may be due to the differences in the composition of the two experimental diets. In this study, all experimental variables such as water source, sub-adult fish, culture enclosure (concrete tank), feeding rate, feeding regime, stocking density *etc*. were similar exception of the experimental diets composition. Comparing the results obtained in this study with the findings of Ekanem *et al*. who used the same experimental diets in Earthen pond, variations in fecundity of *C. gariepinus* was noticed[7]. In the present study, fecundity of *C. gariepinus* fed with the two diets revealed a linear relationship with all the biometric parameters (TL, female body weight, OW and MED). Also, correlation coefficient value (r) obtained from fish fed with the two diets indicated a positive significant ($P < 0.05$) relationship between fecundity and all the biometric parameters (TL, female body weight, OW, and MED). This finding accedes with findings of Shafi who observed a direct relationship between fecundity and biometric parameter such as length of fish[19]. Similar results were also reported in different fish[20,21]. In the present study, fecundity was found to be increased linearly with the increase in OW which corroborates with findings of Eyo *et al*. and Eyo *et al*.[3,22]. Water quality parameters including ammonia (mg/L), pH, water temperature (˚C) and DO (mg/L) fell within the range recommended by Boyd for the culture of fresh water fish[23]. This indicates that water quality parameters could

not be responsible in the variations observed in fish fed with the two experimental diets.

Based on the findings obtained from this study, it is concluded that fecundity of *C. gariepinus* reared in concrete tank was significantly influenced by the experimental feed used in this study as evident in higher fecundity obtained from fish fed with Unical aqua feed when compared to fish fed with Coppens feed in concrete tank. Therefore, on the bases of affordability and availability to farmers, Unical aqua feed is recommended as a cost-effective production of *C. gariepinus* female broodstock.

Conflict of interest statement

We declare that we have no conflict of interest.

References

[1] Eyo VO, Edet TA, Ekanem AP. Monogenean parasites of the African catfish *Clarias gariepinus* from two fish farms in Calabar, Cross River State, Nigeria. *J Coast Life Med* 2015; **3**(6): 433-7.

[2] Food and Agriculture Organization of the United Nations. The state of world fisheries and aquaculture. Rome: Food and Agriculture Organization of the United Nations; 2014. [Online] Available from: http://www.fao.org/3/a-i3720e/index.html [Accessed on 20th March, 2016]

[3] Eyo VO, Ekanem AP, Eni G, Edet AP. Relationship between fecundity and biometric indices of the silver catfish *Chrysichthys nigrodigitatus* (Lacepede) in the Cross River estuary, Nigeria. *Croat J Fish* 2013; **71**: 131-5.

[4] Shinkafi BA, Ipinjolu JK. Gonadosomatic index, fecundity and egg size of *Auchenoglanis occidentalis* (Cuvier and Valenciennes) in River Rima, North-Western Nigeria. *Niger J Basic Appl Sci* 2012; **20**(3): 217-24.

[5] Ekanem AP, Ekanem IE. Effects of phyto-protein and normal diet on the growth and gonadal development of *Clarias gariepinus*. *Trop Environ Res* 2010; **9**: 556-9.

[6] Ekanem AP, Eteng SU, Nwosu FM, Eyo VO. Comparative study of the growth and gonad development of *Clarias gariepinus* (Burchell 1822) fed diets with plant and animal-based ingredients in concrete tanks. *J Agric Sci Technol A* 2012; **2**(10): 1203-10.

[7] Ekanem AP, Eyo VO, James PU, Udo NE. Effects of Unical feed on fecundity and gonad development of *Clarias gariepinus*; a comparative study with Coppens commercial feed in Earthen pond. *Int J Sci Res* 2013; **2**(10): 8-14.

[8] Eyo VO, Ekanem AP, Obiekezie AI. A comparative study of egg and sperm quality of *Clarias gariepinus* fed Unical aqua feed and Coppens commercial feed. *Int J Biol Pharm Allied Sci* 2012; **1**(11): 1598-1607.

[9] Eyo VO, Ekanem AP, Jimmy UIU. A comparative study of the gonado-somatic index (GSI) and gonad gross morphology of African catfish (*Clarias gariepinus*) fed Unical aqua feed and Coppens commercial feed. *Croat J Fish* 2014; **72**: 63-9.

[10] Eyo VO, Ekanem AP. Effect of feeding frequency on the growth, food utilization and survival of African catfish (*Clarias gariepinus*) using locally formulated diet. *Afr J Environ Pollut Health* 2011; **9**(2): 11-7.

[11] Eyo VO, Ekanem AP, Eni GE, Asikpo PE, Jimmy UIU. Comparative study of growth performance, food utilization and survival of hatchery bred and wild collected fingerlings of African catfish *Clarias gariepinus*. *Greener J Oceanogr Mar Sci* 2013; **1**(1): 1-10.

[12] Association of Official Analytical Chemists International. *Official methods of analysis of AOAC International*. Vol. 2. 16th ed. Arlinton: Association of Analytical Communities; 1995.

[13] Mesa LM, Caputo V, Eastman JT. Gametogenesis in the dragonfishes, *Akarotaxis nudiceps* and *Bathydraco marrii* (Pisces, Notothenizidae: Bathydraconidae) from the Ross Sea. *Antarct Sci* 2007; **19**: 64-70.

[14] De Silva SS, Anderson TA. *Fish nutrition in aquaculture*. London: Ghapman & Hall; 1995, p. 319.

[15] Musa ASM, Bhuiyan AS. Fecundity on *Mystus bleekeri* (Day, 1877) from the River Padma near Rajshahi City. *Turk J Fish Aquat Sci* 2007; **7**: 161-2.

[16] Ndome CB, Ekwu AO, Ateb AA. Effect of feeding frequency on feed consumption, growth and feed conversion of *Clarias gariepinus* ♂ X *Heterobranchus longifilis* ♀ Hybrids. *Am Eurasian J Sci Res* 2011; **6**(1): 6-12.

[17] Bhattacharya P, Banik S. Study of fecundity of *Ompok pabo* (Hamilton, 1822) an endangered fish species of Tripua, India. *J Fish Livest Prod* 2015; **3**: 153.

[18] Eyo VO, Akpan MM, Udoh IS. Some aspects of the biology of the female blue crab *Callinectes amnicola* (De Rocheburne) from the Cross River estuary, Nigeria. *J Coast Life Med* 2015; **3**(4): 259-64.

[19] Shafi S. Study on fecundity and GSI of *Carassius carassius* (Linneaus, 1758-introduced) from Dal Lake Kashmir. *J Biol Agric Healthcare* 2012; **2**(3): 68-75.

[20] Phukon HK, Biswas SP. Observation on the maturity index and fecundity of *Puntius sophore* (Ham-Buch) from upper Assam. *Asian J Exp Biol Sci* 2012; **3**(1): 247-50.

[21] Buragohain A, Goswami MM. Relationship of fecundity and different body parameters of *Clarias magur* (Hamilton, 1822) in captive condition in the Agro climatic condition of Assam, India. *IOSR J Agric Vet Sci* 2014; **7**(3): 44-50.

[22] Eyo VO, Udoh AG, Etta SE, Ekpo PB, Andem AB. Fecundity and gonadal development of the frillfin goby, *Bathygobius soporator* (Valenciennes, 1837) from the Cross River estuary, Nigeria. *Int J Sci Res Manag* 2013; **1**(9): 476-80.

[23] Boyd CE. *Water quality in warmwater fish ponds*. Auburn: Auburn University; 1979.