Effects of Unical Feed on Fecundity and Gonad Development of *Clarias gariepinus*; A Comparative Study with Coppens Commercial Feed in Earthen Pond

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Abstract: ***This study was carried out to determine and compare the fecundity and gonad development of Clarias gariepinus fed Unical and Coppens feeds in earthen pond for 150 days in the University of Calabar fish farm. Twenty (20) fingerlings of C. gariepinus with mean bulk weight of 0.20 ± 0.02 kg were stocked in four hapas A_1, A_2, B_1 and B_2 fixed in experimental earthen pond measuring 1.5 x 1.0 x 1.0m^3. Fish in hapas A_1 and A2 were fed Unical feed while fish in hapas B1 and B_2 were fed Coppens feed. The design was duplicated three times for the purposes of comparisons. The fishes were fed twice daily at 5% of their body weight. Mean fecundity was 14388.89 ± 4180.89 eggs for fish fed Unical feed and 15575.0 ± 4333.97 eggs for fish fed Coppens feed respectively with no significant difference (P>0.05) between the two feeds. Mean egg diameter (1.44 ± 0.07mm) for Unical feed was not significantly different (P>0.05) from that of Coppens (1.44 ± 0.05mm). Mean gonadosomatic index of fish fed Unical feed (1.60 ± 0.78%) was not significantly different (P>0.05) from fish fed Coppens feed (1.85 ± 0.50%). There was a lineal relationship between fecundity and gonadosomatic index with fish weight, total length and gonad weight of C. gariepinus fed the two feeds. Physicochemical parameters (pH, temperature, dissolved oxygen and ammonia) of water were within acceptable range for tropical fish culture. Unical aqua feed is recommended for C. gariepinus culture on the basis of cost effectiveness as compared to Coppens commercial feed.***

Keywords: Unical feed, Coppens feed, Fecundity and Gonad development, *Clarias gariepinus*

1. Introduction

In Nigeria, fish farming remains the only option that may ensure the maintenance of the current level of per capita supply of fish of 6.6 kg/year especially with the declining situation of capture fisheries. The African catfish (*Clarias gariepinus*), belonging to the family Clariidae is one of the major species cultured in Nigeria because of its high growth rate, large size, good flesh quality, tolerance to poor water quality, ability to withstand high stocking densities, and good taste [1], [2], [3]. Fish feed technology is one of the least developed sectors of aquaculture in Africa and other developing countries of the world [4]. Feed accounts for at least 60% of the total cost of fish production which to a large extent determines the viability and profitability of fish farming enterprise [5]. Despites the rising interest in fish culture business in Nigeria, the production rate is still low because of high cost of imported feeds such as Coppens, Vital, Podder feeds etc, which has resulted in marginal or no profits for the operators.

Fecundity and gonad development is an important component of fish reproductive biology. Studies have shown that fecundity and gonad development have been affected by various factors including feed [6], [7], [8], [9] and [10]. There has been no information on the effect of Unical Aqua feed on the fecundity and gonad development of *C. gariepinus* in earthen pond. The objective of this study was to determine and compare the relationships between fecundity and gonad development of C. gariepinus fed Unical and Coppens Commercial feeds in earthen pond.

2. Materials And Methods

2.1 Description of study area

This research work was carried out in the Institute of Oceanography Fish Farm which is geographically located within the historic peninsula between the Calabar River and the Great Kwa River with elevation of 41 meters above sea level. This area has Latitude of 04°55.9′N and longitude 08°26′E respectively with a total surface area of three hectares (3Ha).

2.2 Experimental Design

This research work lasted for 120 days and was carried out in 4 hapas (A_1, A_2, B_1 and B_2) measuring 1.5 x 1.0 x 1.0 m^3 in earthen pond. A total of 80 post fingerlings of *C. gariepinus*, mean bulk weight 0.20 ± 0.02 kg (10 g for each post fingerling) were collected from the University of Calabar fish farm and stocked in each of the six experimental units (20 in each unit). The stocked fish were acclimated for seven days prior to the start of the feeding trial. The average initial body weight of the fish in each experimental unit was measured using a METLAR MT-5000D electronic balance to the nearest gram. Fish in hapas A_1 and A_2 were fed Unical feed while fish in hapas B_1 and B_2 were fed Coppens feed. The fishes were fed twice daily at 3% of their body weight. Some physicochemical parameters (dissolved oxygen, pH, ammonia and temperature) of the water were measured weekly with a calibrated electronic meter.

2.3 Fecundity and Gonadosomatic Index Estimation

At the end of the experiment (120 days), the hapas were removed from the pond and the fish were collected with the use of hand net. The different sexes were sorted out into different containers for fecundity and gonadosomatic index determination.

2.3.1 Extraction and preparation of eggs

Eggs from each gravid fish were removed by cutting-open the abdomen with a pair of scissors. Eggs were washed in distilled water and weighed on an electronic weighing balance to the nearest 0.1g. The eggs were fixed in Gilson fluid in sample bottles for 48 hours before estimation.

2.3.2 Fecundity determination

Fecundity was estimated by multiplying the weight of the egg mass by 700 [11].

2.3.3 Gonadosomatic index

Fish samples were dissected and the gonads were removed and weighed individually to obtain the gonad weight before calculating the Gonadosomatic index (GSI). Gonadosomatic index (GSI) was calculated according to [12]:

$$GSI = \frac{\text{Gonad weight}}{\text{Whole fish weight}} \times 100$$

2.4 Statistical analysis

Data obtained for fecundity and gonadosomatic index of fish fed Unical Aqua feed and Coppens feed were subjected to T-test analysis for significant difference using Predictive Analytical Software (PASW). Effects with a probability of ($P<0.05$) were considered significant. Correlation and linear regression were also used to determine the relationships between fecundity and gonad development of *C. gariepinus* fed the two feeds.

3. Results

3.1 Fecundity of *C. gariepinus* fed Unical and Coppens feeds in Earthen Pond

Fecundity of *C. gariepinus* fed Unical feed ranged between 8,400eggs in fish with body weight (186.0g), total length (29.3cm), ovary weight (12.0g) and fish with body weight (147.0g), total length (27.0cm), ovary weight (12.0g) to 25,200 eggs in fish with body weight (400.0g), total length (43.5cm), ovary weight (36.0g) with a mean of 14388.89 ± 4180.89eggs.
Fecundity of *C. gariepinus* fed Coppens feed ranged between 9,100eggs in fish with body weight (218.0g), total length (26.1cm), ovary weight (13.0g) to 23,100 eggs in fish with body weight (300.0g), total length (35.6cm), ovary weight (33.0g) with a mean of 15575.0 ± 4333.97eggs.

Egg diameter of *C. gariepinus* fed Unical feed ranged between 1.28mm to 1.52mm with a mean of 1.44 ± 0.07mm while egg diameter of *C. gariepinus* fed Coppens feed ranged between 1.33mm to 1.52mm with a mean of 1.44 ± 0.05mm. Table 1 shows the fish weight (g), total length (cm), fecundity, ovary weight and mean egg diameter of *C. gariepinus* fed Unical and Coppens feeds in earthen pond.

Table 1: Mean fecundity of female *C. gariepinus* fed Unical and Coppens feeds in earthen pond

	Unical Feed					Coppens Feed				
Reps	Weight (g)	Length (cm)	Ovary Wt. (g)	$F_{ecundity}$	MED (mm)	Weight (g)	Length (cm)	Ovary Wt. (g)	Fecu-ndity	MED (mm)
R1	186	29.3	12	8400	1.46	155	27.9	15	10500	1.33
R1	220	26.4	22	15400	1.48	300	34.0	26	18200	1.48
R1	326	34.2	22	15400	1.52	218	26.1	13	9100	1.50
R1	320	34.0	20	14000	1.47	140	27.2	17	11900	1.43
R1	150	27.5	12	8400	1.48	162	28.3	17	11900	1.48
R1	225	27.4	25	17500	1.30	218	26.1	20	14000	1.42
R1	302	34.1	21	14700	1.48	220	26.4	20	14000	1.39
R1	246	28.9	21	14700	1.44	412	43.6	30	21000	1.52
R1	154	27.3	19	13300	1.28	185	29.3	22	15400	1.38
R1	147	27.0	12	8400	1.43					
R2	180	29.5	14	9800	1.51	150	27.2	19	13300	1.47
R2	160	28.2	16	11200	1.50	320	36.0	28	19600	1.50
R2	140	27.0	20	14000	1.48	320	38.0	31	21700	1.46
R2	189	29.5	25	17500	1.44	300	35.6	33	23100	1.47
R2	225	26.5	21	14700	1.41	152	27.3	28	19600	1.42
R2	240	31.2	28	19600	1.43	398	38.6	19	13300	1.37
R2	400	43.5	36	25200	1.38	225	26.3	18	12600	1.45
R2	321	36.1	25	17500	1.47					
Mean ± SD	229.5±76.06	30.42 ± 4.45	20.61± 7.29	14427.78 ± 4180.89	1.44± 0.07	242.19 ± 88.79	31.12 ± 5.62	22.25 ± 6.23	15575.0 ± 4333.97	1.44± 0.05

*MED = Mean egg diameter, SD = standard deviation

3.2 Gonadosomatic Index (GSI) of Male *C. gariepinus* Fed Unical and Coppens Feeds in Earthen pond

Mean gonadosomatic index (Table 2) of male *C. gariepinus* fed Unical feed ranged between 0.63% in fish with body weight (315.0g),total length (35.3cm) and gonad weight (2.0g) to 2.85% in fish with body weight (140.0g),total length (27.1cm) and gonad weight (4.0g) with a mean of 1.60 ± 0.78%. For male fish fed Coppens feed, mean gonadosomatic index (GSI) ranged between 1.21% in fish with body weight (410.0g),total length (43.8cm) and gonad weight (5.0g) to 2.77% in fish with body weight (144.0g),total length (27.2cm) and gonad weight (4.0g) with mean 1.85 ± 0.50%. Table 2 shows the fish weight (g), total length (cm), gonadosomatic index (GSI) and gonad weight (g) male of *C. gariepinus* fed Unical and Coppens feeds in earthen pond.

Table 2: Gonadal development of male *C. gariepinus* fed Unical and Coppens feeds in earthen pond

	Unical Feed				Coppens Feed			
Reps	Weight (g)	Length (cm)	Gonad Wt. (g)	GSI	Weight (g)	Length (cm)	Gonad Wt.(g)	GSI
R_1	334	35.0	3	0.89	182	28.5	5	2.74
R_1	315	35.3	2	0.63	330	34.6	5	1.51
R_1	180	28.6	4	2.22	145	27.0	4	2.75
R_1	146	27.3	1	0.68	200	27.9	4	2.0
R_1	148	27.3	4	2.70	179	30.0	2	1.11
R_1	200	27.8	3	1.50	182	30.0	3	1.64
R_1	201	27.6	2	0.99	144	27.2	4	2.77
R_1					310	36.3	5	1.61
R_2	318	36.0	4	1.25	145	27.0	2	1.37
R_2	221	26.4	4	1.80	148	27.1	3	2.02
R_2	148	27.2	4	2.75	410	43.8	5	1.21
R_2	450	43.8	5	1.11	162	28.3	4	2.46
R_2	390	3.87	6	1.22	245	29.4	5	2.04
R_2	140	27.1	4	2.85	475	44.0	6	1.27
R_2	218	26.1	4	1.83	392	38.5	5	1.27
R_2								
Mean ± SD	243.50± 100.12	28.53 ± 8.79	3.57± 1..28	1.60 ± 0.78	243.27± 111.47	31.97 ± 6.01	4.13 ± 1.19	1.85 ± 0.50

3.3 T-test analysis for fecundity, gonad weight and gonadosomatic index of *C. gariepinus* fed Unical and Coppens feeds in earthen pond

T-test analysis for fecundity, gonad weight and gonadosomatic index of *C. gariepinus* fed Unical and Coppens feeds in earthen pond (Table 3) with a probability effect of ($P < 0.05$) showed that fecundity, gonad weight and gonadosomatic index of fish fed the two experimental diets were not significantly different ($P>0.05$).

Table 3: T-test analysis for fecundity, gonad weight and gonadosomatic index of *C. gariepinus* fed Unical and Coppens feeds in earthen pond

Indices	*Sig.(2-tailed) value*	*Inference*
Ovary weight (Female)	0.948	P>0.05
Fecundity	0.846	P>0.05
Gonad weight (Male)	0.578	P>0.05
GSI (Male)	0.419	P>0.05

3.4 Regression and correlation analysis for fecundity and body parameters of *C. gariepinus* fed Unical and Coppens feeds in earthen pond

Fecundity of *C. gariepinus* fed Unical and Coppens feeds showed a linear relationship with all the body parameters (female body weight, total length and ovary weight). Correlation co-efficient (r) showed a positive significant ($P<0.05$) relationship between fecundity of *C. gariepinus* fed Unical and Coppens feed with body weight, total length and ovary weight (Table 4a and 4b and Figure 1-6).

Table 4a: Values of regression coefficient 'b' intercept 'a' and coefficient of correlation 'r' in relationship between fecundity and body parameters (F/TW, F/TL and F/OW) for female *C. gariepinus* fed Unical feed earthen pond. Equation; y = a+ bx, y = -a+ bx and y = bx.

Relationship						
Ordinate	Abscissa	a	b	R	r^2	Significance of r at 5% level
Fecundity (F)	TW(g)	5917.4	36.19	0.6716	0.451	Significant
Fecundity (F)	TL(cm)	-5181.2	643.28	0.6818	0.4694	Significant
Fecundity (F)	OW(g)	-	700	1	1	Significant

F= Fecundity, TW= Total weight (g), TL = Total length (cm) and OW = Ovary weight (g). * Pearson's product moment correlation value for df =16 is 0.4683 at P = 0.05.

Table 4b: Values of regression coefficient 'b' intercept 'a' and coefficient of correlation 'r' in relationship between fecundity and body parameters (F/FBW, F/TL and F/OW) for female *C. gariepinus* fed Coppens feed earthen pond. Equation; y = a+ bx, y = -a+ bx and y = bx.

Relationship						
Ordinate	Abscissa	a	b	r	r^2	Significance of r at 5% level
Fecundity (F)	TW(g)	9033.8	27.01	0.5533	0.3061	Significant
Fecundity (F)	TL(cm)	-893.83	529.23	0.6865	0.4713	Significant
Fecundity (F)	OW(g)	-	700	1	1	Significant

F= Fecundity, TW= Total weight (g), TL = Total length (cm) and OW = Ovary weight (g). * Pearson's product moment correlation value for df =14 is 0.4973 at P = 0.05.

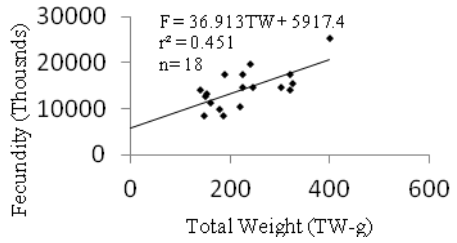

Figure 1: Relationship between Fecundity and Total Weight (TW-g) of *C. gariepinus* fed Unical Aqua feed in earthen pond

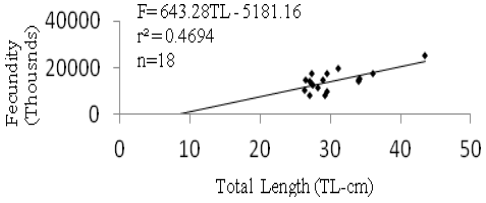

Figure 2: Relationship between Fecundity and Total Length (TL-cm) of *C. gariepinus* fed Unical Aqua feed in earthen pond

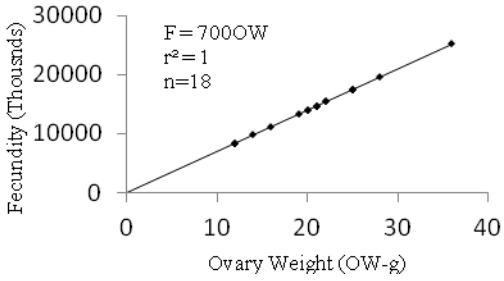

Figure 3: Relationship between Fecundity and Ovary weight (OW-g) of *C. gariepinus* fed Unical Aqua feed in earthen pond

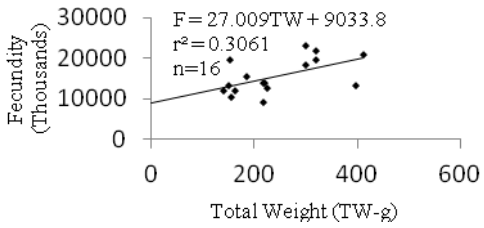

Figure 4: Relationship between Fecundity and Total Weight (TW-g) of *C. gariepinus* fed Coppens feed in earthen pond

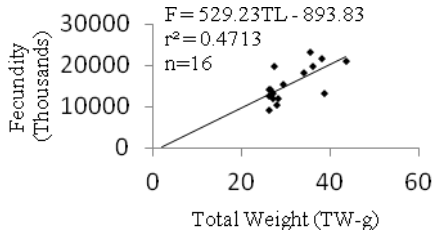

Figure 5: Relationship between Fecundity and Total Length (TL-cm) of *C. gariepinus* fed Coppens feed in earthen pond

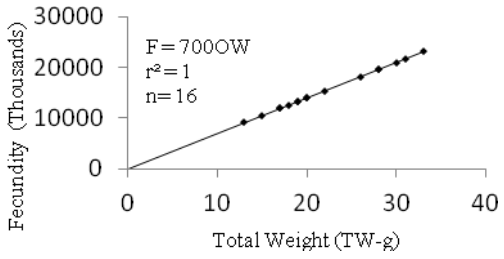

Figure 6: Relationship between Fecundity and Ovary weight (OW-g) of *C. gariepinus* fed Coppens feed in earthen pond

3.5 Regression and correlation analysis for male gonadosomatic index (GSI) and body parameters of *C. gariepinus* fed Unical and Coppens feeds in earthen pond

Male gonadosomatic index (GSI) of *C. gariepinus* fed Unical and Coppens feeds showed a linear relationship with all the body parameters (total weight, total length and gonad weight). Correlation co-efficient (r) showed a negative significant (P<0.05) relationship between gonadosomatic index and total weight of fish fed Unical feed and; gonadosomatic index and total weight and length of fish fed Coppens feed. Correlation co-efficient (r) also showed a negative non-significant (P>0.05) relationship between gonadosomatic index and total length of fish fed Unical feed. Correlation co-efficient (r) showed a positive non-significant (P>0.05) relationship between gonadosomatic index and gonad weight of fish fed the two experimental feeds. Table 5a and 5b and Figure 7-12 shows the relationship between male gonadosomatic index (GSI) and body parameters of *C. gariepinus* fed Unical and Coppens feeds in earthen pond.

Table 5a: Values of regression coefficient 'b' intercept 'a' and coefficient of correlation 'r' in relationship between male gonadosomatic index (GSI) and body parameters (GSI/TW, GSI/TL and GSI/GW) for female *C. gariepinus* fed Unical feed earthen pond. Equation; y = a+ bx, y = -a+ bx and y = bx.

Relationship						
Ordinate	Abscissa	a	b	R	r^2	Significance of r at 5% level
GSI	TW(g)	2.705	-0.0045	0.5875	0.3452	Significant
GSI	TL(cm)	2.0485	-0.0157	0.1783	0.0318	Not Significant
GSI	GW(g)	0.6867	0.2561	0.4258	0.1813	Not Significant

GSI= Gonadosomtic index (%), TW= Total weight (g), TL = Total length (cm) and GW = Gonad weight (g). * Pearson's product moment correlation value for df =12 is 0.5324 at P = 0.05.

Relationship						
Ordinate	Abscissa	A	b	r	r^2	Significance of r at 5% level
GSI	TW(g)	2.6506	-0.0033	0.6137	0.3766	Significant
GSI	TL(cm)	3.8843	-0.0636	0.6401	0.4097	Significant
GSI	GW(g)	1.7262	0.0303	0.06	0.0036	Not Significant

GSI= Gonadosomtic index (%), TW= Total weight (g), TL = Total length (cm) and GW = Gonad weight (g). * Pearson's product moment correlation value for df =13 is 0.5139 at P = 0.05.

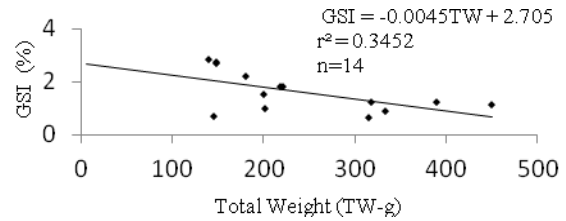

Figure 7: Relationship between Male Gonadosomatic index (GSI) and Total Weight (TW-g) of *C. gariepinus* fed Unical feed in earthen pond

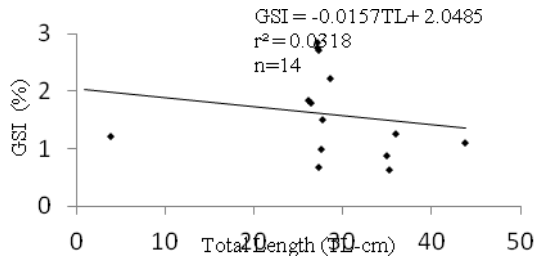

Figure 8: Relationship between Male Gonadosomatic index (GSI) and Total Length (TL-cm) of *C. gariepinus* fed Unical feed in earthen pond

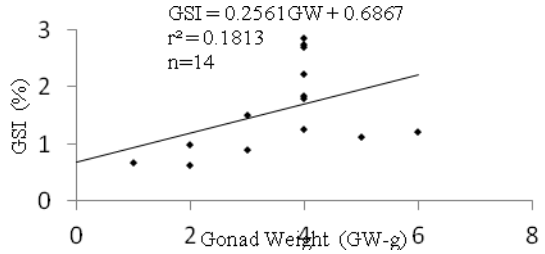

Figure 9: Relationship between Male Gonadosomatic index (GSI) and Total Length (TL-cm) of *C. gariepinus* fed Unical feed in earthen pond

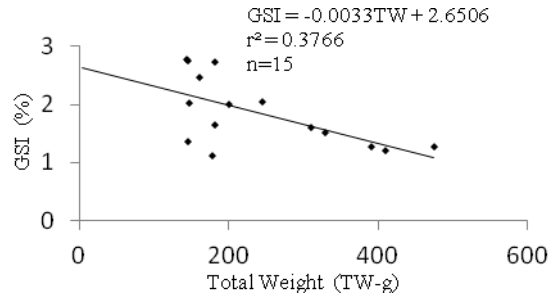

Figure 10: Relationship between Male Gonadosomatic index (GSI) and Total Weight (TW-g) of *C. gariepinus* fed Coppens feed in earthen pond

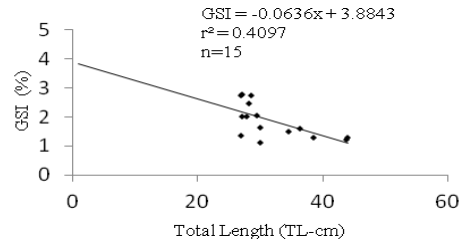

Figure 11: Relationship between Male Gonadosomatic index (GSI) and Total Length (TL-g) of *C. gariepinus* fed Coppens feed in earthen pond

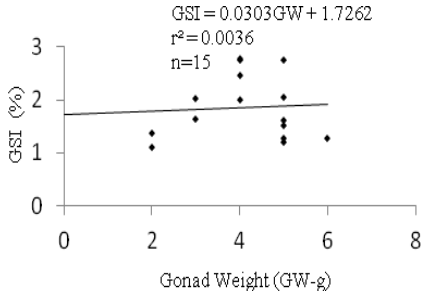

Figure 12: Relationship between Male Gonadosomatic index (GSI) and Gonad Weight (GW-g) of *C. gariepinus* fed Coppens feed in earthen pond

3.6 Physico-chemical parameters

In Hapas A_1 and A_2 fed with Unical Aqua feed, the range of pH was 6.8 – 7.2, water temperature (28.7 – 29.3^{o}C) and dissolved oxygen was 3.5 – 4.0mg/l, ammonia was 0.0mg/l while in hapas B_1 and B_2 fed with Coppens feed, pH ranged between 6.9 – 7.1, water temperature ranged between 28.7 – 29.3^{o}C, dissolved oxygen ranged between 3.5 – 4.0mg/l.

4. Discussions

Results from the present study shows that the *C. gariepinus* fed Unical and Coppens feed responded positively to the two experimental diets in relation to growth in length, weight, fecundity and ovary weight. Fecundity is an important aspect of fish culture used to evaluate the average reproductive characteristics of fish. According to [13], the fecundity of the population may be obtained from the product of the expected fecundity of an average-sized female and the total number of spawning females. [14] reported that the quantity and composition of dietary protein are known to affect fish fecundity. In the present study, fecundity of *C. gariepinus* fed the two experimental diet was not significantly different (P>0.05). This finding could be attributed to the quality of experimental feeds used in this study. Moreover, this could also be attributed to the presence of phytoplankton and zooplankton in the experimental ponds used in this study.

In the present study, it was observed that the fish with same size had different ovary weight and number of eggs in their ovaries. This is in support of [15] who reported a similar observation on *Mystus bleekeri* from the River Padma near Rajshahi City. Our results have shown that fecundity of *C. gariepinus* varies with increase in length and weight of the fish which agrees with [10].

In the present study, ovary weight, male gonad weight and gonadosomatic index (GSI) of *C. gariepinus* fed Unical feed was not significantly different (P>0.05) from fish fed Coppen feed. This is in agreement with [8] who reported that increased dietary protein level of catfish diet up to 40% would produce best gonadal development. This result also agrees with [16] who observed that performance of catfish broodstock can be affected by dietary protein level. Unical and Coppens feeds contain the same crude protein level (42%cp) which will support fast gonadal development in catfish as observed in this study.

Coppens commercial feed is an imported floating feed which engulfs 40–60% of operating cost in intensive fish culture in Nigeria [17]. [18] observed that *C. gariepinus* fed Coppens feed responded more aggressively to the feed than Unical Aqua feed because of the differences in composition of the two experimental diets. Other reasons outlined includes the fact that Coppens feed has fishy odor that makes it more inviting to fish than Unical feed. It was also observed that coppens feed floats whereas Unical feed sinks. Although, the same feeding response was observed in the present study without any influence on fecundity, ovary weight and gonad development.

The fecundity of *C. gariepinus* fed Unical and Coppens feeds in earthen pond were linearly related to fish weight, total length and gonad weight in this study. This was in disagreement with [19] and [20] who reported that fecundity increased exponentially with total length but agrees with [13] who reported a linear relationship between fecundity and total length in the River Asi.

The physicochemical parameters (pH, temperature, dissolved oxygen and ammonia) in the present study were maintained within acceptable range for fresh water fish culture [21] because research their variation could influence growth and gonadal development of fish under culture [22].

4.1 Summary and Conclusion

Results obtained for fecundity and gonadal development of *C. gariepinus* fed Unical and Coppens feeds in earthen pond in the present study has shown no significant difference (P>0.05) between the two feeds. This implies that Unical Aqua feed can compete favorably with Coppens feed in earthen ponds without any negative impact on the fecundity and gonadal development. Considering the cost of Unical and Coppens feeds, Unical feed is more economical for fish farmers than Coppens feed which is two times more expensive. On the bases of these findings, Unical feed is recommended due to its availability and affordability for the production of *C. gariepinus* in earthen ponds.

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References

[1] H. Hogendoorn, "Controlled propagation of the African catfish, C1arias gariepinus (C. and V.) IV. Effect of feeding regime in fingerling culture, Aquaculture", 24: pp. 123- 131, 1981.
[2] Y. X. Fang, X. Z. Guo, J. K. Wang, Z. Y. liv, "Effects of different animal manure on fish farming", In: The Asian Fisheries Forum (J. I. madean ed.). philippines, Asian Fisheries Society, Manila, pp. 117 – 120, 1986.
[3] O. A. Ayinla, G. R. Akande, "Growth response of Clarias gariepinus on silage – based diets. Nigeria Institute of Oceanography and Marine Research", Technical Paper, No. 62, p.15, 1988.
[4] FAO 2003. Fisheries Statistics. World Wide Web electronic publication, accessible at http://www.fao.org. (Accessed 01/13/2013).
[5] D. M. Jamu, O. A. Ayinla, "Potential for the development of aquaculture in Africa. NAGA, 26(3), pp. 6-13, 2003.
[6] Adewumi, "The effects of the heating time of soybean for broodstock nutrition on the reproductive performance of C. gariepinus (Burchell 1822)", Ph.D Thesis, Obafemi Awolowo University, Ile Ife, Nigeria. pp. 162, 2005.
[7] A. P. Ekanem, I. E. Ekanem, "Effects of phyto-protein and normal diet on the growth and Gonadal development of Clarias gariepinus ", Tropical Environmental Research, 9, pp. 556-559, 2010.
[8] O. Sotolu, A. A. Kigbu, "Growth and Gonad Quality of Clarias Gariepinus (Burchell, 1822) Broodstock Fed Varying Dietary Protein Levels", PAT, 7 (2), pp. 61-67, 2011.
[9] A. P. Ekanem, S. U. Eteng, F. M. Nwosu, V. O. Eyo," Comparative Study of the Growth and Gonad Development of Clarias gariepinus (Burchell 1822) Fed Diets with Plant and Animal-based Ingredients in Concrete Tanks", Journal of Agricultural Science and Technology, 2:1203-1210, 2012a.
[10] P. E. Asuquo, A. P. Ekanem, V. O. Eyo, E. J. Pedro, "Effects of diets with Cassav leaf meal (CLM) Manihot utilissima on the growth and fecundity of Clarias gariepinus", African Journal of Bioscience, 5(1): pp. 49-53, 2012.
[11] W. J. A. R. Viveen, C. J. J. Ritcher, P. W. J. Van Oordt, J. A. L. Janssen, E. A. Huisman, "Manual for the culture of the African catfish (Clarias gariepinus). The Netherlands: Directorate General for International Tech. Cooperation. The Hague, pp. 93, 1985.
[12] J. Bolger, P. L. Connolly, "The selection of suitable indices for the measurement and analysis of fish condition", Journal of Fishery Biology, 34: 171- 182, 1989.
[13] S. Yalcin, K. Solak, I. Akyurt, "Certain Reproductive Characteristics of the Catfish (Clarias gariepinus, Burchell, 1822) Living in the River Asi, Turkey", Turkish Journal of Zoology, 25, pp.453-460, 2001.
[14] K. F. Shim, L. Landesman, T. J. Lam, " Effect of dietary protein on growth, ovarian development and fecundity in the dwarf gourami Colisa lalia (Hamilton)", Journal of Tropical Aquaculture, 4:111-123, 1989.
[15] S. M. Musa, A. S. Bhuiyan, "Fecundity on Mystus bleekeri (Day, 1877) from the River Padma Near Rajshahi City", Turkish Journal of Fisheries and Aquatic Science, 7, 71-73, 2007.
[16] O. Sotolu, "Feed utilization and biochemical characteristics of Clarias gariepinus (Burchell,1822) fingerlings fed diets containing fish oils and vegetable oils as total replacements", World Journal of Fish and Marine Science, 2(2), pp. 93-98, 2010.
[17] T. Hetch, "A review of feeds and fertilizers for sustainable aquaculture in sub-Saharan Africa. In M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds). Study and analysis of feeds and fertilizers for sustainable aquaculture development. FAO Fisheries technical paper, No.497.Rome FAO, pp. 77- 109, 2007
[18] A. P. Ekanem, V. O. Eyo, A. I. Obiekezie, U. I. Enin, P. J. Udo" A Comparative Study of the Growth Performance and Food Utilisation of the African Catfish (Clarias gariepinus) Fed Unical Aqua Feed and Coppens Commercial Feed", Journal of Marine Biology and Oceanography, 1:2, 2012b.
[19] G. Gaigher, "Reproduction in the catfish (Clarias gariepinus) in the Hardap Dam, South West Africa", Madoqua, 10, pp. 55- 59, 1977.
[20] D. Clay, "Sexual maturity and fecundity of the African catfish (Clarias gariepinus) with an observation on the spawning behavior of the Nile catfish (Clarias lazera)", Zoological Journal of the Linean Society, 65: pp. 351-365, 1979.
[21] E. Boyd, "Water quality in warmwater fish ponds", Auburn University, Agriculture Experiment Station, Auburn, Ala, 1979.
[22] S. Shalloof, H. M. M. Salama, "Investigations on some aspects of reproductive biology in Oreochromis niloticus (Linnaeus, 1757) inhabiting Abu-zabal Lake, Egypt", Global Veterinaria, 2 (6), pp. 351-359, 2008.

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