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EFFECTS OF DIETARY SUPPLEMENTATION LEVELS OF TIGER NUT (*Cyperus esculentus)* SEED ON GROWTH, SURVIVAL AND REPRODUCTIVE INDICES OF *Clarias gariepinus* BROODSTOCK

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ABSTRACT
The dietary effect of Cyperus esculentus seed powder was examined on the growth performance, survival and reproductive indices of Clarias gariepinus. Eighty (80) male and female catfish broodstock (400±0.00g) were obtained for the experiment, fed twice daily at 3% body weight for 56 days. Five diets with crude protein of 45% were formulated with different inclusion levels of C. esculentus seed powder; Control, TNSM 2 (0.5), TNSM 3 (1.0), TNSM 4 (2.0), and TNSM 5 (3%). Phytochemical screening, water quality, growth performance and reproductive indices were measured using standard methods. Phytochemical screening of C. esculentus revealed the presence of saponins, flavonoids, protein, tannins, steroids, phenol and glucosinolates while alkaloids were not detected. The values of temperature, pH and dissolved oxygen recorded were within the acceptable limits for culture water. The treated groups had better values in weight gain, percentage weight gain, and specific growth rate and feed conversion ratio when compared to the control diet. The reproductive indices show a significant (P<0.05) increase in the treated groups than the control. This result revealed that dietary inclusion of C. esculentus seed powder enhances growth and improves fertility in Clarias gariepinus which will improve the quantity of its seed production.

Keywords: *Cyperus esculentus,* Growth performance, Reproductive indices, *Clarias gariepinus*; Survival

INTRODUCTION

Aquaculture is a fast-growing food-producing sector and developed as an important component of food security in Nigeria and the world at large (Ibrahem *et al.*, 2010). It has several economic importance making the practice a source of food, majorly in form of fish supply. The population of Nigeria is on the rise and there is a corresponding demand for fish consumption (Chukwu, 2006). Nigeria, like most third-world countries, is not able to meet its animal protein requirement for meat, fish and their respective products. This is traceable to fish production which has fallen below expectation (Akinrotimi, 2007) and yet fish plays a significant part in the world protein supplies, particularly in developing countries (Bolaji *et al*., 2011). The African catfish, *C. gariepinus* is a major cultivated fish of high commercial value in Nigeria and is ideal for captive breeding (Adesulu, 2007). It is of great importance to the sustainability of the aquaculture industry in Nigeria. This is because it constitutes an excellent food fish known for its resistance to diseases, high growth rate, resistance to handling and stress, and ability to tolerate a wide range of environmental parameters but many limitations are associated with fry production and the development of better broodstock.

The development of fish seed production has been identified as a rational way of augmenting the dwindling fish supply from the capture fisheries (Dada and Fagbenro, 2008). The ever-growing demand for the seed of *C. gariepinus* calls for more production of high-quality milt which could be used to fertilize the eggs in the hatchery. It has been shown by several studies that medicinal plants can influence fertility in man, animals and fish (Olusola *et al.*, 2021). *Cyperus esculentus,* known as tiger nut, is a crop of the sedge family, widespread across much of the world. Tiger nut is also found to be a cosmopolitan perennial crop of the same genus as the papyrus plant and it is widely distributed in the temperate zones within South Europe as its probable origin and has become naturalized in Ghana, Nigeria and Sierra Leone. The seed of *Cyperus esculentus* is edible, with a slightly sweet nutty flavour. It supplies the body with enough quantity of vitamin E, vitamin C, zinc and quercetin essential for fertility in both men and women and it has been found to stimulate sexual arousal and also improve sexual performance (Dada, 2012) which may have similar effects in fish.

Many studies have shown that antioxidants can enhance fertility either directly or indirectly and most plants rich in antioxidants have the tendency to increase sperm count, and motility and enhance the production of oestrogen and testosterone (Yeganeh *et al.*, 2017). *Cyperus esculentus* has antioxidant steroids present in a quiet number, therefore, a high possibility that *C. esculentus* can promote fertility, but there is little or no documentation on its utilization on indigenous fish species such as *C. gariepinus*. Hence, this study was therefore carried out to investigate the effect of the dietary supplementation of *C. esculentus* seed powder on the growth, survival and reproductive indices of male and female *C. gariepinus* broodstock.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Research and Teaching Farm, Olusegun University of Science and Technology, Okitipupa, Nigeria. The experiment lasted for eight weeks (56 days) between May-June, 2021.

Plants Collection, Identification and Preparation

Tiger nuts were obtained from Mokola Roundabout, Ibadan North Local Government Area of Oyo State, Nigeria. They were authenticated at the Department of Biological Sciences (Botany Programme) of Olusegun Agagu University of Science and Technology, Okitipupa. Tiger nuts were washed with sterile distilled water and air-dried at 25℃ for two weeks after which it was grounded into a fine powder and stored until required.

Collection and Acclimatization of Experimental Fish

Eighty (80) *C. gariepinus* broodstock (40 males and females, mean weight 400 ± 0.01g) were procured from a commercial Farm in Okitipupa, Ondo state, Nigeria. The *C. gariepinus* were acclimatized for two weeks in a fibre holding tank at the Research and Teaching Farm, Ondo State University of Science and Technology, Okitipupa. During this period, they were fed with commercial diets (Coppens, 6 mm) of 40% crude protein twice daily at 3% body weight.

Diets Preparation

The ground tiger nuts at different inclusion levels of 0. 0.5, 1.0, 2.0 and 3.0 with feed ingredients such as fishmeal, soya bean, millet, maize, blood meal, Di-calcium phosphate, salt, vitamin premix and vegetable oil were mixed using manual methods to formulated 45% crude protein. Each diet mixture treated separately was extruded through a 6 mm mincer pelleting machine to form a noodle-like suitable size for the adult *C. gariepinus*. The pelleted diets were sun-dried, packed in labelled polythene bags and stored until required (Table 1).

Table 1: Gross and proximate composition of the experimental diets (g/100g)

	CONTROL	TNSM 2 (0.5%)	TNSM 3 (1.0%)	TNSM 4 (2.0%)	TNSM 5 (3.0%)
Blood meal (80% CP)	23.19	23.19	23.19	23.19	23.19
Fishmeal (72% CP)	11.59	11.59	11.59	11.59	11.59
Soybean (42% CP)	23.19	23.19	23.19	23.19	23.19
Millet (18% CP)	17.02	17.02	17.02	17.02	17.02
Yellow maize (10% CP)	17.02	17.02	17.02	17.02	17.02
Di calcium phosphate	2.00	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00	1.00
Vegetable oil	2.00	2.00	2.00	2.00	2.00
Vit – min premix	3.00	2.50	2.00	1.00	-
Tiger nut seed	-	0.50	1.00	2.00	3.00
Total	100.00	100.00	100.00	100.00	100.00
***Proximate composition (% DM)					
Moisture	5.86	5.47	5.52	5.41	5.54
Crude protein	45.01	45.00	45.01	45.06	45.03
Crude lipid	13.46	13.33	13.87	13.25	13.56
Ash	10.15	11.56	11.59	11.87	11.78
NFE	25.52	24.64	24.01	24.41	24.09

** Vit-premix for vitamin and minerals premix. Each 2.kg of premix contain; 12.5 million international unit (MIU); D_3, 2.5 MIU;E, 40g; K_3 2g; B1,5.5g;BB6,5g; Niacin 55g; Calcium Pantothenate 11.5g; Chlorine chloride 500g; Folic acid, Biotin,0.08g;Manganese, 120g; Iron, 100g; Zinc, 80g, Copper,8.5g; Iodine, 1.5g;Cobalt,0.3g;Selenium, 0.12g; Anti-oxidant, 120g. ** Determined using standard methods [AOAC 2005). All samples were analysed in triplicates. NFE= Nitrogen Free Extract = 100 - (Crude protein + Crude fiber + Lipid content + Moisture content + Ash), *** Proximate composition of experimental diet using standard methods of AOAC, (2005).

Experimental Set-up

Water was sourced from the Research and Teaching Farm borehole and was filled to a depth of 1.2m into five (5) fibre holding tanks and replicated twice. Eighty *C. gariepinus* were stocked into the 10 fibre holding tanks containing eight (8) *C. gariepinus* broodstock (4 males and 4 females) per treatment tank. The diets were assigned to the tanks as designated and were fed at 3% body weight in two equal portions at 08:00hours – 09:00hours and 17:00hours – 18:00hours for 56 days. All fish were removed from each fibre holding tank every fourteen days and batch-weighed, their average weights were recorded and the daily amount of feed for each tank was readjusted accordingly.

Water Quality Parameters

Water quality parameters namely temperature, pH and dissolved oxygen concentration were monitored daily throughout the study period using a mercury-in-glass thermometer, pH meter (Hanna H198106 model) and dissolved oxygen meter (JPP-607 model) as described by APHA (2005).

Biological Evaluation

Weight gain = final body weight-initial body weight

$$\text{Weight gain (\%)} = \frac{\text{(Final body weight} - \text{initial body weight)}}{\text{Initial body weight}} \times 100$$

Increase in standard length (CM) = L2-L1

Where L2 = Final standard length; L1 = Initial standard length

$$\text{Specific growth rate (SGR)} = \frac{100\ (\text{log final body weight} - \text{log initial body weight}}{\text{Time (days)}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Dry weight of feed fed (g)}}{\text{Fish weight gain (g)}}$$

$$\text{Survival rate (\%)} = \frac{\text{Initial Number of Fish Stocked} - \text{Mortality}}{\text{Initial Number of Fish stocked}} \times 100$$

Condition factor (k) = 100W/L3

Where: W= weight of fish (g); L=standard length (cm)

$$\text{Nitrogen metabolism} = \frac{(0.549)\ (a+b)h}{2}$$

Where, a = Initial mean weight of fish; b= final mean weight of fish; h= experimental periods in days (Bello *et al.*, 2012).

Artificial Propagation

Two (2) male and female spawners from each treatment were taken and used for artificial propagation techniques- hormone administration, stripping, fertilization and incubation as described by Olusola *et al*., (2022).

Evaluation of Milt Quality

At the end of the feeding trials, 2 males were randomly selected per dietary treatment and were weighed, killed and dissected to remove the testes to determine milt volume, motility duration, and milt counts and this was done as described by Olusola *et al*., (2021)

Ovary Weight and Egg Size Estimation

At the end of the feeding trials, 2 females were randomly selected per dietary treatment and weighed, killed and dissected to remove the ovaries. The ovaries were carefully weighed after removing excess water on filter paper and counted, the number of eggs per l g and then calculated the total number of eggs. The total number of eggs per ovary was derived by multiplication by the factor; of total weight/10 g. Three (3) fresh eggs were randomly selected per dietary treatment and were used for egg diameter (mm) measurement. For the pear-shaped eggs, the mean diameter of the long and short axes was taken as the diameter of the oocyte (Salau *et. al.*, 2012).

Belly Diameter and Gonado-Somatic Index (GSI)

Two (2) female broodstock were randomly collected from each treatment and determined their belly diameter as follows: Belly diameter =Length of horizontal axis from the ventral region of the pectoral fin to the vent region + belly width. The gonado-somatic index (GSI) was computed according to Olusola *et al*., (2021) as;

$$GSI = \frac{\text{Gonads weight (g)}}{\text{Fish weight (g)}} \times 100$$

Estimation of fecundity, fertilization, and hatchability

One (1) gramme each of egg was measured into ten (10) different bowls which were labelled accordingly. The eggs were fertilized with 1ml of milt from each dietary treatment. The percentage of an egg fertilized as well as the percentage number of eggs hatched and the percentage of survival were computed according to the method described by Ayinla and Akande (2010):

$$\text{Relative fecundity} = \frac{\text{Total number of eggs}}{\text{Bodyweight}}$$

$$\text{Fertilization rate} = \frac{\text{No of the fertilized egg in sample}}{\text{Total no of egg in sample}} \times 100$$

$$\text{Hatching rate} = \frac{\text{No of hatched eggs in a sample}}{\text{Total no of eggs in a sample}} \times 100$$

Statistical Analysis

The values were recorded as a mean ± Standard Error. One-way Analysis of variance (ANOVA) was performed using SPSS 22 for the window software package at ($P< 0.05$) significance level. Significantly different means were compared using Duncan's multiple range test.

RESULTS

Determination of Phytochemicals in Tiger Nuts

The phytochemical screening of tiger nut revealed the presence of saponins, flavonoids, protein, tannins, steroids, phenol and glucosinolates while alkaloids were not detected. The value of these metabolites was low (+), moderate (++), and absent (-) as shown in table 2.

Table 2: Phytochemical screening of tiger nuts

SAMPLES	PHYTOCONSTITUENTS	RESULTS
	Saponins	++
	Flavonoids	++
	Phenol	++
	Alkaloids	-
Tiger nuts	Tannin	+
	Glucosamines	+
	Steroid	++
	Protein	+

Water Quality in culture tanks of *C. gariepinus* fed tiger nut seed supplemented diets for 56 days

The result of the mean water quality of this study revealed that the pH range between 5.6 – 6.3, dissolved oxygen ranged between 5.95 – 6.19 mg/l and the temperature ranged between 27 – 30^{0}C. The highest temperature was recorded in control and lowest in the treated groups except TNSM $_2$ (0.5%). Highest pH was recorded in TNSM $_3$ (1.0%) and lowest in TNSM $_5$ (3.0%) while highest dissolved oxygen was recorded in TNSM $_4$ (2.0%) and lowest in control. These values were within the acceptable limits for culture water (Table 3).

Table 3: Mean water quality of *Clarias gariepinus* fed tiger nut seed supplemented diets for 56 days

	Temperature (^{0}C)	pH (-)	Dissolved Oxygen (mg/l)
Control	30	6.0	6.10
TNSM $_2$ (0.5%)	28	6.1	6.25
TNSM $_3$ (1.0%)	27	6.3	6.33
TNSM $_4$ (2.0%)	27	5.9	6.51
TNSM $_5$ (3.0%)	27	5.6	6.39

Growth Performance and Nutrient Utilization of *C. gariepinus* fed with Dietary Supplementation of Tiger nuts for 56 days

The growth performance and nutrient utilization in terms of body weight gain, feed conversion ratio, percentage weight gain, nitrogen metabolism and specific growth rate were presented in Table 4. The highest weight gain was recorded in TNSM $_4$ (2.0%) and lowest recorded in the control. The highest feed conversion ratio was recorded in the control and the lowest recorded in TNSM $_4$ (2.0%), nitrogen metabolism and specific growth rate ere highest in the TNSM $_4$ (2.0%) and lowest in the control. while survival rate was 100% in all the treatment groups. There was no significant difference (P > 0.05) in the initial body weight and survival rate among the fish fed on a diet containing tiger nuts based diets and the control

Table 4: Growth Performance and Nutrient Utilization of *Clarias gariepinus* fed with Tiger nuts for 56 days

PARAMETERS	CONTROL	TNSM $_2$ (0.5%)	TNSM $_3$ (1.0%)	TNSM $_4$ (2.0%)	TNSM $_5$ (3.0%)
IBW (g)	400.00±0.01^a	400.00±0.00^a	400.00±0.01^a	400.00±0.00^a	400.00±0.00^a
FBW (g)	760.00±2.00^b	780.00±1.86^c	780.00±1.87^c	790.00±2.01^d	690.00±0.22^a
WG (g)	360.00±0.01^b	380.00±0.02^c	380.00±0.03^c	390.00±0.07^d	290.00±0.01^a
PWG (%)	90.00±0.05^b	95.00±0.08^c	95.00±0.04^c	97.50±0.03^d	72.50±0.01^a
SGR (g)	0.50±0.02^b	0.52±0.01^c	0.52±0.00^c	0.53±0.01^d	0.43±0.02^a
FCR	2.00±0.03^c	1.72±0.01^b	1.74±0.03^b	1.61±0.04^a	2.21±0.05^d
SR (%)	100.00±0.00^a	100.00±0.00^a	100.00±0.00^a	100.00±0.00^a	100.00±0.00^a
NM (g)	17831.52±30.74^b	18138.96±20.70^c	18138.96±28.00^c	18292.68±26.42^d	16755.48±27.05^a
PPI	642.86±3.05^b	698.57±4.59^c	698.57±4.91^c	696.43±5.09^d	517.86±2.27^a

Keys: IBW= Initial Body Weight, FBW= Final Body Weight, WG=Weight Gain, PWG = Percentage Weight Gain, SGR = Specific Growth Rate, FCR = Feed Conversion Ratio, SR = Survival Rate, NM = Nitrogen Metabolism, PPI = Production Performance Index, the above values are mean duplicate data, mean values in each row with similar superscript are not significantly different (P > 0.05).

The reproductive performance of male *C. gariepinus* Fed with Dietary Supplementation of Tiger nuts for 56 days

The result of males fed with tiger nuts dietary supplements revealed that the highest weight of the male was recorded in TNSM $_4$ (2.0%) and lowest in TNSM $_5$ (3.0%). The highest Weight of testis was recorded in TNSM $_4$ (2.0%) and lowest in control. The highest milt volume was recorded in TNSM $_3$ (1.0%) and lowest in TNSM $_2$ (0.5%) and TNSM $_5$ (3.0%) while the highest sperm counts was recorded in TNSM $_4$ (2.0%) and lowest in the control (Table 5).

Table 5: Reproductive performances of male *C. gariepinus* fed different graded levels of tiger nut seed for 56 days

PARAMETERS	CONTROL	TNSM $_2$ (0.5%)	TNSM $_3$ (1.0%)	TNSM $_4$ (2.0%)	TNSM $_5$ (3.0%)
Weight of male (g)	760.00±2.00^b	780.00±1.86^c	780.00±1.87^c	790.00±2.01^d	690.00±0.22^a
Weight of testis (g)	2.50±0.50^a	4.00±0.00^a	3.00±0.20^a	4.00±0.00^a	3.50±0.50^a
Milt volume (ml)	1.00±0.01^a	0.60±0.03^a	2.20±0.30^b	1.20±0.08^a	0.60±0.05^a
Motility duration (s)	30.00±0.04^a	38.00±0.06^{bc}	50.00± 0.70^d	42.00±0.09^c	32.00±0.00^{ab}
Sperm count (10^4spm/ml)	399000.00±2000^a	615600.00±1000^e	783090.00±1300^d	512870.00±1200^c	458976.00±1800^b

Key: The above values are mean duplicate data, mean values in each row with similar superscript are not significantly different (P > 0.05).

The reproductive performance of female *C. gariepinus* Fed with Dietary Supplementation of Tiger nuts for 56 days

The results of females *C. gariepinus* revealed highest weight of ovary, number of eggs and relative fecundity in the treated group, TNSM $_5$ (100%) and TNSM $_4$ (75%) respectively and lowest in the control. Gonado somatic index and hatchability was highest in TNSM $_5$ (100%) and lowest in control. fertilization was highest in TNSM $_3$ (50%) and lowest in control. the belly diameter was highest in control and lowest in TNSM $_3$ (50%) (Table 6).

Table 6: Reproductive performances of female *C. gariepinus* fed different graded levels of tiger nut seed for 56 days

PARAMETERS	CONTROL	TNSM $_2$ (25%)	TNSM $_3$ (50%)	TNSM $_4$ (75%)	TNSM $_5$ (100%)
Weight of female g)	760.00±2.00^b	780.00±1.86^c	780.00±1.87^c	790.00±2.01^d	690.00±0.22^a
Belly diameter (mm)	11.20±2.28^a	10.55±3.05^a	9.50±3.10^a	10.90±2.90^a	9.75±2.25^a
Weight of ovary (g)	53.00±1.00^a	103.00±6.34^d	87.00±1.50^b	95.00±2.56^c	141.00±3.20^e
Weight of eggs (g)	165.00±8.70^c	124.00±3.02^b	86.00±0.08^a	130.00±4.61^b	87.00±0.01^a
Size of eggs (g)	0.13±0.02^b	0.10±0.00^a	0.13±0.01^b	0.15±0.03^b	0.10±0.01^a
Relative fecundity	46.20±0.02^a	112.61±1.08^d	101.46±0.34^c	122.46±2.35^e	71.90±0.08^b
Gonado-somatic index	7.10±0.02^a	17.17±0.12^d	15.43±0.06^c	10.96±0.04^b	18.66±0.09^e
Number of eggs (g)	33768.00±1200^a	67568.00±2000^c	57072.00±4000^b	62320.00±3500^{bc}	92496.00±4300^d
Latency period (h0	11.40±0.02^a	13.12±0.04^b	11.45±0.01^a	11.46±0.00^a	13.40±0.04^c
Hatching time (h)	23.55±0.02^a	24.46±0.34^b	24.18±0.06^b	24.35±0.02^b	24.35±0.01^b
Hatchability (%)	62.50±0.88^a	75.84±0.02^c	75.84±0.00^c	84.76±0.20^d	88.96±0.40^e
Fertilization (%)	62.07±2.00^a	93.23±0.00^b	95.42±0.02^b	94.66±0.20^b	93.14±0.00^b

Key: The above values are mean duplicate data, mean values in each row with similar superscript are not significantly different (P > 0.05).

DISCUSSION

The result of the mean temperature, dissolved oxygen and pH recorded in this study were within the ranges that are considered to be good enough for the development of African catfish. This finding supports the report of Olusola and Olorunfemi, (2017) who observed a temperature range of 28- 30^{0}C, dissolve oxygen 6.02 – 7.08 mg/l and pH of 5.70 - 6.19 for *C. gariepinus* fed guava *(Psidium guajava)* leaves and drumstick (*Moringa oleifera)* leaves extracts supplemented diet. The phytochemical analysis revealed the presence of saponins, flavonoids, tannins, protein, steroids, phenol and glucosinolates in *C. esculentus.* Alkaloid was found to be absent in *C. esculentus*. This study was aligned with the report of Ani *et al*. (2021); Charles *et al.*, (2018) and Nwaoguikpe, (2010) who observed the presence of flavonoids, tannin, saponins, steroids, phenols and glucosinolates in *C. esculentus* These constituents may have been responsible for the positive influence of *C. esculentus* seed powder on growth and reproductive indices of *C. gariepinus* broodstock.

During the 56 days of feeding trials, all the treated groups except TNSM $_5$ (100%) had better values in weight gain, percentage weight gain, and specific growth rate and feed conversion ratio when compared to the control diet. The treated group, TNSM $_4$ (2.0%) had the best performance in terms of weight gain, percentage weight gain, specific growth rate, feed conversion ratio and nitrogen metabolism when compared to other treated groups. This result is in accord with Yeganah *et al*., (2017) who reported a better performance in weight gain, survival rate and specific growth in *Cichlasoma nigrofasciatum* of treated groups compared to the control diet, the result is also in agreement with Olusola *et al.* (2021) who report better performance in weight gain, specific growth rate, and feed conversion ratio in *C. garipienus* fed with *Datura stramonium* when compared to the control. It was observed in that the value obtained increases as the inclusion level increase, however, the value decreases at 3.0 % inclusion of tiger nut. The increase in the weight gain of the fish-fed treated groups could be attributed to the presence of growth-promoting constituents (Saponins and flavonoids) present in the diets. These properties could contribute to digestion and nutrient absorption with a subsequent increase in fish weight.

Also, this study observed that diets supplemented with tiger nuts had better values in motility duration, the weight of testes, sperm counts and milt volume compared to the control and there was a significant difference (P < 0.05) among the dietary groups except for the weight of testes. This result was in agreement with Olusola *et al.,* (2022) who reported a higher performance in weight of testes, sperm counts, motility duration and milt volume of C. gariepinus broodstock fed Cattle Stick (*Carpolobia lutea*) leaves when compared to the control diet. This finding also agrees with the report of Sharma *et al.* (2008) who also observed an increase in sperm counts with extract of *Anacyclus pyrethrum* in male rats. The increase in milt volume and sperm counts observed in *C. gariepinus*-fed diet supplemented with graded levels of *C. esculentus* could be linked to the presence of steroids, highly effective antioxidants capable of increasing testosterone production, a key hormone involved in milt quality and production.

The results of this study showed that increased ovary weight, gonado somatic index, fecundity, percentage fertilization, and hatchability of the eggs were better in the treated groups when compared to the control. The hatchability values obtained in this study increased as the inclusion levels of *C. esculentus* increased. Higher fecundity values were obtained in the fish fed with TNSM 4 (122.46) compared to the control (46.5). Similar results were also reported by Adeparusi *et al.* (2011) on the use of the medicinal herb *Kigelia africana* as a fertility enhancing agent for catfish *C. gariepinus.* Dada, (2012) also reported that *C. gariepinus* broodstock fed on *Mucuna prurien* diets supplemented exhibited improved reproductive performance than those fed with the control diet. The increase in the fecundity of *C. gariepinus* which was obtained in this study could be a result of the presence of flavonoids, glycosides and steroids in the plant which are potent antioxidants capable of increasing the production of oestrogen, the major hormone involved in the production and maturation of eggs in the ovaries.

The size of eggs was largest in TNSM 4 (0.15) and this affects the fertilization of the eggs. Some authors however opined that egg diameter is not a good indicator of egg and larval quality. Dada, (2012) reported that fish with lower egg size has high fecundity therefore, the importance of egg size has been difficult to ascertain because of conflicting results from various studies and because of problem in separating the effect of other factors such as age, strain, and nutritional status of the fish. The control had better hatching time compared to the treated groups. It was observed in the result that all the treated groups had higher gonadosomatic index (GSI) compared to the control diet with a significant difference (P < 0.05) among the dietary groups. This report was in accord with the result of Ekpo *et al*., (2018) who reported a high performance in relative fecundity, gonadosomatic index, mean egg diameter, and female ovary weight in *C, garipienus* of *Adenia cissampeloide* treated groups compared to the control. This also agrees with the findings of El-Sebaie *et al*. (2014). The presence of the phytochemical constituents of the plants such as saponins, alkaloids, terpenoids, flavonoids, etc., might have altered the biosynthetic processes underlying the growth and development of the fish and its ovaries in the treated groups in comparison with the control. These constituents may have been responsible for the positive influence of *C. esculentu*s on reproductive indices of *C. gariepinus* broodstock.

CONCLUSION

Viable sperm and eggs are essential components of any successful animal production operation and the success of the reproduction process is dependent on a supply of high-quality gametes. The present study, therefore, suggests that the inclusion of *C. esculentus* seed meal in the diet of *C. gariepinus* should be encouraged since there was a positive effect on the growth, survival and reproduction performance indices of female and male *C. gariepinus*. It is therefore concluded that the potency of *C. esculentus* has promising growth, survival and fertility enhancer instead of using synthetic drugs that are expensive and have a residual side effects on the organism. The inclusion of 2.0% of *C. esculentus* seed would enhance the growth performance, survival and reproductive indices in *C. gariepinus* broodstock in organic fish farming.

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