

Assessment of dietary supplementation of thorn apple (*Datura stramonium*) seed on growth and reproductive performance of *Clarias gariepinus* broodstock

^{1**}Olusola, S. E., ²Aladegboye, C. A., ¹Amulejoye, F. D and ³Fatoba, T. A.

¹Department of Fisheries and Aquaculture Technology, School of Agriculture, Food and Natural Resources, Olusegun Agagu University of Science and Technology, Okitipupa, Nigeria

²Department of Biological Sciences (Fisheries and Aquaculture Programme), School of Science, Olusegun Agagu University of Science and Technology, Okitipupa, Nigeria

³Department of Animal Production and Health, School of Agriculture, Food and Natural Resources, Olusegun Agagu University of Science and Technology, Okitipupa, Nigeria



****Corresponding author:** se.olusola@oaustech.edu.ng;
belloolus@yahoo.com; 2348034110139

Abstract

Certain plants have been regarded as good source of natural medicine and antioxidants, which are capable of preventing stress and potential diseases in animals. Thus, the effects of Thorn Apple Seed (TAS) were investigated on the growth performance and reproductive indices of *Clarias gariepinus*. Four experimental diets composed of Control (0%), TAS₂ (0.5%), TAS₃ (1.0%), and TAS₄ (2.0%) were fed twice daily at 3% body weight of 40% crude protein for a period of 56 days. A total of 96 *C. gariepinus* broodstock (mean weight 884.00 ± 2.83g) were randomly distributed in triplicate into 12 fibre tanks at a stocking density of eight fish per treatment (4 males and 4 females). Biological evaluation and reproductive indices were measured. The result of this study showed that fish fed experimental diets significantly improved performance such as weight gain, specific growth rate, and feed conversion ratio. Reproductive indices were significantly higher ($P < 0.05$) in fish fed thorn apple seed meal-based diets compared to the control. Dietary supplementation of thorn apple seed meal-based diet at 0.5% inclusion levels showed better performance in terms of growth and reproductive indices. Incorporating thorn apple seed in the diets enhanced growth and reproductive indices of the *C. gariepinus* broodstock.

Keywords: *Clarias gariepinus*, *Datura stramonium*, Growth, Reproductive indices, Broodstock

Évaluation de la supplémentation alimentaire en graines de pomme épineuse (*Datura stramonium*) sur la croissance et les performances de reproduction des géniteurs *Clarias gariepinus*



Résumé

Certaines plantes ont été considérées comme une bonne source de médecine naturelle et d'antioxydants, capables de prévenir le stress et les maladies potentielles chez les animaux. Ainsi, les effets de Thorn Apple Seed (TAS) ont été étudiés sur les performances de croissance et les indices de reproduction de *Clarias gariepinus*. Quatre régimes expérimentaux composés de contrôle (0 %), de TAS₂ (0,5 %), de TAS₃ (1,0 %) et de TAS₄ (2,0 %) ont été nourris deux fois par jour à 3 % de poids corporel de 40 % de protéines brutes pendant une période de 56 jours. Un total de 96 géniteurs de *C. gariepinus* (poids moyen 884,00 ± 2,83 g) ont été répartis au hasard en triple dans 12 bacs en fibre à une densité de stockage de huit poissons par traitement (4 mâles et 4 femelles). L'évaluation biologique et les indices de

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reproduction ont été mesurés. Le résultat de cette étude a montré que les poissons nourris avec des régimes expérimentaux amélioreraient considérablement les performances telles que le gain de poids, le taux de croissance spécifique et le taux de conversion alimentaire. Les indices de reproduction étaient significativement plus élevés ($P < 0,05$) dans les régimes à base de farine de pépins de pomme épineux nourris de poissons par rapport au témoin. Une supplémentation alimentaire à base de farine de pépins de pomme épineux à des niveaux d'inclusion de 0,5% a montré de meilleures performances en termes d'indices de croissance et de reproduction. L'incorporation de pépins de pomme épineuse dans les régimes alimentaires a amélioré les indices de croissance et de reproduction du stock de géniteurs de *C. gariepinus*.

Mots clés : Clarias gariepinus, Datura stramonium, Croissance, Indices de reproduction, Géniteurs

Introduction

Fish farming has enhanced food availability in Nigeria and the world at large (FAO, 2012). Product from fish farming is widely exported and traded by several developing countries to earn income. These products are very rich in nutrients that are important to the body. They account for a large percentage of dietary protein supply (FAO, 2012). The fisheries sector has created employment for over 150 million individuals engaged in the marketing, supply, and distribution of the fish products (Cochrane *et al.*, 2009). The African catfish *Clarias gariepinus* is a specie of catfish of the family Clariidae, which is the most cultivated and highly demanded freshwater fish in Nigeria and globally due to its growth rate, place in the food chain, climate and environmental adaptations, disease resistance, breeding characteristics, compatibility with other fish species in cultivation and conversion efficiency (feed-to-flesh) (James and Sampath, 2019; Eyo and Ekanem, 2011). They are found throughout Africa and thus the Middle East and board freshwater lakes, rivers, streams, and swamps, also as human-made habitats like oxidation ponds or even urban sewage systems. Due to the high demand for quality fish and fish proteins globally, there has been a rise in various researches in several ways to enhance fish fertility to satisfy the demand and target productivity in

aquaculture, with a dramatic movement from synthetic drugs to medicinal plants of natural importance. Medicinal plants were not fully utilized because of the value they have for it but recently researchers are now being investigated, evaluated and developed medicinal plants into drugs (Adedeji *et al.*, 2006; Dada and Ajilore, 2009). The plant has been regarded as a good source of natural medicine and antioxidants which are capable of preventing stress and potential diseases in animals (Olusola and Nwokike, 2018). It has some chemical substances which can nourish, heal, poison and improve different organisms (Eshun and He, 2004). Plants contain nutrients such as proteins, vitamins, carbohydrates, iron, fats, minerals and calcium (Gbile, 2000). The use of plant extracts as a fertility enhancer in animals is now on the increase because of the shifting attention from synthetic drugs to natural plant products. Fertility enhancing properties of some plants in some fishes in Nigeria has been ascertained. Some of these plants include *Garcinia kola* (Dada and Ajilore, 2009), *Kigelia Africana* (Adeparusi *et al.*, 2010), *Cariya papaya* (Abioye *et al.*, 2003), Bitter kola (Adedeji *et al.*, 2006), *Vernonia amygdalina* (Erasto *et al.*, 2008), Sweet potato (Ekpo *et al.*, 2017). Natural plants such as *D. Stramonium* could be used as a growth promoter and fertility enhancer. *Datura stramonium* commonly called thorn apple is an erect annual herb forming a bush

up to 1-1.5m tall common in tropical Africa. It belongs to the family *Solanaceae*. *Datura stramonium* can be grown as an ornamental plant. It has medicinal properties and is used as a narcotic, as a growth promoter and it's a highly appreciated in the west and central Africa where it is commonly used in traditional medicine (Ijeh *et al.*, 1996). The use of this plant can easily be accepted by rural farmers to enhance fertility in fishes. The plant is available all round in the tropics and subtropical regions. However, there is little or no information on the uses of *D. stramonium* on *C. gariepinus*. This study investigated the potential of *D. stramonium* as a growth promoter and fertility enhancer.

Materials and methods

Plant collection and identification

Thorn apple seeds were obtained from Ero, Ifedore Local Government Area of Ondo State, Nigeria, and was authenticated by the Department of Biological Sciences (Botany Programme), Olusegun Agagu University of Science and Technology, Okitipupa.

Preparation of thorn apple seed

Thorn apple seeds were obtained from the pods and air-dried for four weeks after which they were ground into fine powder

and stored at room temperature until required.

Collection and acclimatization of experimental fish

Experimental broodstock (mean weight 884.00± 2.83g) were obtained from a farm in Okitipupa, Ondo State, Nigeria. One hundred and twenty (120) *C. gariepinus* broodstock were acclimatized for two weeks in fibre holding tanks at the Research and Teaching Farm, Olusegun Agagu University of Science and Technology, Okitipupa. During this period, they were fed with commercial diets (Coppens) of 40% crude protein twice daily at 3% body weight.

Experimental diets

The ground seed of thorn apple at different inclusion levels of 0.5%, 1.0%, and 2.0% with feed ingredients such as fishmeal, soya bean, millet, maize, blood meal, Di-calcium phosphate, salt, vit-min premix, and vegetable oil was formulated to 45% crude protein. Each diet mixture treated separately was extended through a 6 mm mincer pelleting machine to make a noodle-like suitable size for the adult fish. The pelleted diets were sun-dried, packed in labelled polythene bag and stored until required (Table 1).

Table 1: Proximate and gross composition of experimental diets (g/100g)

INGREDIENTS	CONTROL (0%)	TAS 2 (0.5%)	TAS 3 (1.0%)	TAS 4 (2.0%)
Fishmeal	8.34	8.34	8.34	8.34
Soya bean	16.68	16.68	16.68	16.68
Blood meal	16.68	16.68	16.68	16.68
Yellow maize	25.15	25.15	25.15	25.15
Wheat bran	25.15	25.15	25.15	25.15
Starch	1.00	1.00	1.00	1.00
DCP	2.00	2.00	2.00	2.00
*Vit- min premix	2.00	1.50	1.00	-----
Vegetable oil	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Thorn apple seed	-----	0.50	1.00	2.00
**Proximate composition (% DM)				
Moisture	7.05±0.01 ^a	7.02±0.03 ^a	7.28±0.04 ^b	7.79±0.00 ^c
Crude protein	40.01±0.02 ^a	40.02±0.01 ^a	40.05±0.03 ^a	40.02±0.01 ^a
Crude lipid	13.95±0.05 ^{bc}	14.00±0.01 ^c	13.88±0.02 ^b	13.65±0.04 ^a
Ash	8.61±0.03 ^c	8.52±0.00 ^b	8.49±0.04 ^b	8.38±0.03 ^a
NFE	30.38±0.04 ^b	30.44±0.05 ^b	30.41±0.06 ^b	30.05±0.01 ^a
Gross Energy (KJ/g)	20.18±0.01 ^b	20.21±0.00 ^b	20.17±0.02 ^b	20.01±0.05 ^a

* Vit-min premix for vitamin and minerals premix. Each 2.kg of premix contain; 12.5 million international unit (MIU); D₃, 2.5 MIU; E, 40g; K₂2g; 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), gross energy (KJ/g) = (protein content x 23.6) + (lipid content x 39.5) + (carbohydrate content x 17.2), TAS = Thorn Apple Seed

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Experimental setup

Water was sourced at the research and Teaching Farm borehole and the tanks were filled to a depth of 1.2 m. Ninety-six (96) *C. gariepinus* broodstock (8 fish; 4 males and 4 females) were stocked into 12 tanks with three replicate per treatment. The diet was allocated randomly to the tank and the dietary group of fish was fed at 3% body weight per day at 8.00 – 9.00 hours and 1700 hours – 1800 hours for 56 days. All fish were batch- weighed every two weeks using a meter weight balance to adjust their new body weight.

Evaluation of milt quality

Milt production and quality were determined at the end of the experiment. Two males selected from each treatment sacrificed and therefore the testes removed for milt quality evaluation.

Milt volume

A small incision was made into the lobe of the testes, the milt squeezed out into a petri dish. This was measured with a plastic syringe in ml.

Motility duration

One (1µl) of milt from the male was placed on a Neubauerhaemocytometer; a drop of water was added and covered with a slip. The sperm activity was viewed under an Olympus microscope at 100x magnification to ascertain when all the sperm got stopped (Mims, 1991).

Sperm count

The concentration of sperm was determined by counting the number of spermatozoa in sample diluted with water (100x) during a bird haemocytometer, under 400x magnification (Rainis *et al.*, 2005).

Egg size estimation

Two female brood-stock were randomly collected from each treatment and used for egg size estimation and percentage fertilization. Five eggs were randomly collected from females in each treatment and viewed under a light microscope filled with calibrated ocular meter

rule/micrometre to calculate the size of the egg as described by Francis *et al.* (2013) as mean egg size (mm)

$$\text{Egg size} = \frac{\text{length of long axis} + \text{length of the short axis}}{2}$$

Estimation of fecundity, fertilization, and hatchability

A calculation involving relatively fecundity, fertilization rate, and hatching rate were calculated twenty- four hours after fertilization of sample (1g= 818 eggs), dead eggs and unviable eggs which turn whitish were collected after removal of "kakaban" by siphoning as shown below:

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

Fertilization rate=

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

Hatching rate=

$$\frac{\text{No of hatched egg in a sample}}{\text{Total no of egg in a sample}} \times 100$$

(Adebayo and Popoola, 2005)

Hatching time

The time of first hatching was observed across the treatments and recorded.

Gonadosomatic index (GSI)

This was measured according to the modified methods of Dada and Ajilore, (2009) as:

$$\text{GSI} = \frac{\text{Weight of gonad}}{\text{Weight of fish}} \times 100$$

Weight of ovary

Two female *C. gariepinus* were killed and a dissected, the ovary was carefully removed by using dissecting set and batch-weighed using a digital weight balance. (S. Mettle, max = 500g, d= 0.01g)

Belly diameter

Three female brood-stock were randomly collected from each treatment and determined their belly diameter as follows:

Belly diameter=

$$\frac{\text{Length of the horizontal axis from the ventral region of the pectoral fin to the vent region} + \text{belly width}}{2}$$

Selection of spawner

Female with thinly separated greenish or brownish eggs were seen oozed out freely from the vent on slight press on the abdomen and males with genital papilla

were observed to be reddish or rose in colour indicating they were matured. Two females and males spawner were selected from each treatment.

Collection of pituitaries

A male fish of *C. gariepinus* was killed thirty minutes before the hypophysation of the female spawner. The lower jaw of the fish was cut open with a dissecting knife and the palate of the mouth opened with a sharp knife at the location of the pituitary in the skull situated on the ventral portion of the brain. The pituitaries were collected with a spatula and ground in a mortar containing 2ml of saline solution.

The collection and the preservation of milt

A male brood fish was obtained from each treatment, killed and dissected to remove the testes. An incision was made in testes lobes to collect the milt. The milt was collected in a small vial with 5 mL saline solution.

Hormone injection

Two female spawners were injected using 5 ml graduated syringe intramuscularly with pituitary hormone suspension that was obtained from the male at an angle of 45° in the dorsal muscles in the direction of the tail.

Stripping and fertilization

Injected spawner were two females from each treatment and were stripped of their eggs after the latency period into clean, well-labelled dry bowls and weighed. The milt was evenly distributed over the egg mass of the sample of each treatment with a 5 ml saline solution and a proper mixing was done by rapid agitation in a clockwise and anti-clockwise direction and afterwards, some clean water was added.

Incubation

Fertilized eggs from each treatment were evenly distributed in a single layer of a netting substrate "kakaban" of 2 mm mesh size and water was allowed to run through

the incubation period to obtain adequate oxygen supply. After hatching, siphoning was done and hatchlings were counted and the incubation period was recorded appropriately.

Biological evaluation

Weight gain = final body weight - initial body weight

Weight gain (%) =

$$\frac{(\text{Final bodyweight} - \text{initial bodyweight}) \times 100}{\text{Initial body weight}}$$

Specific growth rate (SGR) =

$$\frac{100(\log \text{final bodyweight} - \log \text{initial bodyweight})}{\text{Time (days)}}$$

Feed conversion ratio (FCR) =

Dry weight of feed fed (g)

Fish weight gain (g)

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

Initial Number of Fish stocked

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

Where a = Initial mean weight of fish; b = final mean weight of fish; h = experimental periods in days (Nwanna, 2003).

Statistical analysis

Growth performance and reproductive indices resulting from the study were subjected to a one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, 2006 version 20.00). Duncan multiple range tests were accustomed to compare differences using individual means at P = 0.05.

Results

Growth performance and nutrient utilization of *C. gariepinus* fed dietary supplementation of *D. stramonium* seed 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 are presented in Table 2.

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Table 2: Growth performance and nutrient utilization of *C. gariepinus* fed different graded levels of thorn apple for 56 days

PARAMETERS	CONTROL (0%)	TAS 2 (0.5%)	TAS 3 (1.0%)	TAS 4 (2.0%)
Initial body weight	884.00±2.83 ^a	884.00±2.83 ^a	884.00±2.83 ^a	884.00±2.83 ^a
Final body weight	1280.00±28.28 ^a	1630.00±28.28 ^d	1555.00±21.21 ^c	1515.00±35.36 ^b
Weight gain	400.00±28.3 ^a	750.00±28.3 ^d	675.00±21.21 ^c	590.00±28.28 ^b
Weight gain (%)	45.46±2.22 ^a	85.23±3.21 ^d	76.71±2.41 ^c	67.05±3.12 ^b
Specific growth rate	0.29±0.01 ^a	0.47±0.01 ^a	0.46±0.01 ^a	0.84±0.61 ^a
FCR	1.66±0.12 ^c	0.86±0.04 ^a	1.01±0.04 ^{ab}	1.09±0.05 ^b
Survival rate	100.00±0.00 ^a	100.00±0.00 ^a	90.00±7.1 ^a	90.00±7.1 ^a
Nitrogen metabolism	33203.32±439.79 ^a	38583.72±434.79 ^d	37430.82±326.09 ^c	36119.09±427.95 ^b

Key: The above values are mean triplicate data, mean values in each row with similar superscript are not significantly different ($P > 0.05$). FCR =Feed Conversion Ratio, TAS = Thorn Apple Seed

The reproductive performance of male and female C. gariepinus fed dietary supplementation of D. stramonium seed

The results of males *C. gariepinus* fed *D. stramonium* in terms of milt volume, sperm counts, the weight of testes, and females in

terms of the weight of eggs, size of eggs, the weight of ovary, relative fecundity, hatching time and latency period were better in the treated groups compared to the control. These reproductive indices were significantly different ($P < 0.05$) among the dietary groups (See Tables 3a and 3b).

Table 3a: Reproductive performances of male *C. gariepinus* fed different graded levels of thorn apple seed for 56 days

PARAMETER	CONTROL (0%)	TAS 2 (0.5%)	TAS 3 (1.0%)	TAS 4 (2.0%)
Weight of male fish (g)	900.00±282.84 ^a	900.00±282.84 ^a	1000.00±282.84 ^a	900.00±284.84 ^a
Weight of Testes (g)	6.25±0.21 ^b	8.75±0.29 ^c	4.75±0.41 ^a	6.10±0.94 ^{bc}
Milt volume (ml)	3.50±10.28 ^a	5.40±0.28 ^c	4.60±0.28 ^b	4.75±0.41 ^{bc}
Motility duration (sec)	40.00±2.83 ^a	59.50±2.12 ^c	51.00±2.83 ^b	52.50±2.12 ^{bc}
Sperm count (10^4 spm/ml)	450000.00±26760 ^a	486000.00±25455 ^a	460000.00±28284 ^a	450500.00±13438 ^a

Key: The above values are mean triplicate data, mean values in each row with similar superscript are not significantly different ($P > 0.05$). TAS = Thorn Apple Seed

Table 3b: Reproductive performances of female *C. gariepinus* fed different graded levels of thorn apple seed for 56 days

PARAMETER	CONTROL (0%)	TAS 2 (0.5%)	TAS 3 (1.0%)	TAS 4 (2.0%)
Weight of female (g)	1000.00±282.8 ^a	1300.00±182.8 ^a	1000.00±282.8 ^a	1100.00±282.8 ^a
Belly Diameter (mm)	10.65±0.07 ^{ab}	10.63±0.32 ^{ab}	11.18±0.46 ^c	9.75±0.49 ^a
weight of ovary (g)	110.91±0.03 ^b	130.29±0.03 ^c	130.62±0.03 ^d	180.50±0.01 ^a
Number of eggs	21,100.00±0.03 ^d	18,777.60±0.3 ^b	12,384.00±2.83 ^a	20,909.10±0.71 ^c
Weight of eggs (g)	109.90±0.28 ^c	97.85±0.35 ^b	65.00±0.99 ^a	108.90±0.28 ^c
Size of eggs (mm)	1.40±0.03 ^a	1.00±0.03 ^a	1.20±0.03 ^a	1.10±0.03 ^a
Relative fecundity	21.10±0.00 ^d	14.44±0.00 ^b	9.53±0.00 ^a	19.01±0.00 ^c
GSI	10.99±0.02 ^d	7.52±0.03 ^b	6.45±0.03 ^a	9.90±0.03 ^c
Latency period (hr)	10.50±0.03 ^d	9.35±0.0 ^b	9.23±0.03 ^a	10.39±0.01 ^c
Hatching time (hr)	20.60±0.28 ^a	20.26±0.03 ^a	20.30±0.0 ^a	21.70±0.14 ^b
Hatchability %	63.54±0.28 ^b	66.24±0.16 ^c	59.90±0.28 ^a	67.71±0.28 ^d
Fertilization%	50.52±0.03 ^a	97.79±0.03 ^b	97.19±0.03 ^d	96.35±0.03 ^c

Key: The above values are mean triplicate data, mean values in each row with similar superscript are not significantly different ($P > 0.05$). GSI = Gonado Somatic Index, TAS = Thorn Apple Seed

Discussion

The result of the study showed a significant ($P < 0.05$) increase in weight gain, percentage weight gain, and nitrogen metabolism among the dietary groups. The treated groups had better values in weight gain, percentage weight gain, specific growth rate, and feed conversion ratio compared to the control diet. There were no significant ($P > 0.05$) differences in the initial body weight, specific growth rate,

and survival rate among the fish fed on a diet containing thorn apple seed meal-based diets and the control. The increase in the weight gain of the fish fed treated groups could be attributed to the presence of growth-promoting constituents (saponins, tannins, and flavonoids) present in the plant. These properties could contribute to digestion and nutrient absorption with a subsequent increase in the fish weight of the treated groups. It was observed in the result

that fish fed with thorn apple seed meal-based diets had better values in the weight gain, percentage gain, and specific growth rate compared to the control diet. This result was in accord with Yeganah *et al.* (2017) who reported a better performance in weight gain, survival rate and specific growth rate in *Cichlasomanigrofa sciatum* fed *Tribulus terrestris* compared to the control diet. The result was also in agreement with Adeparusi *et al.* (2010) who reported a better performance in weight gain, specific growth rate, and feed conversion ratio in *C. gariepinus* fed the treated diets compared to the control diet. It was observed that the values obtained in the thorn apple seed meal-based diet decrease as the inclusion level increases. The result of this study shows a increase in fertilization and the latency period among the dietary groups. The treated groups had a better result in fertilization and hatching time with significant ($P < 0.05$) difference compared to the control diet. Diets treated with thorn apple seed had better values in motility duration, the weight of testes, and weight of ovary and milt volume, belly diameter, hatchability, and fertilization compared to the control diet with a significant ($P < 0.05$) difference among the dietary groups. This result was in agreement with the report of Francis *et al.*, (2013) who reported better performance in milt motility, milt count, egg size, fertilization and hatchability in *Heterobranchus bidosalis* fed *Vernonia amygdalina* compared to the control. This finding was in agreement with Oluyemi *et al.* (2007) who reported an increase in sperm counts of rats treated with extracts of *Garcinia cambogia*. Sharma *et al.* (2008) observed an increase in sperm counts of *C. gariepinus* broodstock fed extract of *Anacyclus pyrethrum* compared to the control diet, which was similar to the present findings. It was observed that the weight of ovary increases as the inclusion level increases in the thorn apple seed meal-

based diet, this was higher than the value recorded in the control diet. They were significantly ($P < 0.05$) different among the dietary groups. Milt volume was higher in treated groups compared to the control. The result of the sperm count decreases as the inclusion level increases in the treated groups and they were significantly different ($P < 0.05$) among the dietary groups. Diets treated with thorn apple seed had better values in the latency period and hatchability compared to the control diets. It was observed in the result that all the treated groups had low gonadosomatic index (GSI), relative fecundity, and low weight of eggs compared to the control diet with significant ($P < 0.05$) difference among dietary groups. This report was in accord with the result of Ekpo *et al.*, (2017) who reported a lower performance in relative fecundity, gonadosomatic index, mean egg diameter, and female ovary weight in *C. gariepinus* of treated groups compared to the control. These findings were similar to the report of Eyo *et al.* (2016) who reported a decrease in fecundity and egg diameter in *C. gariepinus* fed Coppens feed and Unical aqua feed compared to the control. This may be due to phytochemical constituent of the plant such as saponins, alkaloids, and flavonoids, etc. which might have altered the biosynthetic processes underlying the growth and development of the fish and its ovaries in the treated groups compared to the control. However, there was no significant difference ($P > 0.05$) in the weight of male fish, the size of eggs, sperm counts, the weight of females among the fish fed on a diet containing thorn apple seed and the control.

Conclusion

This study showed that dietary inclusion of *D. stramonium* seed can enhance the fertility of *C. gariepinus* broodstock. Thorn apple is very much abundant in Nigeria and the world at large. This plant can be

incorporated in *C. gariepinus* diet as a fertility enhancer because they are not expensive, readily available, and biodegradable with no side effects on the organism. The inclusion of *D. stramonium* at 0.5% could enhance the growth performance and reproductive indices in *C. gariepinus* broodstock.

Conflict of interest

During this study no conflict of interest was observed.

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