



Comparative Studies on *Clarias gariepinus* Pituitary Extracts and Synthetic Hormone on Induced Spawning and Growth Performance of the African Catfish *Clarias gariepinus* Fry



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Abstract

Comparative Studies on *Clarias gariepinus* Pituitary Extracts and Synthetic Hormone on Induced Spawning and Growth Performance of the African Catfish *Clarias gariepinus* Fry was carried out at the hatchery unit of the Fisheries Department Farm of the Modibbo Adama University of Technology Yola, Adamawa State, Nigeria. Twelve Catfish brood stocks were used for the breeding. Two other catfish broods were sacrificed for the extraction of pituitary extract to induce the brood catfish. Ovaprim was also used as the synthetic induce hormone as control (T₁) for male and female injected with 100%. The treatment includes the following; T₂, T₃, T₄ and T₅ for each treatment two brood stocks a male and female is treated with same level of hormone T₂ (African catfish pituitary extract-ACPE, 100%), T₃ Combined inducers with (50% synthetic-50% ACPE), T₄ (25% ACPE and 75% ovaprim) and T₅ (25% ovaprim and 75% ACPE). The relative fecundity was higher for the brood fish treated with T₂ with (38.37%) comparing it with the lowest T₄ with (27.88%). The latency and hatchability periods were between 9.05-12 and 48 hours respectively for each of the female across the treatment. The female fish injected with ovaprim 100% (T₁) has lower percentage hatchability (56.30%) compared with those injected with 100% ACPE T₂ (60.99%). The combination of ovaprim and ACPE at different doses were also observed, the combination of 25% ovaprim and 75% ACPE also recorded a remarkable values of hatchability percentage (59.39%) compared to the 50% ovaprim and 50% ACPE. Survival rates also followed the same pattern with the hatchability rate. The survival rate was higher in female treatment with 100% ACPE (92.60%) And lower in fish treated with 100% ovaprim (63.45%) The growth rate of the fry also showed significant difference between the fry treated with different inducers; the T₂ has the highest growth rate ranging from of 0.029-0.236 and the lowest with 0.029-0.200 for T₄. Other parameter also includes the Mean weight gain of 0.217 of T₂ which is the highest and the lowest with 0.171 for T₄. Specific growth rate of T₂ with 0.896 which is the heist And T₄ having the least with 0.685bt fir relative growth rate T₂ has the lowest with 14.01 and 16.96 for T₄ The results showed both ACPE and ovaprim aided spawning in African catfish although female fish treated with ACPE enhanced higher hatchability and fries produced from ACPE injected female had higher survival rate, therefore it can be concluded that ACPE hormone yielded the best results in fish seed production

Keywords: Pituitary extract; Synthetic hormone; Induced spawning; *Clarias gariepinus*; Fry

Introduction

Globally, the demand for fish is geometrically growing along with the population growth, urbanization and increasing wealth (World Bank, 2013). The World Bank reported that per capita fish consumption will increase fastest in rich countries and in some parts of the world, such as China, where aquaculture thrives, leading to growing regional disparities between supply and demand (World Bank, 2013). Most worrying, however, are

the declines in projected consumption for sub-Saharan Africa, where, levels of food and nutrition insecurity with poverty are alarming. Fish makes up such a high proportion of about (32%) of animal-source foods. The World Bank (2013) estimates that per capita fish supplies in sub-Saharan Africa is likely to shrink by 1% per annum, from 6.8kg in 2010 to 5.6kg in 2030; this is by far the lowest in the world with global average of 18.2kg, this will increase trade incident of the fish in the international market.

Aquaculture remains the only viable alternative for increasing fish production in order to meet the protein needs of the people. No other group of vertebrate serves man in so many forms as fish [1]. African Catfish (*Clarias gariepinus*) is a hardy species for aquaculture purpose. It is widely accepted in the tropics and commands good commercial values, Even though, the species hardly breeds in captivity all year round efforts is to be intensify on research for it artificial seed production [2]. Several researchers have shown that pituitary hypophysation is effective in inducing the spawning of *C. gariepinus*. Nigeria is the leading catfish fish producer in Africa but this could still be improved upon by availability of induced spawning hormones. Synthetic hormones have been used to induce maturation, spawning and ovulation by using GnRH Analog with Dopamine Antagonist and Luteinizing hormone releasing hormone (LHRH). Ovaprim, which is a combination of Salmon GnRH analog combined with a dopamine, has proved to be extremely successful in breeding of *Clarias gariepinus*. Sex steroids in female fish perform major roles in Oocyte maturation, ovulation and spawning. Synthesis of vitellogenin and increase in ovarian size during final oocyte maturation is controlled by 17 β -estradiol, which is directly related to gonad somatic index [3]. Although a trend exist to apply alternative synthetic hormone substances to induce spawning in catfish and other cultured fishes, hypophysation still remains the most common technique. This method is still widely employed particularly for the fish which are economically very essential but do not spawn in confined waters of aquaculture. *Clarias* pituitary extract (CPE) and Luteinizing hormone-releasing hormone analogue (LHRHa) are two well-known hormones for controlling ovulation in Channel catfish [4].

To solve the problem of quality fish seed availability, induced breeding technique through the use of fresh *Clarias* pituitary extract for induction of gonad maturation and ovulation of the same fish species should be exploited. Depending on commercial hormones that are difficult to come by, costly and some adulterated cannot help fish farmer, rather using natural pituitary extract [5] could be a viable substitute.

Materials and Methods

Study area

The study was carried out at the hatchery unit of the Fisheries Department Farm of the Modibbo Adama University of Technology Yola, Adamawa State, Nigeria. Yola as shown lies between latitude 9 ° 130 North and longitude 12°27 ° East (Wikipedia, 2015 retrieved).

Brood stock selection

The brood stock of the *C. gariepinus* was obtained from the Federal Department of Fisheries Yola, fish farm; and was acclimatized in the concrete tank of the Fisheries Department Farm of the Modibbo Adama University of Technology Yola for 24 hours. The mature gravid females were selected based on well distended swollen soft abdomen, reddish vent, and gentle

extraction of few eggs by depressing of the fish abdomen using the finger. Mature males were also selected based on their reddish pointed genital papillae [6].

Source of hormone

Non synthetic hormone: Pituitary extract were collected from matured Males and Female Bloodstock each using the method of [7]. A specimen must be sacrificed and the head cut off so as to access the brain easily using either hacksaw or well sharpen knife the head is divided in the middle by the mouth leaving the surface of the bone of the head.

The pituitary is found as small round shaped organ, pink-white, situated at the vent part of the basis (Selle turica). Each gland is then weight and transferred into a seal test tube containing 0.9% Normal saline, it was then pulverized in a proclaim mortar with 3ml/ normal saline solution till smooth and ready for injecting .

Synthetic hormone: For the synthetic hormone, Ovaprim was used, the Ovaprim is produced by Syndell laboratories, Canada during the early 1990 and up till today it is being used as an inducer for fertility, the product is liquid containing D-Arg6, Pro9, Net s-GnRH and domperidone, it contain 20mg of salmon ganodotropin and 10mg of domperidone per ml of inject able solution dissolved in an organic solution, single application of ovaprim was used as described by [8,9].

Table 1: Dosage of Synthetic (Ovaprim) and Non Synthetic (ACPE) Used in Female Treatments.

Treatments	ABW (g)	Hormones	Dose/kg Body Weight (ml)
T1	1600	100% ovaprim	0.5
T2	700	100% ACPE	0.35
T3	1450	50 % ovaprim + 50 % ACPE	0.725 + 0.3625
T4	1300	25 % ACPE + 75% ovaprim	0.08125 + 0.1625
T5	1600	25 % ovaprim + 75% ACPE	0.35 + 0.5

Hormone injection: The male and female brood stock were weighed separately using a 10kg Camry Premium Table weighing balance Table 1. The females were injected based on their weight with a pituitary gland extract collected from the mature *C. gariepinus* males and the Ovaprim hormone procure from the market respectively. The pituitary gland extract (non-synthetic hormone) was administered intramuscularly (above the lateral line, towards the tail) at the recommended rate of 1ml per kg body weight of female fish and half dosage for male [10]. The Ovaprim (synthetic hormone) was administered intramuscularly (above the lateral line, towards the tail) at the recommended rate of 0.5ml per kg body weight of female fish and half dosage for male [10]. After the injection, the brood stock was kept back into the concrete tank, with the males being separated from the females for a latent period of 12 hours.

Dosage of Synthetic (Ovaprim) and Natural (African Catfish Pituitary Extract) Hormone Used on Female Treatments. The dosage of synthetic (ovaprim) and natural (African catfish pituitary extract) hormone used in the treatment of female *Clarias gariepinus* brood stock was based on their average body weight of the female fish taken before the experiment.

Dosage of synthetic (ovaprim) and natural (African catfish pituitary extract) hormone used on male treatments

The dosage of synthetic (ovaprim) and natural (African catfish pituitary extract) hormone used in the treatment of male *Clarias gariepinus* brood stock was based on their average body weight of the male before the experiment.

Dosage of combine inducers (synthetic and natural) hormones used on both female and male brood stocks

The dosage of combine inducers used to induce both female and male brood stocks were based on the average body weight during the experiment.

Determination of optimum latency periods

Determination of optimum latency period using *clarias* pituitary extract: The treatments used were replicated twice with measured amount of the extract 1ml/kg per fish [11]. For the treatment on 100% natural hormone (pituitary extract) twelve hours latency period (treatments) that is the time between hormone injection and the time ready for stripping was monitored on hourly basis to check if it is ready for stripping. After it was injected and were placed in an aerated plastic trough and covered with Nets and tied with rubber tube to avoid jumping out of the brooders for that period of time [11].

Determination of optimum latency period using synthetic hormones : Hormone (Ovaprim) is administered to the brooder at 0.5ml/kg for treatment of 100 % synthetic hormone treatment, eight to ten hours latency period (treatments) that is the time between hormone injection and the time ready for stripping was monitored on hourly basis, no replication for this treatment. After it was injected and were also placed in an aerated plastic trough and covered with Nets and tied with rubber tube to avoid jumping out of the brooders for that period of time.

Effectiveness of using combined inducers: The effectiveness of using combine inducers of 50%, 50% and 75%, 25% Ovaprim and pituitary extracts respectively, their effectiveness was prominent as described [12].

Relative fecundity: Number of mature oocytes in a female divided by the total weight of that female.

Milt and eggs collection

The milt was collected by sacrificing the male. The two lobes of the male’s testes were removed, cleaned with tissue paper and kept in a cleaned Petri dish. The abdomen of the female was well

cleaned with tissue paper in order to avoid contact between the eggs and water. Then the females were stripped of their eggs by a gentle application of pressure on the abdomen to release the eggs. The eggs were collected in a dry, well cleaned plastic bowl Figure 1.

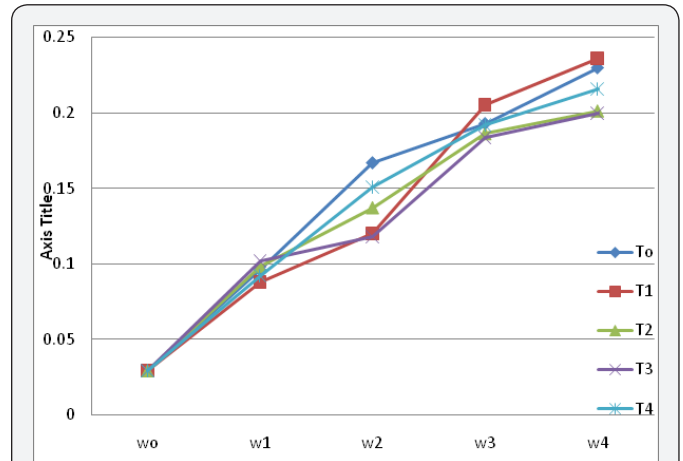


Figure 1: Mean Weight Gain of *Clarias gariepinus* Fry Fed For 28 Days.

Artificial fertilization

The testes of the male was cut open using a razor blade and the milt was squeezed out, and then 0.9% saline solution (NaCl) was added to the milt in order to facilitate fertilization after which the milt was used in fertilizing the already stripped eggs. It is a dry fertilization hence the percentage fertilization was calculated [12].

Hatchability period

The hatchability period is the period required for incubation of the eggs from initiation to complete incubation of the eggs which is 48 hours.

Percentage hatchability: The number of hatchlings was estimated using the volumetric method. The hatchling after swimming into the happa tanks containing 900 Liters of water, a sample of 1 liter was collected and the number of hatchlings was estimated from the sample. The percentage hatchability was calculated from the number of fry counted as described by [13].

$$\text{Percentage hatchability} = \frac{\text{Number of hatched eggs}}{\text{Number of Eggs weight}} \times 100 \dots\dots\dots 1$$

Incubation and hatching of eggs: Incubation and hatching of eggs was carried out in 5 aerated hatchery tanks with each measuring 1,000 liters. Each hatchery tank was filled with 900 liters of water containing incubation nets of 1mm mesh size for substrate attachment of eggs. The fertilized eggs were evenly spread on the incubation nets in the tanks at temperatures between 26-32 °C.

Feeding of larvae: Three days after hatching, after all yolk reserved had been re-absorbed, feeding of the new hatchlings started exogenously.

Culture of live food for the fry: The rotifers used in feeding the larvae; a zooplankton of the genus *Brachionus* was cultured in the Fisheries Department Farm of the Modibbo Adama University of Technology Yola as described by [14].

Experimental set-ups

The experiment was subjected to a complete randomized design (CRD) with 5 experimental sets in replicates consequently 5x2 giving a total of 10 experimental units. In this study, 6 female Brood fish and 6 male Brood fish making the total of 12 brood stocks was used for the study. Two brood fish were sacrificed for the pituitary gland, the remaining ten were used for the treatments, that is one male and one female for each the treatments. The treatments were designated as T₁, T₂, T₃, T₄ and T₅ respectively. Treatment T₁ was 100% synthetic hormone (Ovaprim) administered to both Male and Female brood stock base on the size of the fish as control, treatment T₂ 100% Pituitary extract treatment to both the Male and Female base on the size of the brood fish, treatment T₃ 50%:50% of both pituitary and Ovaprim combine treatment to both fishes base on it sizes., treatment T₄ 25%:75% treatment of Ovaprim and pituitary treatment to both fishes respectively, base on it, treatment T₅ 72%:25% treatment of pituitary and Ovaprim treatment to both fish respectively. The Fry were fed at a fixed feeding rate of 10% body weight 4 times daily between the hours of 07:00 and 23:00 at regular interval for a period of 28 days with live food.

Water quality parameters

Water quality parameters such as pH, temperature, dissolved oxygen and ammonia were monitored twice weekly, using pH meter, mercury in bulb thermometer, dissolved oxygen test kit and an ammonia test kit respectively.

Fish weight measurement

The initial body weight of each set of fish was measured using a sensitive weighing balance before stocking and subsequently bulk weighing of fish in each tank was done after every 15 days.

Analysis of fish growth and nutrients utilization

The growth was expressed as mean weight gain; specific growth rate and survival rate [15]. Nutrient utilization indices were expressed as feed conversion ratio and protein efficiency ratio [16].

Mean weight gain (MWG): The fish mean weight gain was determined as the difference between the final mean weight of the fish at the end of the experiment and the initial mean weight in grams [17].

$$MWG = ((W_1)-(W_0))/n \dots\dots\dots 2$$

Where: W0 = initial mean weight; W1= final mean weight; n = number of fish in the tank

Specific growth rate (SGR): This is the mean percentage increase in body weight per day over a given time interval [18].

In this study, the time interval is 28 days.

$$SGR = ((L_n)(W_1)-(L_n)(W_0))/T \times 100 \dots\dots\dots 3$$

Where: W1 = final mean weight; W0= initial mean weight; T = time interval

Survival rate (SR): Survival rate was also determined as defined by the equation below [19].

$$SR (\%) = N_1/N_0 \times 100 \dots\dots\dots 4$$

Where:

N1 = Final number of fish at the end of the experiment

N0 = Initial number of fish at the beginning of the experiment.

Cost analyses

- a. Cost of natural hormone =#1000 x3.005575ml=30005.75
- b. Cost of synthetic hormone =#700/ml x2.525ml=1767.5
- c. Cost of fry produced= Hatchability x no. of fry produced x amount sold 5
- d. Net profit = cost of fry produced -cost of hormone 6

$$Cost\ Benefit\ Ratio = \frac{Cost\ of\ fry}{Cost\ of\ hormones}$$

Statistical Analysis

The result obtained was subject to one way analysis of variance (ANOVA). The statics differences between the treatments means were separated using Duncan’s multiple range tests [20]. SPSS [21] statistical package for windows software was used to run the result.

Results

Water quality parameters taken from the experimental tanks for the hatching period

Table 2: Water Quality Parameters Taken from the Experimental Tanks during Hatching Period.

Parameters	T1	T2	T3	T4	T5
Temperature (oC)	28.6	27.6	28.6	26.6	27.6
pH	6.5	6.5	6.4	7.1	6.2
Dissolved Oxygen (mg/l)	5.2	6	6	5.9	5.4
Ammonia (mg/l)	0.04	0.03	0.03	0.02	0.03

Table 2 shows water quality parameters taken from the experimental tank during hatching period. The temperature range was within 27.6 - 28.6; while pH was between the ranges of 6.2 -7.1. Dissolved oxygen was within the ranges of 5.2 to 6.0 and ammonia was within the range of 0.02 - 0.04.

Induced ovulation and spawning of *Clarias gariepinus* using synthetic (ovaprim) and non synthetic (African catfish pituitary extract) hormones

Table 3 shows the average body weight, mean egg weight, relative fecundity, and hatchability, survival rate, hatching

periods and latency periods of all the treatments while T₂ recorded the highest survival rate of 92.60 % and T₁ recorded the lowest survival rate of 63.45%. Hatchability of 60.99% was recorded in T₂ which was the highest and the lowest hatchability

of 56.30% was recorded in T₁ treatment. Mean egg weight of 177.98% was recorded in T₂ which was the highest while the lowest mean egg weight of 92.75% was recorded in T₄ [22-25].

Table 3: Induced Ovulation and Spawning of *Clarias gariepinus* Using Synthetic (Ovaprim) and Non Synthetic (African Catfish Pituitary Extract) Hormones.

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅
ABW (g)	1600 _a	700 _d	1450 _b	1300 _c	1600 _a
MEW (g)	116.75 _b	177.98 _a	106.75 _c	92.75 _d	120.75 _b
Relative fecundity	29.36 _c	38.37 _a	29.16 _c	27.88 _d	30.26 _b
Hatchability (%)	56.30 _d	60.99 _a	58.41 _b	57.34 _c	59.39 _b
Hatching Periods (hrs)	48.00 _a	48.00 _a	48.00 _a	48.00 _a	48.00 _a
Latency (hrs)	9.05 _d	12.00 _a	11.00 _b	10 _c	9.08 _d
Survival (%)	63.45 _d	92.60 _a	88.65 _c	89.34 _b	90.15 _b

The rate of growth of fry taking after every seven days for 28 days.

Table 4: Growth Parameters of the Fry.

Parameter	T ₁	T ₂	T ₃	T ₄	T ₅
Initial weight (g)	0.029	0.029	0.029	0.029	0.029
Final weight (g)	0.23	0.236	0.201	0.2	0.216
Mean weight gain	0.201	0.207	0.172	0.171	0.187
Relative Growth Rate	14.42	14.01	16.86	16.95	15.5
Specific growth rate	0.817	0.896	0.689	0.685	0.757

Table 4 shows the rate of growth of fry taking after every seven days for 28 days, the initial weight of all the fry after hatching was 0.029(gm) T₁ the control range from 0.029-0.230(g) T₂ growth range from 0.029-0.236(g) which shows the highest, growth rate the growth T₃ range from 0.029-0.201(g), the growth of T₄ range 0.029-0.200(g). For T₅ the growth rate range from 0.029-0.216(g) it is clear that the fry for T₂ the final weight of 0.236 has the highest weight and T₄ has the lowest with 0.200(g) at 28 days the growth parameter taken for the fry includes; the initial and final weights, relative growth weight, mean weight gain and specific growth rate.

Table 5: Cost Analysis of Using Different Hormones to Produce *Clarias Gariepinus* Fry.

Treatments	Cost of Fry (#)	Cost of Hormones (N)	Net Profit (N)	Cost Benefit Ratio
T ₁	10556.3	1767.5	8,788.50	5.97
T ₂	11143.8	3005.75	8138	3.71
T ₃	12828.7	1591.125	11237.58	8.06
T ₄	10741.3	2076.437	8664.61	5.17
T ₅	11118.8	2696.1875	8422.56	4.12

In Table 5 the growth parameter taken for the fry includes; the initial and final weights, relative growth weight, mean weight gain and specific growth rate. The initial weight was the same for the hatched fry for the whole treatment at the end of 7 days and the final weight gained ranging from 0.200-0.236(g) T₅-T₃ this shows that there is significant difference of the fry hatched from 100% ACPE than other treatment. The mean gain weight of T₄ which obviously higher with 0.207(g) and lowest with T₅ with 0.171(g) induced with 100% ACPE and 25% ACPE+75% ova prim respectively. The relative growth rate of the fry ranged from 16.96 for T₅ and 14.01(g) for T₃ the specific growth rate for the fry also ranged from 0.896 for T₃ and 0.685 for T₅.

Discussion

The study observed the induced spawning and hatching of fries of (*Clarias gariepinus*) treated with synthetic (ovaprim) and non-synthetic (African catfish pituitary extract, ACPE) hormones.

It also shows the survival rates of the fry for the period of four weeks. Weight of gravid female used in each treatment ranged from 700g-1600g.

All the fish responded well to both the synthetic (ovaprim) and the non-synthetic (African catfish pituitary extract) hormones. The spawning occurred within 9.05-9.08hrs after injection at a constant temperature of 27 °C, the study shows the success of using African catfish pituitary extract (ACPE) in fry production. The latency period for induced ovulation and spawning is higher in T₂ with 100% ACPE having 12.00 and lesser with T₁ with 100% ovaprim having 9.05 which served as the control this was not in line with [26] who stated The latency period of African Catfish using (GnRHa) combine dopamine antagonist hormone ranged from 10.33 to 15 hours for the seven ovulated groups (Table 6). Data demonstrated significant differences among these groups. The lowest latency period was (10.33 hours) in group 9. In the

contrary, the longest latency period was (15 hours) in group 3. It is also not in line with [27] who stated that, the maximum latency period of 11 hours, 20 minutes is recorded in a study,

this could be as a result of ovaprim dosage-dependent as was observed for mammalian gonadotropin, methyl testosterone and partially purified Salmon gonadotropin.

Table 6: Dosage of Synthetic (Ovaprim) and Non Synthetic (ACPE) Used in male Treatments.

Treatments	ABW (g)	Hormones	Dose/kg Body Weight (ml)
T ₁	550	100 % ovaprim	0.275
T ₂	1000	100 % ACPE	0.5
T ₃	450	50 % ovaprim + 50 % ACPE	0.1125+0.225
T ₄	500	25 % ACPE + 75% ovaprim	0.625+0.125
T ₅	550	25 % ovaprim + 75 % ACPE	0.275+0.362

Keys:

T₁ = Control 100% Ovaprim; T₂ = Treatment 1 100% ACPE

T₃ = Treatment 2 50% Ovaprim+50% ACPE; T₄ = Treatment 3 25% ACPE + 75% Ovaprim

T₅ = treatment 4 25% Ovaprim+75% ACPE; ACPE = African Catfish Pituitary Extract

ABW = Average Body Weight

The hatching rate was higher in T₂ and lower in T₁, T₅ which was a combined inducer also recorded a high hatchability rate of 59.39%, and there is significances difference in the hatchability rates in all the treatments. These values do not agree with Olaniyi & Akinbola [28] that reported the hatching rates of 46.3% in ovaprim and 25.99% in ACPE in African catfish *Clarias gariepinus*, this study is not also in agreement with Saidin [29] who reported that artificial ovipositor by stripping of *C. gariepinus* gave low hatching rates of 10-45%. The differences observed in these study compare to the work of the above cited authors may be as a result of handling and water quality parameters maintained during the hatching periods.

According to Olaniyi & Akintola [30] fry absorb their Yolk sac after three days but the results of the research showed that fry from T₁ did not completely absorb their yolk sac. However, the fry from T₂ absorbed their yolk sac completely. This could be as a result of delay in hatchability of T₁ or the temperature of the incubation tank as in line with Woynovorich & Horvath [31] who stated that a number of environmental factors such as temperature, pH, dissolved oxygen and calmness to play decisive role in ovulation and that temperature are of vital importance. Faster growths were observed in ACPE after feeding commenced compared to fries produced from ovaprim.

In this study the growth rate is also higher in T₂ which is within 0.029-0.236 and lesser in T₄ with 0.029-0.200, feeding started to some of the fry with Rotifer (live feed) three days after complete absorption of the yolk sac for T₂ while other five days after their completion absorption of the yolk sac, this could be the reason of their delay in growth [32-36]. The survival rate of fry after four weeks was higher in T₂ and lower in T₁ generally; it was observed that there is significant difference in the survival rate of fry after four weeks in all treatments (P < 0.05).

This study is in accordance with Olaniyi & Akinbola [37] who reported 50.14% in ovaprim and 82.98% in ACPE in four weeks rearing hatched fry of African catfish (*Clarias gariepinus*). This

study also agreed with the work of Adebayo & Popoola [38] who observed survival rate of greater than 60% after thirty days of rearing hatched fry of African catfish (*Clarias gariepinus*). The cost of fry produced is highest in T₃ and lowest in T₂, The cost of hormone used was also higher in T₂ and lower in T₃ this was because of the high cost of hormone used, The Net profit was also higher in T₃ and lower in T₁. The Cost Benefit Ratio is higher in T₃ and lower in T₂ with lower production profit. This is almost close to the findings of Olaniyi & Akinbola [39] who reported to have almost same value of cost of production as in T₂ (ACPE) compared with ova prim. In the same vein, ACPE had higher gross profit (N 68,060) and ova prim treated females had lower value (N 42, 485.24). Based on this study, it is suggested that fish seed production can be encouraged through the use of natural hormones (African catfish pituitary extract) which is more readily available unlike the synthetic hormone (ovaprim) whose supply varies with changes in import duties [40-44].

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