Sudan University of Science and Technology

College of animal production Science and Technology

Department Of fisheries and wild life science

Spawning and Rearing Performance of African Catfish (*Clariasgarpinauis*)larvae to Fingerlings Stage: by using anural Hormone (CPG) and synisitic Hormones (Ova prim and HCG)

فقس ورعاية سمك القرموط الافريقي من طور اليرقات إلى طور الاصبعيات بإستخدام الهرمون الطبيعي (الغدة النخامية للكارب) والهرمونات الصناعية (اوفا بريم و الغدد التناسلية المشيمية البشرية)

A Thesis Submitted in Partial Fulfillment of the Requirement of the B.Sc. Degree in Fisheries and Wildlife Science (Honor)

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الآيـــــة

قَالَ تَعَالَىٰ:

أَعُوذُ بِٱللَّهِ مِنَ ٱلشَّيۡطَٰنِ ٱلرَّجِيمِ

﴿ قُل لَّوۡ كَانَ ٱلۡبَحۡرُ مِدَادٗا لِّكَلِمَٰتِ رَبِّي لَنَفِدَ ٱلۡبَحۡرُ قَبۡلَ أَن تَنفَدَ كَلِمَٰتُ رَبِّي وَلَوۡ

جِئۡنَا بِمِثۡلِهِۦ مَدَدٗا ﴿١٠٩﴾ ﴾ صدق الله العظيم

الكهف: ١٠٩

DEDICATION

TO MY LOVELY FAMILY

TO ALL

TO MY FRIENDS

WITH ALL OUR DOAA

Acknowledgement

All gratitude is goes to Allah who guided us to bring forth to light this project. We feel indebted to our supervisor Dr.Asaad H. Widaa for his skilful guidance and invaluable suggestion at various stages of this work, we simply cannot find the right words to express our gratitude to him, patience, advice and unlimited support were our light to find out our way throughout the project period.

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To All We are grateful

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Table of Abbreviations

Abbreviation	Meaning
FAO	Food and Agricultural Organization
U.S.	United States
C. gariepinus	*Clariasgariepinus*
GnRHa	Gonadotropin Releasing Hormone analogue
CPE	Carp Pituitary Extract
LHRAa	Luteinizing Hormone-releasing Hormone analogue
SGnRHa	Syndel's Gonadotropin Releasing Hormone analogue
CPH	Carp Pituitary Homogenate
CPG	Carp Pituitary Gland
GSI	Gonado somatic Index
PGE	Pituitary gland extract
HCG	Human Chronic Gonadotropin
PG	Pituitarygland
B.W.	Body Weight
Kg	Kilograms
Ml	Milliliters
G	Grams
SPSS	Social Sciences program

ABSTRACT

Using Statistical Analysis `the obtained data in this study were subjected to one-way (ANOVA) analysis of variance (snedecor,and Cochranl, 1986),(Sokal,and Rohlf,1981). Data were entered and analyzed using Statistical Package for Social Sciences program (SPSS) for Windows, Version 16 (Log Xact8 ,Cross over,USA),

This study was conducted to see the effect of hormones for brood stoke catfish in the intensive farming system through three types of hormone HCG, Ova prim and carp pituitary gland powder to release the eggs from brood stock catfish. It was evaluated average fecundity, weight and length for brood stock that have been injected. Were obtained the following results at GSI account in hormone formulations of purified were GSI = 3.27 for Ova prim hormone, HCG hormone = 2.91 and pituitary gland of carp = 1.91, the average weights of brood stock that have been injected with 500 HCG, 540 Ova prim and 485 for pituitary gland powder the average length and weight fry (5.85 -101.38) (1.56-5.655) (1.78-5.77) for Ova prim, HCG and pituitary gland powder of fish carpRespectively

It has to examine the relationship between fecundity and length and weight, and found that there is a high significant difference in fecundity between the fish that has them three hormones while no significant difference in length and weight, were also investigated the correlation between weight and length for fry showed a significant difference strong for each frybest ratio trace length and weight hormone HCG (93.5%), hormone Ova prim (90.3%) and powder pituitary hormone carp (87.6%).

Through this study, we can obtain a suitable fry from these three hormones in intensive farming system conditions and it can be rearing till marketing size.

Key words :

Spawning - Rearing - Human Chronic Gonadotropin - Ova prim - Carp Pituitary Gland

الخلاصة

بإستخدام التحليل الإحصائي تعرض البيانات التي تم الحصول عليها في هذه الدراسة إلى تحليل one-way (ANOVA) تحليل التباين (snedecor,and Cochranl, 1986),(Sokal,and Rohlf,1981).

تم إدخال البيانات وتحليلها بإستخدام الحزمة الإحصائية للعلوم الإجتماعية للنوافذ Version 16 (Log Xact8 ,Cross over,USA)

أجريت هذه الدراسة لمعرفة تأثير الهرمونات لأسماك القرموط في نظام الاستزراع المكثف عبر ثلاثة أنواع من الهرمونات HCG ,Ova prim ومسحوق هرمون الغدة النخامية لاسماك الكارب وذلك باخراج البيوض من أمهات أسماك القرموط. وتم حساب متوسط الخصوبة والوزن والطول بالنسبة للأمهات التي تم حقنها. تم الحصول على النتائج الأتية عند حساب GSIفي هرمون Ova primكانت GSI=3.27 وهرمون HCG=2.91 وهرمون الغدة النخامية لاسماك الكارب =, 1.91متوسط أوزان الأمهات التي تم حقنها HCG 500، Ova prim 540 ، 485 لمسحوق هرمون الغدة النخامية لاسماك الكارب كانت متوسطات الطول والوزن للزريعة (5.85 -101.38) (1.56-5.655) (-1.78 5.77)لهرمونHCG, Ova prim و مسحوق هرمون الغدة النخامية لاسماك الكاربعلي التوالي.

تمت دراسة العلاقة بين الخصوبة والطول والوزن ووجد ان هناك فرق معنوي في الخصوبة بين الاسماك التي تمت عليها معاملات الهرمونات الثلاثة بينما لايوجد فرق معنوي في الطول والوزن ، ايضا تمت دراسة معامل الارتباط بين الوزن والطول بالنسبة للزريعة اظهرت فرقا معنويا قويا افضل نسبه تتبع الطول والوزن هرمون HCG(93.5%) ،هرمون Ova prim (90.3%) ومسحوق هرمون الغدة النخامية لاسماك الكارب(87.6%).

من خلال هذه الدراسة يمكن الحصول على الزريعة باستخدام الهرمونات الثلاث في ظروف الأسرفي نظام الاستزراع المكثف وانه يمكن رعايتها .

مفاتيح الكلمات :

التفقيس - الرعاية - الغدة النخامية للكارب - اوفا بريم - الغدة التناسلية المشيمية البشرية

CHAPTER ONE

INTRODUCTION

1.1. Aquaculture Background

Aquaculture is defined as the culture of aquatic organisms under controlled or semi-controlled conditions (Stickney, 1996). According to the Food and Agricultural Organization of the United Nations (FAO; 2003), total world fishery production in 2002 was 133 million tons, of which 41.9 million tons came from aquaculture. In the United States (U.S.), per capita consumption of seafood rose to a record 16.3 pounds of fish and shellfish per person in 2003 ("Seafood consumption," 2004). However, due to many inherent aquaculture production issues in the U.S. such as environmental regulations and high labor, land, and energy costs, much of this seafood is cultured overseas and imported. This contributes to a national seafood trade deficit in excess of $7 billion annually (National Marine Fisheries Service, 2004).

Fish is the cheapest source of animal protein consumed by the average Nigerian, accounting for about 40% of the total protein intake (Atanda, 2007). One of the major problems identified as hindering the promotion and development of aquaculture in the country is the scarcity of fish fingerlings of the desired cultured species (Adewolu *et al*., 2008). If the potential of one million tons of fish as speculated by(FAO ,2004) were to be realized at a semi-intensive management level of fingerlings production, then at least two billion fingerlings would be required annually from all sources (Atanda, 2007).

In 2012, the total world production of fisheries was 158 million tons of which aquaculture contributed 66.6 million tons, about 42 percent. (FAO,

2014) The growth rate of worldwide aquaculture has been sustained and rapid, averaging about 8 percent per annum for over thirty years, while the take from wild fisheries has been essentially flat for the last decade. The aquaculture market reached ($86 thousand million) in 2009.(Blumenthal, 2010).

A United Nations report titled The State of the World Fisheries and Aquaculture released in May 2014 maintained fisheries and aquaculture support the livelihoods of some 60 million people in Asia and Africa (FAGF).

1.2.Cat Fish (*Clarias Gariepinus)* Production In Africa

In recent years, the culture of species of the catfish belonging to the Clariidae family is fast gaining global attention. In Africa, especially Nigeria, the species mostly cultured are *Clarias gariepinus,* Heterobranchus sp and their hybrids (Adewolu et al., 2008). They are widely cultured owing to their high market price, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content (Adewolu and Adeoti, 2010) reported that inter-specific hybrid fishes transfer desirable traits between species, combine desirable trait of two species into a single group of fishes. In Nigeria, getting fast growing fish seed have been a major problem to farmers targeting high yields. Hybrid clariid catfish has increased rapidly in the last few years and apparently market demand is still increasing (Odedeyi, 2007).(Ayinla and Nwadukwe 1989) found that there are variations in the sizes of fingerlings produced from the same clariid brood stock at the same time and that the variations in sizes of the fingerlings might be related to the variations in sizes of their eggs. Among the culture able fin fish in Nigeria, catfish is the most sought after fish species, very popular with fish farmers and consumers. It commands

very good commercial value in Nigerian markets (Ezenwaji, 1985; Ayinla et al., 1994). The catfish is very important to the sustainability of the aquaculture industry in Nigeria. The blending of high survival rate and fast growth rate into the hybrid "heteroclarias" offers higher production prospects.

African catfish *clarias gariepinus*(Burchell ,1822) is one of the most higly valued species in africa (Egypt, Ethiopia , Chana , Mali ,and Nigeria) and asia (China, Iindonesia , Malaysia, Philippines and Thailand).recently *Clarias gariepinus* has been introduced in some European and Latian America countries and its culture has increased in scale(FAO, 2014).

African catfish *Clarias garipinus is* distributed throughout Africa it is of growing economic value in the African aquaculture industry(Goda et.,2007;Osman et al., 2009).

African sharp tooth catfish *Clarias gariepinus* is a typical air-breathing catfish with a scale less, bony elongated body with long dorsal and anal fins, and a helmet like head . Color varies dorsally from dark to light brown and is often mottled with shades of olive and grey while the underside is a pale cream to white (Skelton, 2001). It can grow very large with a maximum reported length of 170 cm (IGFA, 2001) and weight of 60 kg (Robbins et al., 1991).

The genus Clarias was reviewed in the 1980s, which resulted in several widespread species being synonymized (*Clarias capensis* of southern Africa, *C. mossambicus* of central Africa and C. lazera of west and north Africa) under the name *Clarias gariepinus* (Teugels ,1986).

The native range of *C. gariepinus* covers most of the African continent, with the exception of Maghreb, Upper and Lower Guinea, and the Cape provinces of South Africa (Picker and Griffiths ,2011).

Clarias gariepinus is considered to be omnivorous displaying both scavenging and predatory Behavior (Bruton, 1979a). It is known to have an

extremely varied diet consuming fruits and seeds, all types of aquatic invertebrates and small vertebrates, small mammals and even plankton (Bruton 1979a, Skelton 2001). Larger individuals show a specific dietary shift towards fish as they grow bigger (Willoughby and Tweddle ,1978). However, inactive foods, which it detects with its sensory barbells before securing with its array of very fine teeth prior to gulping, are generally preferred (Bruton ,1979a, Skelton 2001).Alternatively, it can be an efficient predator and even hunt in 'packs' where it may herd shoals of small fish against submerged aquatic vegetation before devouring them (Merron, 1993). Solitary feeding, social hunting and coordinated pack-hunting foraging and Behavior even feeding migrations have all been observed (Bruton 1979a, Merron, 1993).

Hatching of the eggs occurs soon after spawning, usually after 24 to 36 hours (Bruton, 1979b). There is no parental care of the young (Hecht et al., 1988). Average fecundity of Lake Sibaya *C. gariepinus* was found to be approximately 45 000 eggs for a 2 kg Catfish have been used in traditional capture-based African aquaculture for centuries. Experimentation began in the 1940s in South Africa at the Jonkershoek Fish Research Station with some degree of success (Hey, 1941). Domestication was further stimulated by the work of Greenwood (1955) and by the 1970s*; C. gariepinus* was widely farmed across Africa (Hecht et al., 1988).

1.3. Hormone Stimulation

Following spawning difficulties, hormone stimulation trials were undertaken in both Africa and Europe (FAO, 2012). Today *C. gariepinus* culture has become more widespread, especially with recent advances in aquaculture techniques, such as the progress towards balanced commercial fish (Bruton ,1979b). Environmental and hormonal manipulation of ovulation in the

fish have become of practical importance in the fish farming industry for two main reasons; to solve the problem of spawning asynchrony cyprinids which necessitates frequent brood stock handling (Crim and Glebe 1984; lin and peter 1996) and for accelerating or delaying gametogenesis in captive brood stock, spawning may be scheduled to yield fry whenever needed (Lam ,1983) Use of exogenous hormones is an effective way to induced reproductive maturation and produce fertilized eggs(mylonas and zanuy2009).

Originally, culturists utilized carp pituitary (CP) and this is still widely used particularly for the major Indian carps, Chinese carps and the common carp *Cyprinus carpio* (lam, 1983; park,et al.,1994). Human chorionic gonadotropin (HCG) has been used to induce final maturation of oocytes and also as a tool for utilization in commercial in aquaculture (mylonas,et al.,2009 ;Kelly and kohler,1994).

Artificial reproduction in catfish species especially C. gariepinus and H. bidorsalis have been studied by several authors (Haniffa,et al , 2000)

1.4 . Objective Of The Study

1. Investigate the reproductive, growth and hatchability of *Clarias gariepinus* when induced with synthetic hormone of pituitary gland from female of *Clarias gariepinus* .
2. Evaluate different techniques which permit spawning, incubation, hatching of eggs and rearing under controlled environment.

CHAPTER TWO

LITERATURE REVIEW

2.1. Taxonomy Of *Clarias gariepinus*

Clariid cat fishes are characterized by the presence of a unique arborescent suprabranchial organ formed by the second and the fourth gill arches, which enables them to breath atmospheric oxygen (Teugels and Adriaens,2003). The family is composed of 15 genera and presently includes 89 species occurring in fresh waters from Africa (13 genera, 74 species), Asia Minor (1 genera, 1 species also present in Africa), and South East Asia (3 genera and 15 species) (Teugels, 2003).

African sharptooth catfish Clarias gariepinus is a typical air-breathing catfish with a scaleless, bony elongated body with long dorsal and anal fins, and a helmet like head . Colour varies dorsally from dark to light brown and is often mottled with shades of olive and grey while the underside is a pale cream to white (Skelton, 2001). It can grow very large with a maximum reported length of 170 cm (IGFA, 2001) and weight of 60 kg (Robbins et al, 1991).

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2.2.Natural Distributin And Habitat

The native range of C. gariepinus covers most of the African continent, with the exception of Maghreb, Upper and Lower Guinea, and the Cape provinces of South Africa (Picker and Griffiths , 2011) . According to (Skelton 2001) it is probably the most widely Distributed fish in Africa. (Jubb , 1967) describes its natural distribution as occurring as far south as the Orange River system in the west and the Umtamvuna River in the east of South Africa. C. gariepinus is widely tolerant of many different habitats, even the upper reaches of estuaries, but is considered to be a freshwater species. It favours floodplains, slow flowing rivers, lakes and dams (Skelton, 2001). It can tolerate waters high in turbidity and low in dissolved oxygen, and is often the last or only fish species found in remnant pools of drying rivers (Safriel and Bruton, 1984, Van der Waal, 1998).

2.3Biology

2.3.1.Diet And Mode Of Feeding

Clarias gariepinus is considered to be omnivorous displaying both scavenging and predatory behaviour (Bruton, 1979a). It is known to have an extremely varied diet consuming fruits and seeds, all types of aquatic invertebrates and small vertebrates, small mammals and even plankton (Bruton1979a, Skelton 2001). Larger individuals show a specific dietary shift towards fish as they grow bigger (Willoughby and Tweddle, 1978). However, inactive foods, which it detects with its sensory barbells before securing with its array of very fine teeth prior to gulping, are generally preferred

(Bruton 1979a, Skelton 2001).Alternatively, it can be an efficient predator and even hunt in ‘packs’ where it may herd shoals of small fish against submerged aquatic vegetation before devouring them (Merron , 1993). Solitary feeding, social hunting and coordinated pack-hunting foraging behaviours and even feeding migrations have all been observed (Bruton 1979a, Merron 1993**).**

2.4.Growth

Clarias gariepinus is considered to have a rapid growth rate (in length and weight), the rate of which strongly depends on ambient conditions and habitat (Bruton and Allanson 1980, Hecht and Appelbaum 1987, Britz and Pienaar 1992). Growth has been found to be positively density dependent (Hecht and Appelbaum 1987). Individuals have been recorded to reach 200 mm SL within a year (Bruton and Allanson 1980, Skelton 2001). In females, the growth rate decreases after 3 years resulting in the males reaching larger sizes (Skelton, 2001). Individuals of this species are known to live for eight or more years (Bruton and Allanson 1980).

2.5. Reproductin

Shoals of the fish migrate upstream or to the shores of still water bodies prior to breeding (de Moor and Bruton 1988). Courtship, spawning and egg laying takes place at night often after rain (Bruton , 1979b). Eggs usually adhere to submerged vegetation, either aquatic or terrestrial vegetation that has recently been submerged as a result of seasonal water level rise (Bruton 1979b). Hatching of the eggs occurs soon after spawning, usually after 24 to 36 hours (Bruton, 1979b). There is no parental care of the young (Hecht et al., 1988).

Average fecundity of Lake Sibaya C. gariepinus was found to be approximately 45 000 eggs for a 2 kg fish (Bruton 1979b).

2.6. Environmental Tolerance ranges

Clarias gariepinus can endure extremely harsh conditions (Skelton, 2001). It is able to tolerate very low oxygen concentrations and even survive for considerable periods out of water, via the use of a specialised suprabranchial organ (Safriel and Bruton 1984, Hecht et al. 1988). This organ is a large paired chamber with branches above the gill arches specifically adapted for air breathing (Maina and Maloiy 1986) and allows it to move over land even when not forced to do so by drought (Welman 1948, Johnels, 1957). Water temperatures between 8 and 35°C, salinities of 0 to 10‰ and a wide pH range are all tolerated (Safriel and Bruton 1984). C. gariepinus exhibits high growth rates between 25 and 33 °C, with optimum growth recorded at 30°C (Britz and Hecht , 1987). The ability of the fish to be able to tolerate these extreme conditions allows it to survive even in moist sand or in borrows with an air-water interface (Bruton 1979c, Van der Waal 1998).

2.7. History Of Domestication

Catfish have been used in traditional capture-based African aquaculture for centuries. Experimentation began in the 1940s in South Africa at the Jonkershoek Fish Research Station with some degree of success (Hey , 1941). Domestication was further stimulated by the work of (Greenwood, 1955) and by the 1970s, C. gariepinus was widely farmed across Africa (Hecht et al , 1988). Following spawning difficulties, hormone stimulation trials were undertaken in both Africa and Europe (FAO, 2012). Today C. gariepinus

culture has become more widespread, especially with recent advances in aquaculture techniques, such as the progress towards balanced commercial fish feeds, the testing of different tank construction materials, and the use of closed systems which rely on water recirculation. In addition to a food source, C. gariepinus has been used as a biocontrol species in mixed-sex tilapia farms, as well as a bait fish (FAO , 2012). Clarias gariepinus is now being artificially hybridized with a number of other similar catfishes such as the Vundu Heterobranchus longifilis, the product of which is also producing viable offspring (Hecht and Lublinkhof 1985); triploids are being produced as well (Henken et al. , 1987), as are tetraploids (Varadi et al., 1999).

2.8. Natural and Artificial Stimulation

Hormones

Synthetic hormones are prepared to stimulate spawning in fishes whether or not they are out of natural breeding season, some of the ones in contemporary use include Ovaprim, Ovatide, Human Chorionic Gonadotropin (HCG) and Deoxycorticorsterone Acetate (DOCA) (Adebayo and Popoola, 2008). Others include WOVA-FHTM, Carp pituitary extract (CPE) and Dagin (Yaron *et al*., 2009).

2.9. Ova Prim Hormone

Induced breeding performance of African Mud Catfish *Clarias gariepinus* was evaluated using five different doses of normal saline diluted Ovaprim at 0%, 25%,50%, 75% and 100% while undiluted Ovaprim served as the control, The Ovaprim was administered at the rate of 0.5ml for each

treatment per kg body weight of the fish, represented as treatments A,B,C,D and E respectively ,The mean weight of the stripped eggs collected were 18.45g,17.50g,and17.25g in treatments A,B and C respectively with no significant difference ($p<0.05$) in values. Spawning did not occur in D and E, thus no egg was collected. Percentage fertilization of the stripped eggs in treatments A,B and C were 88.70%,87.50% and 77.38% respectively with treatment A showing significant difference ($p<0.05$) from B and C. Percentage hatchability from the stripped eggs were 56.58%,54.07% and 57.75% for treatments A,B and C respectively with no significant difference($p<0.05$)among the three treatments ,while percentage survival of the fry were observed to be 40.27%,40.87% and 42.52% in treatments A,B and C. There was no significant difference ($p<0.05$) in the survival rate among the treatments. Comparative cost benefit analysis between the control (undiluted Ovaprim) and the different doses of normal saline diluted Ovaprim shows that saline diluted Ovaprim at 50% is the most cost effective. In conclusion, generic Ovaprim with 50% normal saline will ensure spawning in *Clarias gariepinus* with high percentage hatchability of eggs and survival of the fry. (Olumuji and Mustapha , 2013) Furthermore, Induced spawning of African mudfish *Clarias gariepinus* was conducted at different ovaprim doses, to observe the situation that will provide the highest number of eggs,Females of *C. gariepinus* were injected with different doses of ovaprim 0,5ml/kg, 1.0ml/kg and 1.5ml/kg. The fish in control experiment were injected with 0.0ml/kg of ovaprim,The eggs collected from injected fishes were fertilized with milt from male *C. gariepinus*. The fertilized eggs from fishes injected with 0.5ml/kg, 1.0ml/kg and 1.5ml/kg were placed in netting fabrics in bowls of water and were placed inside the laboratory,The results obtained showed that increase in the dosage of sGnRHa enhanced the production of more eggs and the highest number of eggs was obtained with

1.5ml/kg of ovaprim,It also reduced ovulation period,The fish that were injected with 0.5ml/kg produced the least amount of eggs and were stressed during the process of removal of eggs resulting in death,A dosage of 1.0ml/kg was recommended for artificial spawning of *C. gariepinus* for subsistence fish culture because the eggs oozed out directly with slight stroking of the belly of the fish and no mortality was recorded. 1.5ml/kg could be injected if the farmer has the facility to hold large numbers of larvae. (Achionye and Israel., 2012) .

Muhammad Naeem et al.,(2013) A study was conducted to observe the effect of intramuscular injection of ovaprim-C on the number of eggs/kg, fertilization rate and hatching percentage at a private fish hatchery and research center at Faisalabad, Pakistan, during May to June 2008, on *Labeo rohita* (Rohu),Studied fish specimens were spawned successfully following a single dose of injection of ovaprim-C (LH-RH analogue) with 0.4 ml kg-1 for female and 0.05 ml kg-1 for male brooders,Ova and milt were stripped simultaneously and mixture was stirred for 15 to 30 s during which fertilization occurred. Hatching occurred within 18 to 30 h after fertilization. The experiment was conducted in circular spawning tank with 2 m diameter,If it is impossible to determine the absolute and relative fecundity, then these parameters can be determined from the body weight. Average number of eggs/kg, fertilized eggs/kg and hatchlings/kg was 63574, 49067 and 39952, respectively. Overall fertilization and hatchling %age was 77.50% and 81.39% respectively,Wet body weight was observed to have a positive influence on absolute (r=0.983) and relative fecundity (r = 0.910) in log-log scale.

2.10. HCG Hormone (Human Chronic Gonad Tropin)

S. U. Mahmood,(2003)Two hormone preparations viz. Human Chorionic Gonadotropin (HCG) and pituitarygland (PG) suspension were compared for their comparative efficacy on the breeding performance of a air breathing catfish Clarias batrachus. It was found that HCG induced fish gave better ovulation response than PG. Both fertilization and hatching of eggs were significantly (p<O.Ol) higher in HCG treated fish than PG. On all consideration, HCG was found more suitable for induced of c. batrachusover PG.

2.11. Carp Pituitary Gland

E. BRZUSKA,(2003) THE results of controlled reproduction of African catfish (Clarias gariepinus) females after ovulation stimulation with carp pituitary (4 mg/kg body weight) or with Aquaspawn preparation (complex of GnRH-a and domperidone) (0.5 ml/kg) were examined. It was found that after pituitary stimulation 100% and after Aquaspawn treatment 87.5% of females yielded eggs of satisfactory quality. In the group treated with the synthetic stimulator females yielded eggs of higher weight. the statistically significant ($P \leq 0.05$) higher weight of eggs was found if it was expressed in percentages of female body weight. After 12-, 24-, and 28-hour incubation the quality of eggs obtained after Aquaspawn treatment was better than that recorded in the case of pituitary application and differences between the results being statistically significant ($P \leq 0.05$). In the presented experiment the investigated material was composed of females from two categories determining their body weight, i.e. lighter females (average body weight of 4.89 ± 0.49 kg) and heavier females

(average body weight of 6.96 ± 0.72 kg). No statistically significant differences were recorded between the investigated averages for any of the traits determining the weight or the quality of obtained eggs, however heavier females yielded eggs of higher weight expressed in grams.

Efe Okere et al,.(2015) This study compared the effectiveness of Ovaprim and pituitary gland extract (PGE) in induced spawning of the African mud catfish, *Clarias gariepinus*, using reproductive output and fry quality indices. At a mean temperature of 26.0±0.700C, latency period for Ovaprim and PGE were 613 and 745 minutes, respectively. Workers fecundity was significantly higher ($p<0.05$) for brooders treated with Ovaprim (36086.00 ±7215.50eggs) than PGE induced spawners (20978.00 ±6782.15eggs). Hatching rates also followed the same trend, in which significantly higher hatching success was recorded for Ovaprim ovulated eggs (83.5%) than PGE induced eggs (63.7%). Fry survival rate was 81.90 ±1.10% for Ovaprim treated fish, while PGE induced fish fry had 77.73±1.33%; percentage deformed fry was significantly minimal for Ovaprim treated. However, all Ovaprim-treated spent fish died few hours post stripping, contrary to PGE spent brooders that were fully recovered. Production cost analyses revealed that the use of Ovaprim resulted in about 25% cost reduction. It is thus concluded that Ovaprim is superior to PGE in induction of breeding in *Clarias gariepinus*. This not with standing, the mortality suffered by all the spent fish treated with Ovaprim raises food safety concerns. This however, needs to be validated.

2.12. Fecundity

Size and weight of gonad gives a good indication of breeding season of any species in natural environment. The fecundity is termed as number of eggs

contained in ovary of a fish (Nikolsky.,1963) . Fecundity has a significance relationship with the natural environment accorded to eggs (Lagler, and Mille., 1967). In fishery, for evaluating the commercial potentialities of its stock, life history, practical culture and actual management, an adequate knowledge about fecundity is necessary (Lagler., 1956)(Doha and Hye .,1970) . Fecundity also determines the index of density dependent factor affecting the population size (A.C. Simpson.., 1951). Fecundity, size of the eggs and weight of the ovary of a fish are interrelated in life history traits that have commonly been used to characterized different populations of fishes (Healey and Heard., 1984) (Beacham and Murray., 1987).Various factors like changing environment, length, age etc. (Arup Buragohain1, Goswami2.,2014) Fecundity of an indigenous Indian cat fish Clarias magur (Hamilton, 1822) during spawning season (April to July, 2011) has been studied. Relationship of fecundity (F) with body weight (BW), total length (TL), ovary length (OL), ovary weight (OW), gonadosomatic index (GSI%) and ova diameter (OD) was calculated. Fecundity is found to be the lowest (3947.91 ± 506.42) in the month of April and the highest (10957.47 ± 3031.49) in the month of June. The value of Correlation coefficient (r) between F and BW is highly significant (r=0.95) followed by F and OW (r=0.88) > F and OL (r=0.74) > F and TL (r=0.60) and > F and GSI (r=0.51). The correlation between with F and OD has not shown significant correlationship (0.09). Fecundity exhibits the highest correlationship (r) with BW, OW, TL and GSI during the month of June. (Arup and Goswami,2014)

2.13. Length –Weight Relationship, Condition Factor Of *Clarias Gariepinus* Juveniles Reared In Concrete Tanks

Onome et al, (2013) Concrete tank culture of *Clarias gariepinus* is one of the most common fish farming systems in Nigeria. There is therefore need to know the growth pattern and condition of this fish in concrete tanks as there has been information on those from the wild and indoor recirculation system tanks. Length-Weight Relationship of *C. gariepinus* juveniles reared in concrete tanks in Aleluya Farm, Woji, Port Harcourt, Nigeria was studied. The fish samples were sexed, the lengths and weights measured according to standard methods. Temperature, pH, dissolved oxygen (DO) and ammonia (NH4) were determined following standard methods. The "b" value for the males was 7.74 while that of the females was 6.96 and combined sexes 7.87. The regression equation was Log W=-65.78+7.87 Log L (r = 0.90). Condition factor ranged between 1.06 (males) and 1.15 (females). The water quality parameters were within the acceptable range for fish production. *C. gariepinus* juveniles reared in concrete tanks exhibited positive allometric growth and in good condition of health. This growth pattern favours fish farming as it enhances its profitability.

CHAPTER THREE

MATERIALS AND METHOD

3.1. STUDY AREA

This study was conducted Fish Hatchery Sudan University of Science and Technology, Khartoum, East of the Nile, Hilt Kuku. The main form of water for agriculture. This farm is based on fish breeding scientific and commercial purposes in the concrete basins circular, rectangular and square form. This is facility carrying fish hatchery. The kind of the most important fish species used in this farm tilapia and catfish.

3.2. Collection And Selection OF Brood Fish

Three hundreds of female and male C. gariepinus apparently healthy female 200 mala100 female fish with weight ranging from 300g –800g were purchased from a fish farm the Nile east , Khartoum State. We selected brood fish by external morphological characteristics, using the method of (Ayinla et al. 1994). Females were selected on the basis of their bulging abdomen as well as egg color. The selected fish were kept in an outdoor concrete tank at the Sudan University of science and technology farm for 6 month prior to the breeding date. They were fed 5% of total biomass with Coppens pelleted fish feed (48% crude protein) twice daily. Feeding was suspended a day prior to the hormonal treatments.

3.3. Water Holding Facilities

Water Holding Facilities Eighteen liters of bore-hole water was introduced into ten plastic containers (30-litre capacity) arranged in rows of fives on an elevated platform in the hatchery section of the demonstration Farm. The dimension of the plastic containers was 40cm x 30cm x 26cm. The fish holding containers were equipped with a simple flow through system with an overhead reservoir containing water properly conditioned before use. Each of the plastic containers closed (in a dark ambience) 27 hours of injecting the brood fish.

3.4. Pituitary Extraction And Preparation Pituitary Glands

The pituitary extraction were extracted from five of the male brood fish, they were weighed so as to get a corresponding weight to that of the recipient fish. The head of the male donor was cut off after stunning the fish, and subsequently the lower jaw was also cut off. The ventral side of the brain was opened to expose the pituitary gland. Glands were collected with a pair of tweezers and putted in bottle and keeps it frozen and placed in a beaker containing 2m0.9% normal saline solution. Each of the glands was crushed in a mortar using a pestle. Two mill meter of 0.9% normal saline solution was added and the suspension decanted and collected into a 2ml syringe. The freshly collected pituitaries were immediately injected into the female spawn. This was done in the evening hours at about 5pm.

3.5. Administration Of Hormone

The two-four female were divided fish with one set of fish representing the replicates for each treatment. Ova prim and pituitary extract were administered on each set of gravid female fish. The mean weight of female brooders used in pituitary and Ova prim treated fish was 500g. Pituitary suspension was drawn into a 2ml syringe, and then injected intramuscularly above the lateral line of the fish toward the dorsal section and pointed to the ventral side. After withdrawal of the needle, the fish were gently rubbed at the site of injection to avoid back flow of the injected fluid. Each female from the second group was injected with a dose of 0.5ml Ova prim/kg of body weight (Haniffa and Sridhar, 2002). The injected fish were kept separately in well-labeled containers measuring 40cm x 30cm x 26cm containing water. The containers with the injected fish were covered with heavy boards so as to prevent the fish from leaping out. (EfeOkere, et,al .2015).

3.6. Preparation Of Milt

Two male fish were killed, dissected carefully and their milt sac obtained. The weight of each mal was obtained and recorded alongside the weight of each of the gonad. A small incision was then made on the lobes with a sharp razor blade and the milt squeezed into a dry Blamin dish. Milt was washed into the Petri dish with 0.9% normal saline solution (Ayinla, 1991; Nwadukwe et al., 1993).

3.7. Stripping, Fertilization And Incubation Of Egg

Latency period was recorded for each of the fish in each group and stripping took place within 10 and 12 hours after injection at a mean temperature of 28.05ooC. With slight pressure at the ventral part of the abdomen, ovulated eggs oozed out freely and were collected into a dry Blamin dish of known weight. This was done for each treated female fish, and collected eggs were weighed and recorded. Workers fecundity was the determined from the data. A sample of 1g was collected from the stripped eggs from each female and fertilization was done by pouring the prepared milt onto the eggs. The mixture of 1g was incubated separately on the spawning substrate (kakaban) placed in water in each of the plastic containers (Szabo et al., 2002).

Basic water quality parameters were determined; temperature was measured with mercury in-glass thermometer. Dissolved Oxygen and pH were measured using pH meter (WTW pH 330) and DO (Model MW600) meter, respectively. Plastic continuer was used so as to enhance proper aeration. Post hatching. Larvae were reared with constant water supply and by the third day their yolk sacs were fully absorbed and the fry were seen swimming in the containers. Fry Survival rate was determined by records of number of dead fry in each treatment medium. Live larvae were fed with decapsulated Artemia, Bio Nutr- fish (special nutritional additive for cultured fish) three times daily.

3.8. Ova Prim Hormone

On Thursday, 26/05/2016, two female were injected with 0.4 ml by Ovaprim and the average was (500 g), did not release eggs before 12 hours and

then stripping. Two male fish were killed, a small incision was then made on the lobes with a sharp razor blade and the milt squeezed into a dry Blamin dish. Milt was washed into the Petri dish with 0.9% normal saline solution .It has been added to sperm eggs have been fertilized with water and moving components of the dish until white foam appears and turns white color to reddish .The egg were Placed in netting material and Wrap the gauze . Eggs were taken by dipping gauze by a mattress in a dish Blamin post has eggs in the water and the water was oxygenated with the aid of aerators. Three Plastic basin containing eggs were placed inside the hatchery. The average temperature was 27 ± 5 and Maintaining the level of water quality, has been hatching on the second day after the end of the specified number of hours) 27hours(a day 27/05/2016).

3.9. HCG (Human Chorionic Gonadotropin)

On Thursday, 28/07/2016, two female were injected by HCG and the average weight was (500 g) dosage (0.42, 0.75) release eggs after 12 hours and then stripping. The testes were removed from three male fish, incised and squashed in normal saline solution (0.9) to get sperm suspension. A drop of sperm suspension was add to egg and moving components of the dish until white foam appears and turns white color to reddish . Eggs were taken by dipping gauze by a mattress in a dish Blamin post has eggs in the water and the water was oxygenated with the aid of aerators. Three Plastic basin containing eggs were placed inside the hatchery. The average temperature was 28 ± 5 and Maintaining the level of water quality, has been hatching on the second day after the end of the specified number of hours 27hours (a day 29/07/2016).

3.10. Carp Hermone

On Tuesday, 9/08/2016, two female were injected by carp pituitary gland as powderIt was solved with distilled water. The average was (400 g) dosage 3.5 mg each gland release eggs after 12 hours and then stripping.

The testes were removed from three male fish, incised and squashed in normal saline solution (0.9) to get sperm suspension. A drop of sperm suspension was add to egg and moving components of the dish until white foam appears and turns white color to reddish . Eggs were taken by dipping gauze by a mattress in a dish blamin post has eggs in the water and the water was oxygenated with the aid of aerators. Three Plastic basin containing eggs were placed inside

the hatchery. The average temperature was 28 ± 5 and Maintaining the level of water quality, has been hatching on the second day after the end of the specified number of hours) 27 (hours a day 10/08/2016).

3.11. Measurement Of Gonad Somatic Index (GSI)

The gonad somatic Index (GSI) values were measured by recording of gonad weight and body weight of male and female separately on an electronic balance throughout the study period. Following equation was used to determine GSI:

$$GSI = \frac{\text{Weight of the gonad (g)}}{\text{Weight of the fish (g)}} \times 100$$

3.12. Estimation OF Fecundity

The most accurate method of enumeration of fish eggs that is fecundity is probably by actual count. This method of direct counting was found to be much time consuming and rather impossible in case of fishes which are highly fecund. When the actual counting of eggs is impracticable, approximate fecundity may be obtained by gravimetric methods (Lagler 1952) which has been successfully used by (Doha and Hye, 1970); (Shafiet al, 1978);(Dewan and Doha 1979) ;(Das et al, 1989). The egg in the sample was counted, number of egg of the sample multiplied by the total weight of both the ovaries which gave the total number of eggs of a particular fish. In this way fecundity Average fish were obtained by using following equation:

$$F = \frac{N \times \text{Gonad weight (g)}}{\text{Sample weight (g)}}$$

Where F = Fecundity

N = number of egg in the sample

To establish the relationship between fecundity total length, fecundity body weight and fecundity gonad weight, the original data were subjected to linear regression and correlation analysis. The total length, body weight and gonad weight were taken as independent variables (x- axis) and the fecundity was regarded as dependable variable (y-axis).

3.13. Statistical Analysis

`The obtained data in this study were subjected to one-way (ANOVA)analysis of variance (snedecor,and Cochranl, 1986),(Sokal,and Rohlf,1981). Data were entered and analyzed using Statistical Package for

Social Sciences program (SPSS) for Windows, Version 16 (Log Xact8 ,Cross over,USA), was used to compare the proportions and 95% confidence intervals (95% CI) ,differences between proportions were considered statistically significant if 95% CI did not overlap, Results are presented as means ± standard error of the mean (S.E.M).

CHAPTER FOUR

RESULTS

Result in Table (4.1) shows there were significant different in weight, fecundity and GSI.HCG Record high fecundity followed by carp and then ova prim ,GSI high in ova prime followed by HCG and carp.

Table (4.1): show the average fecundity, weight and GSI.

Hormone	$\bar{X} \pm SD$		
	Weight	Fecundity	GSI
Ova prim	540^{a}	4.02 ± 00^{c}	3.27^{a}
HCG	500^{b}	8.75 ± 0.24^{a}	2.91^{b}
Carp PG	485^{c}	5.48 ± 58^{b}	1.99^{c}
Sig	*	*	*

a,b,c: mean with the same column followed by different superscript are significantly difference at ($p\leq0.05$).

*: significant difference at ($P< 0.05$).

Sig: significant

Data in table (4.2) reflected there were significant variations in fry weight and fry length among between different treatments of hormones.

Table (4.2): show the average fry weight and length.

Hormone	X ± SD	
	Fry weight	Fry length
Ova prim	101.38^{a}	6.85^{a}
HCG	1.54^{c}	5.66^{c}
Carp PG	1.78^{b}	5.77^{b}
Sig	*	*

a,b,c: mean with the same column followed by different superscript are significantly difference at ($p \leq 0.05$).

*: significant difference at ($P < 0.05$).

Sig: significant

Result in Table (4.3) show there is no signification in weight and length of fry, but show different significant (fecundity highest in HCG) carp and ova prim .

Table (4.3): show the Relationship between fecundity, body weight and length.

Parameters Hormones	Body weight M±SD	Fecundity M±SD	Length M±SD
Ovaprim	4.75±65	4.02±00[c]	46±5
HCG	5.82±75	8.75±0.24[a]	56±10
Carp PG	5.80±95	5.48±58[b]	57±13
Sig	Ns	**	Ns

a,b,*c:* mean with the same column followed by different superscript are significantly difference at (p≤0.o5).

**: significant difference at (P< 0.01)

NS: not significant at (P> 0.05)

Table (4.4) The result shows the correlation on weight and length that there is a strong fit direction highly significant.

Table (4.4): show the correlation between fry weight and length.

Hormones	Correlation coefficient	Sig	R^2
Ovaprim	.950	**	90.3%
HCG	.967	**	93.5%
Carp PG	.936	**	87.6%

**: highly significant difference.

Result in Table (5.4) show the average of weight and length the Ovaprim record high average flowed by carp and then HCG

Table (5): show the average of fry length and fry weight

Parameters	Wight	Length
Hormones	M±SD	M±SD
Ovaprim	2.33+1.469	6.85+1.69
HCG	1.51+0.796	5.66+1.56
Carp **PG**	1.78+1.36	5.77+1.80
Sig	*	*

a,b,c: mean with the same column followed by different superscript are significantly difference at (p≤0.o5).*: significant difference.

Figure (4.1) the result shows the relationship between fecundity and ovarian weight, researchers found that the relationship is a positive all the increased weight of the fish the greater the weight of the ovary.

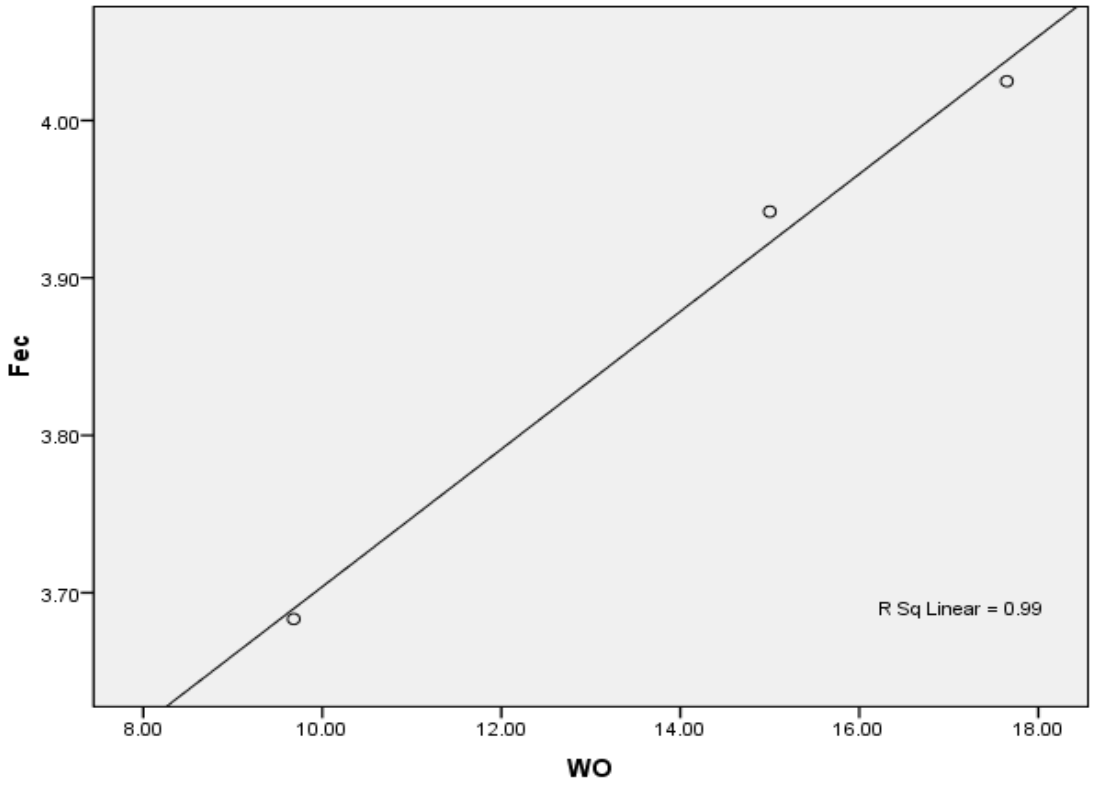

Figure 4.1: show the Relationship between fecundity and Wight of ovaries.

Figure (4.2) shows the relationship between weight of ovaries and GSI, found that there is a direct correlation between weight and ovarian GSI

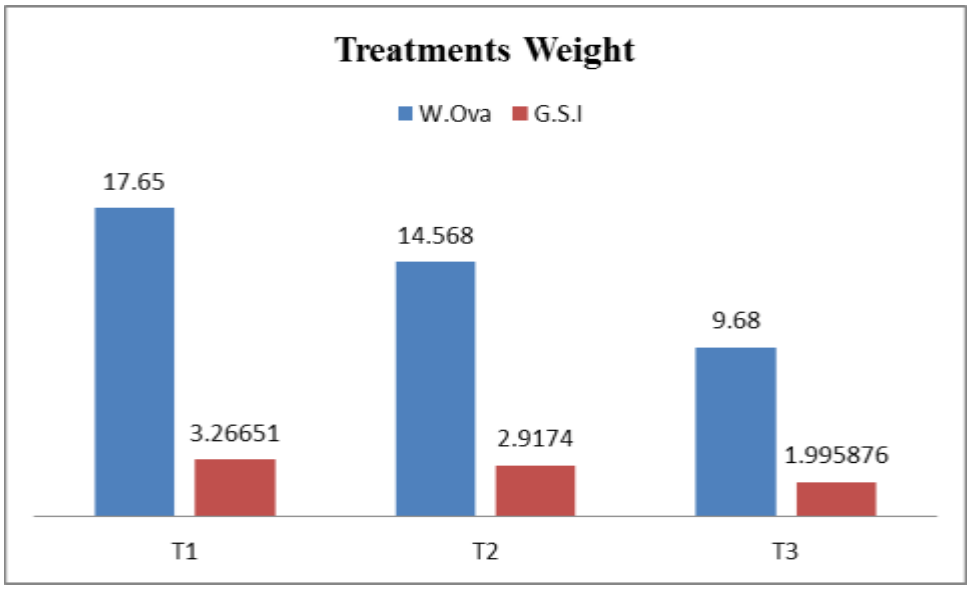

Figure 4.1: show the Relationship between average weight of ovary and gonado somatic index.

CHAPTER FIVE

DISCUSSION

Fecundity of an indigenous Indian cat fish *Clarias magur* (Hamilton, 1822) during spawning season (April to July, 2011) has been studied. Relationship of fecundity (F) with body weight (BW), total length (TL), ovary length (OL), ovary weight (OW), gonadosomatic index (GSI%) and ova diameter (OD) was calculated. Fecundity is found to be the lowest (3947.91 ± 506.42) in the month of April and the highest (10957.47 ± 3031.49) in the month of June. The value of Correlation coefficient (r) between F and BW is highly significant (r=0.95) followed by F and OW (r=0.88) > F and OL (r=0.74) > F and TL (r=0.60) and > F and GSI (r=0.51). The correlation between with F and OD has not shown significant correlationship (0.09). Fecundity exhibits the highest correlationship (r) with BW, OW, TL and GSI during the month of June.

In this study Fecundity is found to be the lowest in ova prime treatment (4.02 ± 00^{c})in the month of may , the highest in HCG in the month of July (8.75 ± 0.24^{a}) ,then carp PG in the month of August (5.48 ± 58^{b}).the lowest fecundity in ova prim it may refer to the differences in the weathers (temperature). Concrete tank culture of *Clarias gariepinus* is one of the most common fish farming systems in Nigeria. There is therefore need to know the growth pattern and condition of this fish in concrete tanks as there has been information on those from the wild and indoor recirculation system tanks. Length-Weight Relationship of *C. gariepinus* juveniles reared in concrete tanks in Aleluya Farm, Woji, Port Harcourt, Nigeria was studied. The fish samples

were sexed, the lengths and weights measured according to standard methods. Temperature, pH, dissolved oxygen (DO) and ammonia (NH4) were determined following standard methods. The “b” value for the males was 7.74 while that of the females was 6.96 and combined sexes 7.87. The regression equation was Log W=-65.78+7.87 Log L (r = 0.90). Condition factor ranged between 1.06 (males) and 1.15 (females). The water quality parameters were within the acceptable range for fish production.

In the present study *C. gariepinus* juveniles reared in concrete tanks exhibited positive allometric growth and in good condition of health. This growth pattern favours fish farming as it enhances its profitability .the highest correlation between fry weight and length, in the fry that treated with HCG (96%) followed by ova prime (95%) and carp PG(93%).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The study was conducted at the fish hatchery in the College of Animal production Science and Technology to detect The effect of HCG, and ova prim as synthetic hormones' and Carp pituitary gland as natural hormones . The statistical analysis revealed a significant different at(P <0.05)for all treatments. The length and weight of the fry were affect significantly by ova prim followed by Carp pituitary gland and HCG. While fecundity was effect significantly by HCG, followed Carp pituitary gland and ova prim.

6.2 RECOMMENDATIONS

- Further studies are required to examine the development and growth performances of larvae and fry produced by the induced breeding techniques.
- Further studies of fry until they reach weights of marketing and consumer acceptability.
- Hormones are injected at the same time until it is better to compare and temperatures are in the rang (28-32) and best suited 30
- It must be hatchery fully equipped and provide all by farming Requirements.

REFERENCES

- Adebayo O.T. and O.M. Popoola, 2008. Storage Period; its effect on efficacy of non-piscine (frog) Hormone used in inducing ovulation in African Catfish. *Int. Jour Zool. Res, 4: 124*-128

- Adewolu, M.A. and Adeoti, A.J. 2010. Effect of mixed feeding schedules with varying dietary crude protein levels on the growth and feed utilization of Clarias gariepinus (Burchell, 1822) fingerlings. J. Fish. Aquat. Sci., 5: 304-310. DOI: 10.3923/jfas.2010.304.310.

- Adewolu, M.A., Ogunsanmi, A.O. and Yunusa A. 2008. Studies on Growth Performance and Feed utilization of two clariid catfish and their hybrid reared under different culture systems. European Journal of Scientific Research, 23(2): 252-260.

- Artificial induction of spawning by human chorionic gonadotropin (HCG) or carp pituitary extract (CPE) in olive flounder, Paralichthys olivaceus. J. Aquaculture, 7: 89-96.

- Arup Buragohain1, M. M. Goswami, (2014) Relationship of Fecundity and different body parameters of *Clarias magur* (Hamilton, 1822) in captive condition in the Agro climatic condition of Assam, India. *Department of Zoology, Fish Biology and Fishery Science, Gauhati University, Guwahati -781014, Assam,India.*

- Atanda, A.N. 2007. Freshwater fish seed resources in Nigeria. Bondad-REanteso, M.G. (Ed.), Assessment of freshwater fish seed resources for

sustainable aquaculture. FAO Fisheries Technical Paper No. 501. Rome, FAO 628P: 361-380.

- Ayinla O.A, Kayode O, Idoniboye–Obu, Oresegun A, Aidu V.T.1994. Use of Tadpole meal as substitute for fishmeal in the diet of *Heterobranchus bidorsalis* (Geoffery St Hillarie 1809).Journal of Aquaculture in the Tropics, 9, ,25-33
- Ayinla O.A. 1991. Spawning of selected culturable species: In: Ayinla, O.A. (ed.) Proceeding of the fish seed propagation course. African Regional Aquaculture Centre (ARAC), Aluu, Port Harcourt, 14 – 28 August, 1991. Pg 104.
- Ayinla, O.A. and Nwadukwe, F.O. 1989. Fingerlings size variation among freshwater catfish: Effect of brood stock sizes. In: A.O. Onyia and G.N. Ajana (Eds.), Fish for food: Meeting the demand. Proceeding of a Conference, 13-17 November 1989. Fisheries Society of Nigeria: 43-47.
- Blumenthal, Les (, 2010). "Company says FDA is nearing decision on genetically engineered Atlantic salmon". Washington Post. Retrieved August 2010.
- Britz, P.J. & Hecht, T. (1987). Temperature preferences and optimum temperature for growth African sharptooth catfish (Clarias gariepinus) larvae and post larvae. Aquaculture 63: 205-214.
- Britz, P.J. & Hecht, T. (1987). Temperature preferences and optimum temperature for growth African sharptooth catfish (Clarias gariepinus) larvae and post larvae. Aquaculture 63: 205-214.

- Britz, P.J. and Pienaar, A.G. (1992). Laboratory experiments on the effect of light and cover on the behaviour and growth of African catfish, Clarias gariepinus (Pisces: Clariidae). Journal of Zoology 227: 43-62.

- Britz, P.J. and Pienaar, A.G. (1992). Laboratory experiments on the effect of light and cover on the behaviour and growth of African catfish, Clarias gariepinus (Pisces: Clariidae). Journal of Zoology 227: 43-62.

- Bruton, M.N. (1979a). The food and feeding behaviour of Clarias gariepinus (Pisces: Clariidae) in Lake Sibaya, South Africa, with emphasis on its role as a predator of cichlids. Transactions of the Zoological Society of London 35: 47-114.

- Bruton, M.N. (1979a). The food and feeding behaviour of Clarias gariepinus (Pisces: Clariidae) in Lake Sibaya, South Africa, with emphasis on its role as a predator of cichlids. Transactions of the Zoological Society of London 35: 47-114.

- Bruton, M.N. 1979a. The food and feeding behaviour of Clarias gariepinus (Pisces: Clariidae) in LakeSibaya, South Africa, with emphasis on its role as a predator of cichlids. Transactions of theZoological Society of London 35: 47-114.

- Bruton, M.N. and Allanson B.R. (1980). Growth of Clarias gariepinus in Lake Sibaya, South Africa. South African Journal of Zoology 15: 7-15.

- Bruton, M.N. and Allanson B.R. (1980). Growth of Clarias gariepinus in Lake Sibaya, South Africa. South African Journal of Zoology 15: 7-15.

- Bruton, M.N.(1979b). The breeding biology and early development of Clarias gariepinus (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus Clarias (Clarias). Transactions of the Zoological Society of London 35: 1-45.

- Bruton, M.N.(1979b). The breeding biology and early development of Clarias gariepinus (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus Clarias (Clarias). Transactions of the Zoological Society of London 35: 1-45.

- Burchell, (1822) reared in concrete tanks. Aquacult. Res. v. 38, p. 279-287, 2007. http://dx.doi.org/10.1111/j.1365-2109.2007.01663.x.

- Crim, L.W. and B.D. Glebe, 1984. Advancement and synchrony of ovulation in Atlantic salmon with pelleted LHRH analog. Aquaculture, 43: 47-56.

- Das, M., S. Dewan, and S. C. Debnath. (1989) Studies on fecundity of *Heteropneustes fossilis* (Bloch) in a minipond of Bangladesh Agricultural University, Mymensingh. *Bangladesh J. Agril. Sci*., 16(1): 1-6.

- de Moor, I & Bruton, M.N.(1988). Atlas of alien and translocated indigenous aquatic animals in southern Africa. South African National Scientific Programmes Report No. 144. CSIR.

- de Moor, I & Bruton, M.N.(1988). Atlas of alien and translocated indigenous aquatic animals in southern Africa. South African National Scientific Programmes Report No. 144. CSIR.

- Dewan, S. and S. Doha. (1979) Spawning and fecundity of certain pond fishes.*Bangladesh J. Agril*., 4(1): 1-8.
- Doha,S. and A. M..Hyne.(1970) Fecundity of Padma river hilsa, *Hilsa ilisha* Trans. *Amer. Fish. Soc*.., 97(4): 350-355.
- E. BRZUSKA,(2003), Artificial propagation of African catfish (Clarias gariepinus): differences between reproduction effects after stimulation of ovulation with carp pituitary homogenate or GnRH-a and dopaminergic inhibitor, *Czech J. Anim. Sci., 48, 2003 (5): 181–190*
- Efe Okere, Ebere Samuel Erondu, Nenibarini Zabbey,(2015), Evaluating the Efficacy of Pituitary Gland Extracts andOvaprim in Induced Breeding and Fry Quality of *Clariasgariepinus*, Burchell (Pisces: Claridae), *Agriculture, Forestry and Fisheries.* Vol. 4, No. 2, 2015, pp. 71-76.doi: 10.11648/j.aff.20150402.18
- Efe Okere, Ebere Samuel Erondu, Nenibarini Zabbey2015; 4(2): 71-76Evaluating the Efficacy of Pituitary Gland Extracts and Ovaprim in Induced Breeding and Fry Quality of *Clarias gariepinus*, Burchell (Pisces: Claridae) Department of Fisheries, Faculty of Agriculture, University of Port Harcourt, PMB 5323 Choba, Port Harcourt, Rivers State, Nigeria
- FAO (2005-2012). Cultured Aquatic Species Information Programme. Clarias gariepinus. Cultured Aquatic Species Information Programme. Text by Rakocy, J. E. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 18 February 2005. [Cited 11 September 2012].
- FAO (2005-2012). Cultured Aquatic Species Information Programme. Clarias gariepinus. Cultured Aquatic Species Information Programme.

Text by Rakocy, J. E. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 18 February 2005. [Cited 11 September 2012].

- FAO (2014) The State of World Fisheries and Aquaculture 2014 (SOFIA)
- FAO (Food and Agriculture Organisation) 2004. World aquaculture supply of catfish and tilapia. FAO Fisheries Report No 733. FAO, Rome. 46 pp.
- Food and Agricultural Organization of the United Nations. (2003). FISHSTAT plus. Retrieved March 23, 2005, from http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp
- GODA, A. M. A. S.; El –HAROUN, E. R.; CHOWDHURY, M. A. K,(2007). Effects of totally or partially replacing of fish meal by alternative protein sources on growth of Africa catfish Clarias gariepinus
- Greenwood, P.H. (1955). The reproduction of Clarias mossambicus in Lake Victoria. In: Second Symposium on African hydrobiology and inland fisheries, 1956. CSA Publication No. 25. pp. 77-78.

- Greenwood, P.H. (1955). The reproduction of Clarias mossambicus in Lake Victoria. In: Second Symposium on African hydrobiology and inland fisheries, 1956. CSA Publication No. 25. pp. 77-78.

- Haniffa M.A. K., Sridhar, S. 2002. Induced spawning of spotted murrel (*Channa punctatus*) and catfish (*Heteropneustes fossilis*) using human chorionic gonadotropin and synthetic hormone (Ovaprim). Veterinarski Arhiv, 72, 51 – 56

- Hecht, T. and Lublinkhof, W. (1985). Clarias gariepinus x Heterobranchus longifilis (Clariidae: Pisces): a new hybrid for aquaculture. South African. Journal of Science 81: 620-621.

- Hecht, T. and Lublinkhof, W. (1985). Clarias gariepinus x Heterobranchus longifilis (Clariidae: Pisces): a new hybrid for aquaculture. South African. Journal of Science 81: 620-621.

- Hecht, T. and S. Appelbaum, (1987). Notes on the growth of Israeli sharptooth catfish (Clarias gariepinus) during the primary nursing phase. Aquaculture, 63: 195–204.

- Hecht, T. and S. Appelbaum, (1987). Notes on the growth of Israeli sharptooth catfish (Clarias gariepinus) during the primary nursing phase. Aquaculture, 63: 195–204.

- Hecht, T., Uys, W. and Britz, P.J. (Editors). (1988). Culture of sharptooth catfish, Clarias gariepinus, in southern Africa. National Scientific Programmes Unit: CSIR, SANSP Report 153, 1988, pp 146.

- Hecht, T., Uys, W. and Britz, P.J. (Editors). (1988). Culture of sharptooth catfish, Clarias gariepinus, in southern Africa. National Scientific Programmes Unit: CSIR, SANSP Report 153, 1988, pp 146.

- Henken, A.M., Brunink, A.M. and Richter, C.J.J. (1987). Differences in growth rate and feed utilization between diploid and triploid African catfish, Clarias gariepinus (Burchell, 1822). Aquaculture 63: 1–14.

- Hey, D. (1941). Practical freshwater fish culture. Department of Nature Conservation, Cape Town. 118 pp.

- Hey, D. (1941). Practical freshwater fish culture. Department of Nature Conservation, Cape Town. 118 pp.
- IGFA, (2001). Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA.
- IGFA, 2001. Database of IGFA angling records until 2001. IGFA, International Game Fish Association Fort Lauderdale, USA office, 2009.
- Johnels, A.G. (1957). The mode of terrestrial locomotion in Clarias. Oikos 8: 122-129.

- Johnels, A.G. (1957). The mode of terrestrial locomotion in Clarias. Oikos 8: 122-129.

- Jubb, R.A. (1967). Freshwater fishes of southern Africa. A.A. Balkema, Cape Town; viii + 248 pp.

- Jubb, R.A. (1967). Freshwater fishes of southern Africa. A.A. Balkema, Cape Town; viii + 248 pp.

- Kelly, A.M. and C.C. Kohler, 1994. Human chorionic gonadotropin injected in fish degrades metabolically and by cooking. J. the World Aquaculture Society,25 : 55-57.
- Lagler, K. F. (1952). *Studies in Freshwater Fishery Biology*. Ann Arbor, Michigan pp. 199
- Lam, T.J., 1983. Environmental influences on gonadal activity in fish. In: Fish Physiology ? B (eds.W.S. Hoar, D.J. Randall and E.M. Donaldson),pp: 65-116. Academic Press, London.

- Lin, H.R. and R.E. Peter, 1996. Hormones and spawning in fish. Asian Fisheries Sci., 9: 21-23.

- Maina, J.N. and Maloiy, G.M.O. (1986). The morphology of the respiratory organs of the African airbreathing catfish (Clarias mossambicus): A light, electron and scanning microscope study, with morphometric observations. Journal of Zoology 209: 421-445.

- Maina, J.N. and Maloiy, G.M.O. (1986). The morphology of the respiratory organs of the African airbreathing catfish (Clarias mossambicus): A light, electron and scanning microscope study, with morphometric observations. Journal of Zoology 209: 421-445.

- Merron, G.S. (1993). Pack-hunting in two species of catfish, Clarias gariepinus and C. ngamensis, in the Okavango Delta, Botswana. Journal of Fish Biology 43: 575–584.

- Merron, G.S. (1993). Pack-hunting in two species of catfish, Clarias gariepinus and C. ngamensis, in the Okavango Delta, Botswana. Journal of Fish Biology 43: 575–584.

- Muhammad naeem ,Amina zuberi , Muhammad Ashraf, Waqas , Abir ishtiaq and najam-ul-Hasan, (2013) , induced breeding of ladeo rohita through single application of ovaprim – c at faisalabad hatchery Pakistan , VOL. 12(19) PP .27 22-2726,8 MAY ,2013.

- Mylonas, C.C., A. Fostier and S. Zanuy, 2009.Brood stock management and hormonal manipulation of fish reproduction. Aquaculture, 197: 99-136.

- National Marine Fisheries Service (NMFS). (2004). Current fisheries statistics No. 2004- 2. Retrieved March 23, 2005, from http://www.st.nmfs.gov/st1/trade/documents/TRADE2004.pdf

- O.K. Olumuji* and M.K. Mustapha,(2013), Induced Breeding of African Mud Catfish, *Clarias gariepinus* (Burchell 1822), with different doses of Saline diluted Ovaprim, *The Israeli Journal of Aquaculture - Bamidgeh, IJA:64.2013.824, 6 page*

- OSMAN, A. G. M.; WUERTZ, S.; MEKKAWY, I. A. A.; EXNER, H.; KIRSCHBAUM,F. Embryo(2009). toxic effects of lead nitrate of the African catfish Clarias gariepinus (Brurchell 1822). J. Ichthyol, v. 23, p. 48-58, 2007.

- Park, I.S., H.B. Kim, H.J. Choi, Y.D. Lee and H.W. Kang, 1994.

- Picker, M. and Griffiths, C. (2011). Alien & invasive animals, a South African perspective. Struik Publishers, Cape Town.

- Picker, M. and Griffiths, C. (2011). Alien & invasive animals, a South African perspective. Struik Publishers, Cape Town.

- Picker, M. and Griffiths, C. 2011. Alien & invasive animals, a South African perspective. StruikPublishers, Cape Town.

- Robins, C.R., Bailey, R.M., Bond, C.E., Brooker, J.R., Lachner, E.A., Lea, R.N. & Scott, W.B. 1991. World fishes important to North Americans. Exclusive of species from the continental waters of the United States and Canada. Am. Fish. Soc. Spec. Publ. 21: 243 p.

- Robins, C.R., Bailey, R.M., Bond, C.E., Brooker, J.R., Lachner, E.A., Lea, R.N. and Scott, W.B.(1991). World fishes important to North Americans. Exclusive of species from the continental waters of the United States and Canada. Am. Fish. Soc. Spec. Publ. 21: 243 p.

- Robins, C.R., Bailey, R.M., Bond, C.E., Brooker, J.R., Lachner, E.A., Lea, R.N. and Scott, W.B.(1991). World fishes important to North Americans. Exclusive of species from the continental waters of the United States and Canada. Am. Fish. Soc. Spec. Publ. 21: 243 p.

- S.U. mahmood , K . Ahmed , M.S. Ali and M.E.HOQUE , Conparison of two hormone preparations on the reproductive performance of air breathing catfish Clarias batrachus , Bangladesh J.fish . Res, 7(1) , 2003: 21-26

- Safriel, O. and Bruton, M.N. (1984). A cooperative aquaculture research programme for South Africa. South African National Scientific Programmes Report 89. CSIR, Pretoria, pp. 79.

- Safriel, O. and Bruton, M.N. (1984). A cooperative aquaculture research programme for South Africa. South African National Scientific Programmes Report 89. CSIR, Pretoria, pp. 79.

- Safriel, O. and Bruton, M.N. (1984). A cooperative aquaculture research programme for South Africa. South African National Scientific Programmes Report 89. CSIR, Pretoria, pp. 79.
- Safriel, O. and Bruton, M.N. (1984). A cooperative aquaculture research programme for South Africa. South African National Scientific Programmes Report 89. CSIR, Pretoria, pp. 79.

- Sea food consumption rose again in 2003. (2004, September 27). Retrieved December14,2004,from http://www.noaanews.noaa.gov/stories2004/s2322.htm

- Shafi, M., M. M. A. Quddus, and M. Hossain. (1978) studies on length-weight relationship sex ratio, size composition, gears and abundance of *Hilsa ilisha* in the river Padma, *Dacca Univ. Stud*. B., 26:123-127.

- Skelton, P. (2001). A complete guide to the freshwater fishes of Southern Africa. Struik Publishers, Cape Town.

- Skelton, P. (2001). A complete guide to the freshwater fishes of Southern Africa. Struik Publishers, Cape Town.

- Skelton, P. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik Publishers,Cape Town.
- Snedecor, G.W. and Cochran W.G., (1968). Statistical methods, 6 edn. Iowa State University Press, Ames.
- Sokal, R.R. and F.J. Rohlf, (1981). Biometry. W.H. Freeman and Company, New York.
- Stickney, R. R. (1996). Aquaculture in the United States. New York: John Wiley &Sons.

- Szabo, T., Medgyasszay, C., Horvath, L. 2002. Ovulation induction in nase (*Chondrostoma nasus*, Cyprinidae) using pituitary extract or GnRH analogue combined with domperidone. Aquaculture, 203, 389 -395, IGFA, (2001). Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA.

- Teugels, G.G. (1986). A systematic revision of the African species of the genus Clarias (Pisces; Clariidae). Annales Musée Royale de l'Afrique Centrale Sciences Zoologiques, 247.

- Teugels, G.G. (1986). A systematic revision of the African species of the genus Clarias (Pisces; Clariidae). Annales Musée Royale de l'Afrique Centrale Sciences Zoologiques, 247.

- Teugels, G.G., Adriaens, D., (2003). Taxonomy and phylogeny of Clariidae: an overview. In: Arratia, G., Kapoor, G., Chardon, B.G.M.,Diogo, R. (Eds.), Catfishes. Science Publishers, Enfield, USA, pp. 465–487 ISB N 1-57808-261-7
- Teugels, G.G.,(2003). State of the art of recent Siluriform systematics.In: Arratia, G., Kapoor, B.G., Chardon, M., Diogo, R. (Eds.),Catfishes. Science Publishers, Enfield, USA, pp. 317–352 ISBN 1-57808-261-7.

- Van der Waal, B.C.W. (1998). Survival strategies of sharptooth catfish Clarias gariepinus in desiccating pans in the northern Kruger National Park. Koedoe - African Protected Area Conservation and Science 41: 131-138.

- Van der Waal, B.C.W. (1998). Survival strategies of sharptooth catfish Clarias gariepinus in desiccating pans in the northern Kruger National Park. Koedoe - African Protected Area Conservation and Science 41: 131-138.

- Varadi, L., Benko, I., Varga, J. and Horvath, L., (1999). Induction of diploid gynogenesis using interspecific sperm and production of tetraploids in African catfish, Clarias gariepinus (Burchell, 1822). Aquaculture 173: 401–411.

- Welman, J.B. (1948). Preliminary survey of the freshwater fisheries of Nigeria. Lagos.

- Welman, J.B. (1948). Preliminary survey of the freshwater fisheries of Nigeria. Lagos.

- Willoughby, N.G. and Tweddle, D. (1978). The ecology of the catfish Clarias gariepinus and Clarias ngamensis in the Shire Valley, Malawi. Journal of Zoology 186: 507-534.

- Willoughby, N.G. and Tweddle, D. (1978). The ecology of the catfish Clarias gariepinus and Clarias ngamensis in the Shire Valley, Malawi. Journal of Zoology 186: 507-534.

- Yaron,Z.,Bogomoinava,A.,Drori.,S.,Biton,I.,Aizen,J.,Kulikovsky,Z and Levavi-Sivan, B (2009).Spawning induction in the Carp:Past experience and future Prospects - A Review.*The Israeli Journal of Aquaculture – Bamidgeh 61 (1) 5-26*

APPENDIX

Mixing feather

Normal saline


0.9% w/v Sodium Chloride
Intravenous Infusion BP
0.9
250 ml
B BRAUN

Su rs

scalpel

How we inject the fish

After 12 hrs. From injection