COMPARISON OF THE GROWTH PERFORMANCE OF *Clarias gariepinus* FRY RAISED WITH A COMMERCIAL FEED (Coppens) AND A FARM MADE FEED

BY

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF AQUACULTURE AND FISHERIES MANAGEMENT, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF AGRICULTURE DEGREE, B. AGRIC (FISHERIES)

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DEDICATION

This work is dedicated to God almighty, the reason for my existence and my relevance, my Father, Rev.Dr. E.A Okpako for his relentless effort towards the education and success of his children, to my Mother, Mrs. Julie Okpako and to my siblings, I love you all.

It is dedicated also to all fisheries scientist and academicians.

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CERTIFICATION

This is to certify that this project work was carried out by **Evans Oghenemarho OKPAKO** with matriculation number **AGR1600477** of Department of Aquaculture and Fisheries Management, Faculty of Agriculture, University of Benin, Benin City. In fulfillment for the award of Bachelor of Agriculture (B. Agric) degree in Fisheries of University of Benin

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ABBREVIATION AND ACRONYMS

ANOVA	Analysis of variance
CRD	Completely randomised design
CP	Crude protein
D.O	Dissolved oxygen
FAO	Food association organisation
FCR	Feed conversion Ratio
GAE	Gross Assimilation energy
GDP	Gross domestic profit
MMT	Million metric tonnes
SED	Standard Error deviation
SGR	Specific growth rate
PI	Performance Index

ABSTRACT

This study investigated the growth performance of African catfish (C*larias gariepinus)* fry raised with a commercial feed (Coppens) and a farm made feed. Three treatments were used with three replicates per treatment. A total of 1800 fry were obtained and the experiment was conducted for a period of four weeks using experimental plastic bowls, with 200 fry per bowl.

The water quality parameters (Temperature, pH, Ammonia content, Dissolved oxygen) were recorded and were within acceptable range. The effects of different diets on specific growth rate (SGR), survival rate (SR) and feed utilization were determined. Among the various experimental feeds, Treatment 1(Coppens) produced a better result compared to the others in terms of weight gained and specific growth rate. The lowest growth performance was with fry in Treatment II (Fry fed farm made feed). Estimated cost of feeding was higher in farm made feed and combined feed (N5,260), with lowest values occurring in fry fed with it Coppens (N4,600).

During the experiment Coppens performed better than the other experimental feeds, it showed a higher survival rate and low pollution level. It also showed a better feed utilization and the highest performance index..

CHAPTER ONE

1.0 INTRODUCTION

The African catfish (*Clarias gariepinus*) is a major warm water specie in Africa (Ghana, Ethopia, Egypt, Mali and Nigeria) and Asia (Malaysia, the Philipines and Thailand) and has been introduced in Europe (the Netherlands, Germany and Belgium) Latin America (Brazil), (Food and Agriculture Organization (FAO, 1997; Ali and Ofoche, 2001). Culture of African Catfish (*Clarias gariepinus*) has received considerable attention since the early 1970s and 1980s but the industry remains relatively underdeveloped largely due to dependence on aquatic products from capture fisheries (Adewumi and Olaleye, 2011). Currently, due to decline in most products from capture fisheries an increased demand for protein of aquatic products, the need for an alternative source, particularly from aquaculture is growing. This is to augment fish supply from the wild (capture fisheries). The importance of aquaculture; in improving the diet of the people, generating employment in rural areas and in conserving foreign exchange through import substitution, has increased in recent years.

For aquaculture industry to thrive, apart from development of adequate manpower, there is need to research and develop various inputs of production, such as feed. The need for feed development for various life stages of fish is becoming increasingly urgent as feeds play major role in the growth and development of fishes. Improper feeding or the use of feeds with low quality leads to poor or stunted growth in fishes, poor reproductive rate, weak immunity thus making the fishes prone to diseases and mortality. This in turn leads to low productivity and losses to fish farmers.

One of the major obstacles confronting the development of the aquaculture industry is availability of affordable and high quality fish feeds (FAO 2006; Mwanja *et al*., 2006). Fish production is made practically impossible without the supply or availability of fish seeds. For fish species, the fry period is considered critical in their life history.The transition from endogenous to exogenous feeding is a critical event in the life of a fish. Great losses are sustained in the hatchery, as fry weans over from yolk sac feeding to exogenous feeding. Sucess of fry rearing largely depends on the availability of suitable diets that are readily consumed, efficiently digested and provides the required nutrients to support good growth and health (mohanty *et al*., 2002). It is generally acknowledged that the farmers choice of feed during the first few days of hatching is critical to fry survival. Hitherto, the reliance has been on importation of foreign starters feed such as Coppens, Aler aqua, Gemma wean, Skretting, Blue crown, Crown, Aqualis, Top, Topiska, amongst others. Fish nutritionist agree that, important gaps exist in the knowledge of how to administer feed to *Clarias gariepinus* fry in order to obtain both optimal growth and a high survival rate.

However, in recent years, Nigerian fish cultists have made use of several materials to rear the fry of *Clarias gariepinus* (Adewumi and Olaleye, 2011). Consequently, the use of cultured zooplankton, as fry feed has been exploited over the years and some common cultured zooplankton species are *Brachionus sp, Daphnia sp, Moina sp, Cyclops sp, Copepodita sp, Calanoid sp* (Ojutiku, 2008). The use of live organisms also, such as Artemia in the diet of fishes have for the past decades received tremendous attention in countries where aquaculture is well developed. But the cost of feeding fish fry with

Artemia is very high. Only few farmers in countries developing can afford it. As a result, there is the need to find an alternative feed or a combination, for fish fry.

1.1 Justification of the Study

Fish growth and survival rate depends on factors such as the kind of feed, feeding frequency, feed intake and the fish's ability to absorb the nutrients. African catfish (*Clarias gariepinus*) is widely cultured in Nigeria. It is acceptable among consumers and has high economic value. After 3-4 days, when about two-thirds of the yolk sac has been absorbed, the fry (about 2-3mg) begins to swim vigorously in a fish-like manner searching for exogenous food items, failure of which the fry weaken beyond recovery and eventually dieing. This stimulates cannibalism and high hatchery losses.

Starter feeds are important in the growth of *Clarias gariepinus* fry (Egwenomhe *et al*., 2017). Live feeds such as Artemia, rotifers, copepods, cladocerans, have been employed with successful outcomes as starter feeds in the feeding of most fry of *Clarias gariepinus* (Olurin *et al*., 2012). Although *Artemia nauplii* and decapuslated cysts have long been used successfully in starter feeds of most fry, their increasing cost and especially the current rise in adulterated Artemia, are a major constraint to most fish farmers especially in West Africa (Yilmaz *et al*., 2006; Chang *et al*., 2006: Lavens and Sorgeloos 2000). The use of artificial commercial feeds alone is also not encouraging, as they are very expensive and not readily available to farmers. As a result, there is the need to find an alternative feed or combination, for fish fry.

Saha *et al*., (1998) investigated the use of formulated diet as a starter diet for *Clarias batrachus*. Although a level of success was attained, their choice of ingredients (fish meal, baker's yeast, powdered milk, whole egg, boiled chicken egg yolk, cod liver oil, agar, vitamin premix, mineral premix, attractant amongst others) are very expensive and are not readily available. This is not different from the high cost of Artemia Salina and other commercial feeds such as Coppens, Gemma wean, Aler aqua, Crowns, amongst others. Although some researches have been done on replacing fish meal in the compounding of fish feeds, only a few researches have been made on fry diets. Not many suitable fry diets have been developed to meet farmers demand of high quality fish fry feeds at a low cost, readily available and can be a substitute for high cost commercial feeds in Nigeria.

This study is therefore, focused on the search for an effective fish fry diet that is cheaper, readily available and has the possibility of replacing commercial feeds for effective fish fry growth and development.

1.2 Objectives of the Study

The aim of this study is to compare the survival and growth rate of African catfish (*Clarias gariepinus*) fry raised using a popular commercial feed (Coppens) and a farm made feed.

The specific Objectives are to compare:

1. survival rate of *Clarias gariepinus* fry fed with two different diets.

2. growth rate of *Clarias gariepinus* fry fed with two different diets.

3. performance index of *Clarias gariepinus* fry fed with two different diets.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Aquaculture

Aquaculture is the science, technology and business of producing live organisms in limited aquatic system. It is historic to the start of commercial fish farming in China in the 12^{th}century B.C. Then it extends throughout the world (De Silva, 2012). In the past decade due to itsfast development, aquaculture accounts for 76% of global fresh water finfish production (ElSayed, 2006; FAO, 2008). Asia produced 89 percent in volume of world aquaculture production in 2010, (FAO, 2012).

2.2 Aquaculture in Africa

Aquacultures introduction into many countries in Africa was to serve as a source of protein and prevent total dependence on crops in the 1950s. From 1960 to 1990s development of the sector was facilitated by the help of funds from FAO and other governments and nongovernmental organizations. Around $500million was raised by multilateral and bilateral donors to fund 300 project throughout the continent (Brummett and Williams, 2000). Increased technical assistance was also observed during this period. Hecht (2005) divided the developmental stages of aquaculture into three distinct phases:

Phase 1: 1950-1970. The introductory phase: when the sector was popularized but with minimal knowledge and understanding. Most government stations, were built during this era.

Phase 2: 1970-1995. The expansion phase: significant donor support, active RandD, government involvement in seed supply and extension. Industrial commercialization in some African countries (e.g. Nigeria, Madagascar, Cote d'lvoire, Zambia, and South Africa) also took place.

Phase 3: 1995 to present. The adjustment phase: reduced donor support, re-orientation of public support towards facilitation, emergence of the commercial sector.

Africa's contribution to world aquaculture in 2012 amounts to 1,485,367 tonnes (18 times as much as produced in 1990) which is 2.23% of the global production (FAO, 2014). Sub-Saharan Africa contributed only 0.68% of the total production, with Egyptian production of 1 million tonnes for the first time (FAO, 2014). However, the African aquaculture showed the fastest growth in the world at a rate of 11.7% since the turn of the millennium (FAO, 2014). The aquaculture sector in Africa employs more than 290,000 by 2012 accounting for 10% of the world fish farmers (FAO, 2014).

Egypt, Nigeria, Uganda, Madagascar and Zambia are major aquaculture producers in Africa (Bhujel, 2014). Nile tilapia *(Oreochromis niloticus),* Flathead grey mullet *(Mugil cephalus),* and the African catfishes *(Clarias gariepinus)* are the species produced in the highest quantity in the continent (FAO, 2012). Farming system employed includes ponds, raceways, pens, cages and recirculation systems. Ponds range from 500m2 to 2.5ha with production levels of 3-10 tones/ha/year with inorganic or animal manure. Raceways are mainly used for trouts and tilapias. Pens and cages (square and round) range from $15m^3$ to I,600m3 and are used for farming of tilapia, trout, clariid and bagrid catfish and high-density water recirculation systems are used for fingerlings and Table fish production of African catfish in Nigeria and South Africa (Brummett and Williams, 2000; Hecht, 2005).

At 2.23% Africa stands as the continent with the lowest aquaculture production. In Africa, aquaculture development started at about the same time as Asia, but lags far behind in terms of production volume and revenue (Buhjel, 2014). Interplay of institutional, bio-technical and economic factors have been ascribed to the slower development of the sector in the. continent. These factors are stated as follow: lack of clear aquaculture development policy, poor governmental support, weak research and extension as well as research and development linkages, inappropriate and inflexible technical support, heavy dependence on donor support, unavailability of credit, inadequate seed and feed supply both in quality and quantity, lack of farmer participation in extension systems, poor and often unreliable data collection system (Hecht, 2007).

The future for aquaculture in Africa is promising. A rapid decline in wild catch, along with an increase in public awareness and priority given by the government indicates that aquaculture may take off very soon (Buhjel, 2014; Munguti *et at.,* 2014). Rapid growths that were seen in Egypt and Nigeria can be replicated in other parts of the continent. The following are suggested as possible directions for the development of the sector in the continent: careful planning is necessary to guide future aquaculture development and ensure that available resources are well used. strategies for aquaculture development in these countries should be developed. Conducive policy frame work has to be created for the strategy to be implemented. Furthermore, strong and appropriate research and extension system has to be fashioned. Readily flow of information between farmers and professionals and effective training and extension services have to be developed (Brummett and Williams, 2000; Atta-mills *et al,,* 2004).

2.3 Aquaculture in Nigeria

2.3.1 Fresh water aquaculture in Nigeria

Nigeria is the most populated African nation with an estimated population of about 150 million people. At the end of 2012 it's citizens had a projected fish demand of 2.66 million tonnes of fish.

Three major fresh water fish genus are farmed in Nigeria, which are; clarias, tilapia, and heterotis. Earthen ponds and tank cultivation are characterized by high yield, with their efficiency based on aeration, water quality and flow rate etc. Tanks are usually made from treated wood, concrete or PVC plastic and fibre glass with capacities ranging from a few hundred metres to several thousand cubic metres. Even though this cultivation technique is a capital intensive venture the input is usually quickly recovered if the system is well managed. The Nigerian freshwater aquaculture technology is developing still undergoing research and hasgained steady recognition, due to the increasing demand for high source of protein and livelihood that has seen the need for sustainable production.

2.3.2 Brackish water aquaculture in Nigeria

Research estimates that there are about 729,000ha of saline mangrove swamp suitable for development of commercial fish farming (Amosu *et al.,* 2013), Nigeria is characterized by silt rooted trees with dense undergrowth of shrubs, raffia *palms(Raphia sudanicd)* and oil *palms(EIaeis guineensis).* Plant species dominant in the swampy areas of the lagoon include *Rhizopora racemosa* and *Avicennia nitida.* Many fin and shell fishes are abundant in brackish water, which can be cultured with minimum capital in most of the coastal areas, according to (Deekae *et al.,* 1994). Most of the shell fish production in Nigeria is yet to be developed incommercial scale as obtained in other fish producing countries in Asia, like Japan China,Indonesia, Philippines and Thailand amongst others. Hence there is the need to focus more on these areas, in other to enhance food security and employment opportunities for people living in the region.

2.3.3 Marine Aquaculture in Nigeria

Based on dissolved salts, the water chemistry requirement for salinity is 030-50 ppt. Fish farming in this zone does have some major constraints because of the choppy conditions and (heavy rainfall which occur in the coastal belt. The teeming population of engineers of various disciplines, fisheries researchers (biologists and ecologists), seasoned aquaculturists, technologists, technicians and thousands of kilometres of low lying coastline containing billioncubic metres of marine water are mariculture's great potentials (Amosu *et al.,* 2012). The continental shelf is narrow, extending for 15 km in the western area and ranges from 60 km to 80 km in the eastern province. The culture of marine fish species can be a possibility inNigeria, if all the available potentials can be harnessed. The five major constraints of marine fish culture in Nigeria are domiciled in the characteristic nature of the coastal area and can be summarized as follows:

(1) Nigeria coastal areas, like other developed coastal towns in the world, are heavily populated with commercial and industrial activities, which results in pollution;

(2) Inshore and offshore oil exploration usually leads to oil spill with a resultant effect on water chemistry and fish killing.

(3) The Nigeria coastal water from Lagos to Calabar region is very shallow, while coastal mariculture (earthen) will require about 200 m depth above.

(4) Under-developed technology for sustainable aquaculture production in land based industrial mariculture.

(5) Lack of political-will on the part of government to have preferred crude oil to mariculture in the coastal areas due to the dependent nature of the Nigeria mono-economy.

There are over 210 species of fishes in Nigeria water bodies, little fraction of them are receiving cultivation attention from fish farmers. The production of freshwater fish culture is widely accepted and encouraged (contributing between 0.65-1.2 million tonnes of fish annually from inland fresh water alone), followed by brackish water aquaculture, while mariculture is clearly not popular (Amosu, 1997). Some conventional cultivable fish species in Nigeria include: *Clarias gariepinus, Clarias lazera, Heterobranchus sp., Heteroclarias, Tilapia, Oreochromis niloticus, Sarotherodon galilaeaus, Sarotherodon melonoplura, Tilapia zillii, Tilapia ginneansis, Chrysichthys nigrodigitatus, Cyprinus Carpio,* etc.

2.4 The African catfish

Clarias gariepinus, indigenous fish species of Nigeria, can be defined as having an elongated cylindrical body with dorsal and anal fins being extremely long. The head is flattened, highly ossified, and the body is covered with a smooth scale-less skin. It has four distinctive pairs of unbranched barbels (Graaf and Janssen, 1996). The function of the barbels are for prey detection. A supra-branchial or accessory respiratory organ composed of a paired pear-shaped air-chamber, containing two arborescent structures are generally present. The accessory air breathing organ allows the fish to survive for many hours out of the water or for many weeks in muddy marshes (Haylor and Muir, 1998).

Clarias gariepinus is a widespread freshwater benthic species, found- from Turkey, the Middle East, and throughout Africa. It inhabits natural lakes, impoundments, fish ponds, streams, and natural ponds in both shallow and deep waters. Even though some of these habitats are subject to seasonal drying, the specie is capable of living there due to the presence of the accessory breathing organs (Graaf and Janssen, 1996). Bruton, (1979) suggested that *Clarias gariepinus* is a euryphagy. i.e an organism feeding on a wide variety of organisms according to their availability. *Clarias gariepinus* has a remarkable array of anatomical adaptations that made it capable of euryphagy. These adaptations allow the specie to feed on a wide variety of diets and size ranges, from a minute zooplankton to a fish half its own size (Bruton, 1979). The diet of the species included small crustaceans, insects, mollusks, oligochaetes and other fishes (Bruton, 1978 and 1979; Dadebo, 2009 and 2014). *Clarias gariepinus* is a slow foraging predator, with very small eyes, using their four pairs of barbels to feel their way around in the dark and find food detected by the sensitive taste buds covering the barbels and head. Approximately 70 percent of feeding activity takes place at night (FAO, 2014).

Clarias gariepinus shows a seasonal gonadal maturation usually associated with the rainy season. The maturation processes are influenced by annual changes in water temperature and photoperiodicity and the final triggering of spawning is caused by a raise in water level due to rainfall (Graaf *et aL,* 1995). At night spawning usually takes place at in the shallow areas of the rivers lakes and streams. Courtship is followed by high aggressive encounters between males. Courtship and mating takes place in shallow waters between the pairs of males and females. A batch of milt and eggs is released followed by a vigorous swish of thefemale's tail to distribute the eggs over a wide area (Bruton, 1979), There is no parental care to ensure the survival of the catfish offspring except by the careful choice of a suitable site.

2.4.1 Feeding behavior of catfish larvae

Good nutrition is a factor for proper growth of fish and is more pronounced with fish in enclosure as they need adequate nutrition (Omoruwou *et al.,* 2011). *Clarias gariepinus* is an opportunist feeder fish. Many factors are known to influence larval prey selection' within the restrictions imposed by ontogenetic development. These include prey characteristics such as size, density and motion (Yilmaz *et at.,* 2006) and also larval characteristics related with trophic level such as sensory capabilities, previous experience, mouth dimensions, mouth gape and body size and species type (Truemper and Lauer, 2005; Sanchez Heraandez and Cobo, 2015).

Most first-feeding fish larvae are dependent upon vision for prey detection, although non-visual senses have also been implicated in prey detection by selective planktivorous fish larvae (Lee *et at.,* 2014). Many studies pay attention on the relationship between prey size and mouth size as the primary determinant of prey selection (Dabrowski, 1984; Riley *et al.,* 2012). In addition, some water-soluble chemical compounds, i.e. L-amino acids and betaine have influenced the food intake of the larvae as an attractant by stimulating non-visual senses (Yilmaz *et al,* 2006).

2.4.2 *Clarias gariepinus* in aquaculture

The African catfish production has risen tremendously from a mere 5,013 tons in 1992 to 181,601 tons in 2012 (FAO, 2014). Development of seed production and growth technologies, the species ability to withstand high densities, its high growth rate, its ability to feed on a wide array of feed and its high demand in the market can be ascribed to its increased production in the world. Nigeria is the leading producer of *Clarias gariepinus* in the world with a production of 89,193 tons in 2009 (FAO, 2011). The involvement of the private sector in the seed production and formulation of feed, made possible this growth in production (Adewumi and Olaleye, 2011).

Seed production is the critical aspect of any aquaculture practice. The major bottleneck in the culture of *Clarias gariepinus* is seed production, as the species is relatively difficult to reproduce. Larval rearing is still a major problem, with average survival rate of 30% from larvae to fingerling stages, despite many years of research that has established a relatively simple and effective method for induced breeding (Biosciences, 2009). Cannibalism is a fundamental issue and requires an investment of hundreds of man hours to sort the fish into different sizes (Marimuthu *et at.,* 2011; Musa *et aL,* 2012). The other obstacle in the seed production of the *Clarias gariepinus* is its requirement of high protein feed which are generally expensive.

Different methods are employed for the seed production of *Clarias gariepinus.* The most widely used method in recent times is induced spawning followed by larval and fry rearing and producing fingerlings in a hatchery to supply the market. Different systems use different stocking densities, water circulation rates and also obtain different survival rates. In most African countries the most used method for seed production of *Clarias* *gariepinus* is induced spawning followed by larval rearing by the use of live feed (Artemia, Moina, Brachionus and Daphnia), then sub sequentially fry rearing with dry feed, sorting by size and stocking in nursery ponds (Martins *et al.,* 2005; Yong *et at.,* 2006; Matsiko and Mwanja, 2008). However, Reticulating Aquaculture System (RAS) has been shown to produce higher number of seeds and ascertained higher stocking densities (Van de Nieuwegiessen *et at.,* 2008). Up to 3 million lingerlings per year have been reported in intensive RAS in Nigeria (Williams, *et al.,* 2008).

2.4.3 Feed and nutrition in *Clarias gariepinus* larval rearing

Good nutrition in animal production is essential for economical production of a healthy and high quality production. Nutrition is critical in fish farming because feed represents 40-50% of the production costs (Ogello, 2013).

In aquaculture, the rate of feeding and nutrition are very important factors that affect the growth of fish. Hence determining the optimal feeding rate is important to the success of any aquaculture operation (Marimuthu *et al.,* 2011; Omoruwou *et al.,* 2011). Several factors affect the feeding rate in culture systems. Such as fish size, species and rearing systems (Almazan *et al.,* 2004). Feeding rate is also influenced by the feeds nutrient content (Almazan *et aL,* 2004; Marimuthu *et al.,* 2011). For many fish species, the larval period is considered critical in their life history (Trushenski *et al.,* 2006). Successful larval rearing largely depends on the availability of suitable diets that are readily consumed, efficiently digested and provide the required nutrients to support good growth and health (Giri *et al.,* 2002 and Wang *et aL,* 2005). Nutrients which take the most proportion in both natural and formulated fish feeds are proteins, lipids and carbohydrates. Vitamins and minerals are required in minor quantities. When the fish obtains sufficient supply of certain essential nutrients, body functions and growth processes will be effective. African catfish *(Clarias gariepinus}* which efficiently utilizes commercial feeds and grows rapidly, is increasingly becoming an important commercial specie in Africa, Europe andpart of Asia (FAO, 2010). However, its highly cannibalistic nature discourages its rearing in culture systems.

Clarias -gariepinus passes through distinct stages in its life time. The larval stage, which is the initial stage, depends on factors such as temperature and nutrition, etc. Then the fry stage, which is the second stage, is characterized by the redundant movement of the fish to the surface of the water. This movement also signifies that the fish can be stocked into ponds. The fingerling stage is attained when the fins are fully developed and most organs have been formed. It ends with the start of gametogenesis (Hailor and Muir, 1998; Truemper and Lauer, 2005; Sanchez-Hernandez and Cobo,2015).

Several researches in the past three decades did try to come up with solutions for problems associated with larval rearing and nutrition of *Clarias gariepinus.* The nutritional requirements of specific stages of the species have been discovered (Hailor and Muir, 1998). Optimal environmental conditions and feeding behaviors during their early life stages have been understood (Verreth, 1994; Yilmaz *et al,* 2006). Husbandry and feeding technologies that encompass specific and changing practices have been developed (Potongkam, 2006; Musa *et at.,* 2012).

Constant availability of the diet is also emphasized upon. Palatability and digestibility are the most important criterias for choice of feed. These factors are in turn affected by size of the diet in relation to the size of the fish (Osman, *et al.,* 2008). In general, the food size should be around 2-3% of the larval length (Uys and Hecht, 1985). In relation to a certain size, the most important feature of a larval diet is its nutritional quality. Its protein content and dietary levels of essential fatty acids (n-3/n-6) and ammo acids play a crucial role (Vereth, 1994). The nutritional requirement of *Clarias gariepinus* differs slightly at different stages of growth. At larval stage protein requirement of 55% was determined (Uys and Hecht, 1985), while 50 and 40-42% were determined for nursery and grow out phases, respectively. Regarding amino acid requirements,the only requirements for methionine (2.5%) and Lysine 57g/kg were determined (Uys and Hecht, 1985; Fagbenro and Oyedapa, 1998). The fatty acid requirements are unknown, except that a 1:1 ratio of n3 and n6 fatty acids appears to be optimal for growth and body condition (Uys and Hecht, 1985). Crude lipid content of *9%* and carbohydrates content as high as 21 percent of the diet was reported (Uys and Hecht, 1985).

Formulated feeds can be used as a diet for fresh water species as early as mouth opening (Cahu and Infante, 2001). However, attaining feeds which fulfill the nutritional needs of larvae us difficult since nutritional requirements, means of absorption and digestion all change during larval development (Dabrowski, 1984, Olurin and Oluwo, 2010). Although inert diets are well ingested at the early stage, larvae can die with full guts, telling that they are not able to digest compound diets (Cahu and Infante, 2001). Allowing early co-feeding period to prepare the gut for accepting and processing inert diets is better for growth performances than when weaning starts at "the end of the larval stage (Conceicao *et al.,* 2010).

2.4.4 Water quality and hatchery management in *Clarias gariepinus* larval rearing

Water quality is an important factor to have successful fish fingerlings grow out. Temperature and pH play major roles in the determination of the effectiveness of digestive enzymes as a whole. Good water quality management follows preventing accumulation of organic debris and nitrogenous wastes limiting ammonia build up, maintaining appropriate pH and temperature depend on cultured species.

Ammonia which is an end product of the breakdown of organic matter of heterotrophic bacteria is excreted with the droppings of aquatic animals as it is highly soluble when fish is cultured in intensive culture system. It is important to monitor and check the culture systems regularly before it reaches critical level (concentration > 0.5mg/l) (Buttle *et al.,* 1995).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental site

This research was conducted in the Hatchery Unit of the Departmental Fish Farm of Faculty of Agriculture, University of Benin, Ugbowo Campus with Latitude 6.24^0 N and Logitude 5.37^0 E, Ovia North East of Edo State, Nigeria. The culture facility was a semi-circular concrete hatchery tank with a total surface area of 2.5m and a height of 0.73m. Other materials in the farm includes: Two semi-circular concrete tanks structure, p.v.c pipes connected to a bore-hole, hand brush, thermometer, weighing scale, plastic containers, syringes and needles, 9 plastic bowls, spawning mats, hormone (Ovuline), saline solution (0.85% NaCl salt), granule form of salt (Nacl), bore-hole water, scoop net. The feeds for this project were Coppens feed (0.2 mm -0.8mm) and a Farm formulated fish feed.

3.2 Experimental fish

Three sampled broodstock consisting of one male and two females *Clarias gariepinus* were obtained from a reputable fish farm in Benin metropolis and were used to produce the fry for this experiment. The eggs from both females were mixed together and fertilized with the milt from the male. The spawning procedure was carried out as recommended by (Egwenomhe and Obi, 2012).

At about 22 hours after fertilization the presence of hatchlings was noticed around the spawning mats area. On the second day the spawning mats were then carried to the surface of the water and then slowly tilted both ways in order to remove life hatchlings and then it was slowly brought out of the tank and washed with sponge and running water. Flow through water circulation method was carried out every three hours in order to keep the pond water clean.

3.3 Stocking and feeding

On the fourth day the fry were transferred from the concrete tank into 9 experimental bowls already filled with water, with a stocking rate of 200 fry per bowl, thus a total of 1800 fry. The fry were acclimatized while stocking into the experimental bowls to prevent shock stress due to slight variations in temperature of the water. Feeding of the fry commenced on the fourth day after the exhaustion of the yolk sac, the fry were fed with Coppens and a Farm made feed (fish meal and groundnut cake) eight times daily for 6 weeks with good water quality management practices. The fry were fed eight times a day to satiation i.e they were fed every three hours, few minutes after a flow through have been conducted. Dead fry were removed and recorded.

3.4 Experimental Design

The experiment was made up of 3 types of feed (Coppens x farm made feed x combination of both) x4 weeks (28 days) culture period factorial in Complete Randomized Design (CRD). Each Treatment was replicated three (3) times. Thus a total of 9 culture units were used.

Table 1: The Experimental Design/Layout With Respective Treatment s And Replicates

REPLICATION	Treatment		
	T1	**T2**	**T3**
R1			
R2			
R3			
R-Replicate	**T-Treatment (experimental feeds)**		

3.5 Experimental procedure

Weight .of the broodstock, spawning fecundity, percentage fertilization and hatchability is going to be recorded to determine the hatchlings survival from given broodstock size category. The length and weight were monitored on a weekly basis to calculate growth parameters such as weight gain, percentage weight gain, increase in length, percentage length and condition factor and at the end of the experiment, the survival rate was calculated. 9 experimental bowls for project procedure are going to be used. 100 hatchlings are going to be stocked in each bowl. The fry is going to be fed with Inert diet and Coppens. The size of the fish determines the size of feed that will be given to them. Feed ranging from 0.2mm to 0.8mm was fed to the fish. Observations were made on the acceptability and consumption of the feed.

After 2 weeks, 100 fry for each replicate was measured with an electronic weighing balance at the experimental laboratory at the faculty of agriculture on a weekly basis in each replicate and it is used to calculate the growth parameter. The hatchlings were fed thrice daily to satisfaction. Some water quality parameters such as temperature, pH, Dissolved oxygen, nitrite levels were monitored. Dissolved oxygen was measured using a dissolved meter(Brand nan^e; RCYAGO, Model: JPG - 607A). The pH was measured using a hand held pH meter (Hanna instruments, Model: HI98107), Temperature will be measured using a digital thermometer (Brand: ACROMEC, Model: Acromec ST9283B Multi stem Thermometer) and nitrate levels was measured using nirite strips(ACCU - ANSWER strips. Model: SG09100). The above water quality parameters were evaluated because studies have shown that it affect fish.

3.6 Formulation and Preparation of feed

3.6.1 farm made feed (Fish meal, GNC and Egg white)

In the preparation of the farm made feed, Fish meal and chicken eggs were purchased from the market. Then the raw eggs were boiled for about 10-15 minutes after which the egg white is separated from the yolk. The yolk is then crushed to a very fine particle and then mixed with the fishmeal earlier bought to serve as a binder.

3.6.2 Commercial starter feed

The Coppens is to be used as the experimental diet. Coppens has an optimized nutritional balance, physical quality so that it flows ore freely and floats readily on the water surface, Theparticulate sizes are very suitable for the fry it contains high-quality ingredients and an immune stimulant (B-glucans) to support natural disease resistance. Coppens is available in 0.2mm -0.8mm as starter feed for fry.

3.7 Growth parameters determined

Growth parameters were determined using both length and weight.

1. Weight gain (g) = Final weight - initial weight,

2. Percentage weight gain (PWG) = $\frac{\text{weight gain}}{\text{Initial weight}} \times 100$

3. Specific growth rate (g/day) = 100 x $\frac{[\text{In (final weight) - (initial weight)}]}{\text{Rearing period in days}}$

Where "In" represent natural logarithm.

4. Survival rate (SR %) = $\frac{\text{Total number of fish harvested}}{\text{Total number of fish stocked}} \times 100$

5. Performance index = $\frac{\text{Survival rate x weight gain}}{\text{Culture duration in days}}$

3.8 Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) at 5% probability using GenStat (version 12.5) and differences in mean will be compared using Least Significance Difference at P = 0.05.

Plate 1. Formulated farm made feed

Plate 2: The ingredients for farm made feed

Plate 3: Coppens feed 0.2-0.3mm for the experiment

Plate 4: Nessler reagent used for ammonia test

Plate 5: measurement of weight using weighing balance

Plate 6: siphoning, water quality management practice

Plate 7: 200 *Clarias gariepinus*

CHAPTER FOUR

4.1 Survival and Mortality Rate of *Clarias gariepinus* fry fed with commercial and farm made feed:

The survival and mortality rate as shown in Figure 1 below was observed and recorded during the experiment. Farm made feed recorded the lowest survival rate and Coppens having the highest survival rate. Mortality rate ranged from 29% to 51%.

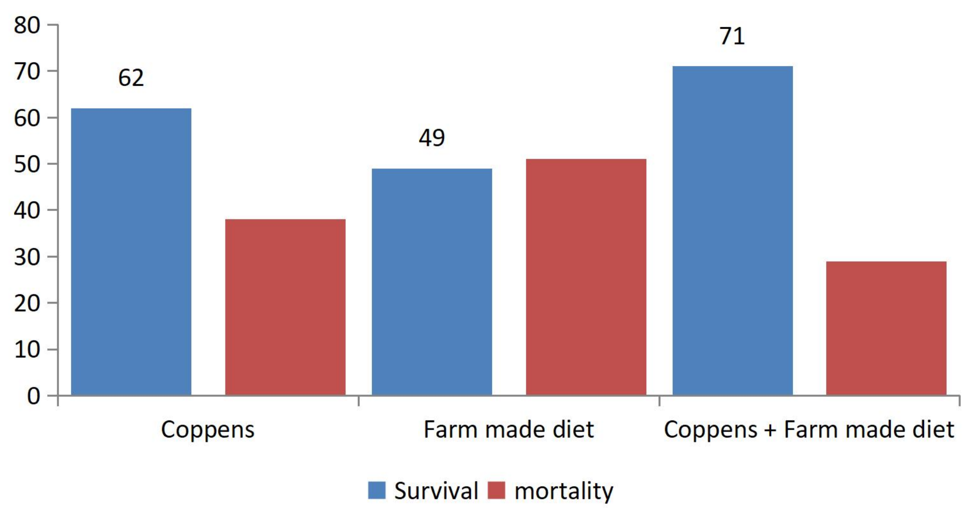

Figure 1 Survival and Mortality Rates

4.2 Results on Feed Utilization (Feed Conversion Ratio)

Coppens had the lowest FCR (1.13±0.13), farm made feed which is our indigenous formulated feed had the highest FCR (1.82±0.30), Combined feed had an FCR of (1.61±0.14) slightly higher than Coppens. There was significant difference between the FCR of Coppens and Farm made feed ($p>0.5$). There was also significant difference between Coppens and the combined diet of coppens and farm made feed ($p>0.5$). There was significant difference between farm made feed and the combined diet of Coppens and farm made feed ($p>0.5$). Coppens had the highest feed utilization as shown in Figure 2 below.

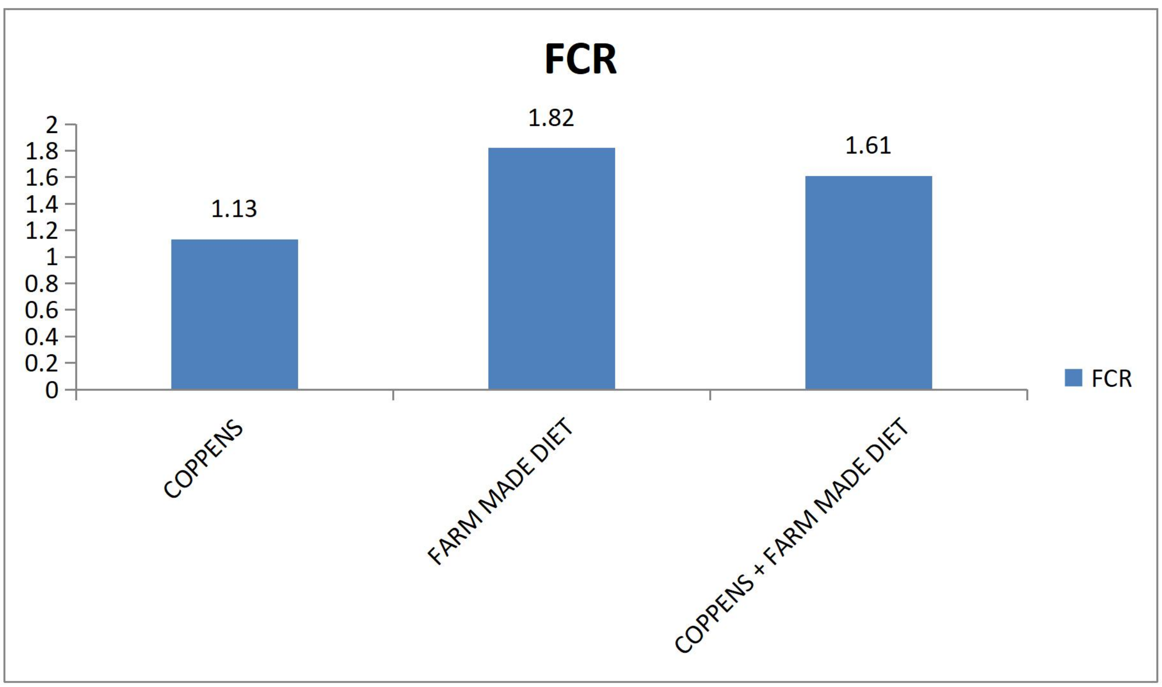

Figure 2: Feed Conversion Ratio

4.3 Results on Growth performance (weight gain, mean length, feed intake and specific growth rate):

4.3.1 Feed intake

At the end of the culture period there was no significant difference ($p>0.5$) between the amount of feed intake among the various treatments. Looking at the various treatments there was a slight increase in the consumption of Coppens feed, but there was a decrease in the consumption of farm made feed as shown in **Table 2**

4.3.2 Weight gained

The weight gained was analyzed at weekly intervals and at the end of the experiment, there was significant difference between Coppens and farm made feed, there was significant difference between farm made feed and the combined feed, but there was no significant difference between Coppens and combined feed which means both Treatment s produced similar mean weight of little difference ($p>0.5$) as shown in **Table 2**.

4.3.3 Mean length

There was significant difference in the mean length value of Coppens compared to farm made feed ($p>0.5$). There was no significant difference between farm made feed and Combined diet, there was also no significant difference between Coppens and combined feed ($p>0.5$) as shown in **Table 2**.

4.3.4 Specific Growth Rate

Fishes fed with Coppens had a higher growth rate compared to fishes fed with farm made feed. farm made feed had a lower growth rate compared to the combined feed, Coppens had a higher growth rate compared to the combined diet. There was a significant difference between Coppens and farm made feed, there was no significant difference between Coppens and Combined feed while there was no significant difference between farm made feed and Combined feed ($p>0.5$). This is shown in **Table 2**.

4.4 Performance Index

Fishes fed with Coppens had a higher profit index compared to fishes fed with farm made feed and combined feed, with the lowest Profit index ocurring with those fed farm made feed This is shown in Table 2.

Table 2: Growth Performance Values.

Parameters	COPPENS(T1)	farm made feed (T2)	COPPENS + farm made feed (T3)	S.E.D
Feed intake(g)	2.81±1.35[a]	2.81±1.09[a]	3.54±1.57[a]	0.321
Weightgain(g)	2.43±0.98[a]	1.49±0.36[b]	2.14±0.83[a]	0.016
Mean length(L)	0.91±0.37[a]	0.56±0.25[b]	0.72±0.29[ab]	0.025
FCR	1.13±0.13[a]	1.82±0.30[b]	1.61±0.14[c]	0.000
SGR(g/d)	2.92±1.52[a]	1.31±0.89[b]	2.43±1.52[a]	0.019
PI	7.52[a]	2.88[b]	7.28[a]	

Values with the same superscripts across rows are not significantly different (P > 0.5)
S.E.D: Standard errors of differences of means.

4.5 Water Quality Parameters

The water quality parameters of the fish culture environment were observed during the 4 weeks of the experiment. At the end of the experiment, it was observed that the combined feed had a higher ammonia content compared to the other treatments as shown in **Table 3.**

4.6 Cost of feeds: 1kg of Coppens feed cost N2,300 for 0.2mm and N2,300 for 0.3mm, totaling N4,600. While, 1kg of farm made feed amounted to N5,260. The amount of each ingredients for the formulation of the farm made feed is shown in **Table 4**

Table 3: Water quality parameters and their mean values.

Treatments	NH_3(mg/l)	Dissolved O_2(mg/l)	PH	Temp.(°C)
COPPENS	0.014^a	5.31^a	6.7^a	27.5^a
farm made feed	0.015^a	5.25^a	6.7^a	27.6^a
COPPENS + farm made feed	0.016^a	5.30^a	6.7^a	27.4^a

Values with the same superscripts across rows are not significantly different (P > 0.5).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Feed utilization

Coppens had the highest feed utilization, this is due to its low feed conversation ratio (1.13±0.13) and the acceptability of the feed by the fry, while farm made feed which is our locally formulated feed had the highest FCR (1.82±0.30) This is due to its high feed conversion ratio and it's low feed utilization and less acceptance of the feed by the fry compared to Coppens. There was significant difference between Coppens, farm made feed and Combined feed in terms of FCR ($P>0.5$). Coppens feed produced more flesh even though there was no significant difference between the amount of feed intake as similarly reported by Cheikyula *et al*., (2019), who reported a low FCR, high specific growth rate and high feed utilization, in the use of Coppens as experimental feed in *Clarias gariepinus* culture. In catfish production, the efficiency of production and fish growth depending on the type of feed the fish is given, is a major factor. Feed conversion ratio (FCR) is an excellent means of figuring the suitability of feeds in fish feeding experiments (Sahu et al., 2007). Feeds with low feed conversion ratio or high efficiency do result in tremendous savings in cost of feed (Gabriel *et al*., 2007).

5.2 Growth performance

Amongst the various experimental feeds, Treatment I (Coppens) produced a better performance than the other feeds in terms of weight gained (2.43 ± 0.98)) and specific growth rate (2.92±1.52). This report is similar to the work of Shapawi et al. (2011) which stated that the imported commercial feed of coppens used gave significant better growth performance in *Clarias gariepinus* than the local feed, which has also been reported to produce better growth performance in various species of fish when compared with local feeds. Ahmed et al. (2012) who showed that commercial feeds enhanced better growth performance of the fingerlings of *Labeo rohita*.

Treatment II (farm made feed) had the lowest weight gain (1.49±0.36) and lowest specific growth rate (1.31±0.89). Treatment III (Combined feed) had weight gain (2.14±0.83) and specific growth rate (2.43±1.52) which were slightly lower than That of Treatment I (Coppens). The lowest growth performance of fish fed with Treatment II might be due to the fact that this feed was less acceptable. Similar result was obtained by Mustapha *et al.,* (2014) in *Clarias gariepinus* using locally formulated feed.

5.3 Performance Index

PI was significantly different between fry fed Coppens and farm made feed, but there was no significant difference with those fed Combined feed (p>0.50). This is due to the high utilization of the Coppens feed by the fishes, leading to a High survival rate and the highest Specific growth rate. Egwenomhe, (2019) also noticed significant differences in PI across three Treatments of *Clarias gariepinus* broodstocks, with those with the highest PI producing best growth performance and reproduction.

5.4 Water quality

Water temperature was not significantly different across Treatment I (Coppens 27.5), Treatment II (farm made feed 27.6), Treatment III (Combined feed 27.4) (p>0.5). This was similar to report by Ogunji and Awoke, (2017), which stated that the highest growth rate of *Clarias gariepinus* was at temperatures between 26- 32°C and temperature value of 40°C critical for *Clarias gariepinus*. Ammonia levels is raised in the pond water due to uneaten feed, faecal matter and dead fish. A feed with high quality tends to produce less ammonia content since it is properly utilized, the lower the value of (NH3), the better the quality of water for fish (Alabaster and Lioyd 1980). Combined feed had the highest ammonia value, despite its high polluting effect due to it's high protein content, it produced the highest survival rate and a high growth rate due to proper water management practices. Coppens had the least ammonia concentration and as such had the highest growth rate, it was followed by farm mad diet . The end product of digestion of the protein present in the feed is ammonia which is excreted through the gills and faeces. The amount of ammonia excreted by the fish is dependent on the percentage of protein present in the feed, the amount of feed put in the aquaculture holding tanks and the rate of feeding (Mustapha *et al* ., 2014).

There was no significant difference in the Dissolved oxygen level in Coppens (5.31) compared to farm made feed (5.25) and Combined feed (5.30). The amounts of dissolved oxygen in water for this experiment were kept at the recommended levels for fish production as reported by (Dewan *et al.* 1991). farm made feed had the lowest dissolved oxygen level compared to coppens and the combined feed. There was no significant difference in the pH level in Coppens (6.7) compared to farm made feed (6.7) and Combined feed (6.7) ($p>0.5$) . This was similarly to report by marimuth et al., (2019) which stated the best hatching rate for *Clarias gariepinus* fry was at pH range of 6.7–7.6.

5.5 Cost of feed

1kg of Coppens feed cost N2,300 for 0.2mm and N2,300 for 0.3mm, totaling N4600. While, 1kg of farm made feed amounted to N5,260. farm made feed cost more because of the high cost of ingredients and feedstuffs in the market, so it was more costly to make farm made feed compared to imported commercial feed (Coppens). Before now commercial feeds were expensive but their price were lower now, than that of farm made feed due to the inflation in cost of feed ingredients in Nigeria currently in 2022 compared to Samuel (2020), whose report stated a higher profit index for locally farm made feed and a lower cost of production compared to industrially made feed.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

During this experiment, Coppens performed better than the other experimental feeds in terms of weight gained and growth rate and performance index. It also showed a very high survival rate and low pollution level. It also showed a better feed utilization due to its low feed conversion ratio, the combined feeds also had a high growth rate and feed conversion ratio and the highest survival rate. Coppens and commercial feed had almost no significance difference in their growth performance except for the survival rate which the combined feed did better. Compared to the other 2 Treatments, Coppens cost of production was minimized due to its high growth performance and feed efficiency. Estimated cost of feeding was highest in farm made feed and Combined feed. Water quality parameters such as pH, temperature, Ammonia, Dissolved oxygen where kept at desired levels for optimum growth and high production of fish.

6.2 Recommendation

The following recommendations are suggested from this study;

- A farmer intending for a better outcome for his fish seeds is advised to use Coppens as they give a high growth rate and a high yield compared to farm made feed and high performance index.

- Further experiments and analysis on formulating local feeds for fish fry production is recommended to be carried out.

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Appendix

Plate 3. Showing the Layout of the experimental bowls for the experiment

Table 4:Total Cost of farm made feed

Items	Price (N)
1kg GNC	900
1kg Fish crumbs	800
Egg	2100
Grinding	800
Transportation	630
Packaging	30

1. Data on Average weight gain parameters(g)

Average Weight of fry= 0.31

Week	Coppens T1R1	Coppens T1R2	Coppens T1R3	farm made feed T2R1	farm made feed T2R2	farm made feed T2R3	Coppens + farm made feed T3R1	Coppens + farm made feed T3R2	Coppens + farm made feed T3R3
1	1.26	1.20	1.25	1.01	1.05	1.03	1.13	1.12	1.10
2	1.87	1.81	1.89	1.32	1.38	1.35	1.64	1.67	1.66
3	3.00	3.05	3.03	1.61	1.63	1.62	2.62	2.65	2.68
4	3.55	3.70	3.60	1.95	1.98	1.93	3.10	3.17	3.16

2. Data on Average length gain parameters(cm)

Week	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
1	0.37	0.45	0.35	0.22	0.25	0.27	0.27	0.29	0.32
2	0.78	0.88	0.85	0.41	0.45	0.46	0.61	0.69	0.76
3	1.03	1.17	1.10	0.62	0.66	0.68	0.80	0.87	0.85
4	1.43	1.31	1.25	0.85	0.88	0.91	1.00	1.09	1.05

3. Data on mortality and survival (%)

%	Coppens	Coppens and farm made feed	farm made feed
Survival	62	71	49
Mortalities	38	29	51

4. Data on water quality parameters

	Dissolved oxygen (mg/L)	pH	NH3 (mg/L)	Temp (^oC)
Coppens	5.31	6.7	0.016	27.5
farm made feed	5.25	6.7	0.014	27.6
Coppens + farm made feed	5.30	6.7	0.015	27.4

5. Data on feed intake(g)

Week	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
1	1.10	1.13	1.16	1.40	1.49	1.43	1.55	1.58	1.50
2	2.04	2.10	2.13	2.31	2.48	2.30	2.71	2.75	2.73
3	3.55	3.36	3.66	3.12	3.19	3.16	4.45	4.50	4.46
4	4.40	4.50	4.57	4.26	4.30	4.28	5.43	5.46	5.40

6. Data on Feed conversion Ratio

Week	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
1	0.87	0.94	1.01	1.39	1.42	1.39	1.37	1.41	1.36
2	1.09	1.16	1.13	1.75	1.80	1.70	1.65	1.67	1.64
3	1.18	1.19	1.21	1.94	1.96	1.95	1.70	1.70	1.66
4	1.24	1.22	1.27	2.18	2.17	2.22	1.75	1.72	1.71

7. Data on specific growth rate(g/day)

Week	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
1	0.83	0.94	0.93	0.04	0.07	0.11	0.44	0.40	0.34
2	2.24	2.12	2.27	0.99	1.15	1.07	1.77	1.83	1.69
3	3.92	4.08	3.96	1.70	1.74	1.72	3.44	3.48	3.52
4	4.52	4.67	4.57	2.39	2.44	2.35	4.04	4.12	4.12