COMPARATIVE ANALYSIS ON THE GROWTH PERFORMANCE OF CATFISH (*Clarias Gariepinus*) FED WITH EARTHWORM AS A REPLACEMENT OF FISH MEAL

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ABSTRACT

Growth performance of African catfish *Clarias gariepinus* fed with earthworm fish meal investigated along with Coppens commercial fed as control for three months. A group of 15 fishes/m^2 with 0.400 ± 0.03kg were shocked in three circular tanks labeled A, B and C (50cm x 30cm x 26cm). Tank A was fed 100% Coppens, (moisture 8.3%, crude protein 45%, crude fiber 1.5%, Ash 9.5%, and Crude lipid 12%). Tank B, earthworm and fish meal at the ratio of (70.30%) (moisture 8.05%, crude protein 39.94%, crude fiber 11.25%, Ash 6.15%, and crude lipid 12%) and Tank C at the ratio of (50:50) (moisture 5.35%, crude protein 39.02%, crude fiber 11.00%, Ash 6.75%, and crude lipid 10%). The fishes were fed 4% of their body weight twice daily, 7am-8am in the morning and 5pm-6pm in the evening. The fingerling stocked were between 2.0 cm in length and 0.4 g in weight. The result however showed Tank B having the highest growth rate of (47.44g) followed by Tank A (46.16g) and Tank C having the lowest value (45.47g). the analysis done using a One-way ANOVA showed no significant difference ($p>0.05$) for food conversion efficiency (FCE) and survival rate (SR). However, there was a significant difference ($p<0.05$) in mean growth rate, weight gain, growth rate, and specific growth rate. Based on these findings, earthworm is recommended on the bases of affordability as a substitute for Coppens commercial feed for the feeding of *Clarias gariepinus.*

{Citation: Omeru, E. D.; Solomon, R. J. Comparative analysis on the growth performance of catfish (*Clarias Gariepinus*) fed with earthwork as a replacement of fish meal. American Journal of Research Communication, 2016, 4(6): 89-125} www.usa-journals.com, ISSN: 2325-4076.

1.0 INTRODUCTION

BACKGROUND OF THE STUDY

Fish is an important and the cheapest source of animal protein and account for about 37% of Nigeria total protein requires (FAO, 2002). Fish provides approximately 16% of the animal protein consumed by the world population (FAO, 1997). It is particularly an important protein source in require where livestock is relatively scarce.

Billions of people mostly in developing countries depend on fish as a primary source of animal protein (FAO, 2000). FAO estimated that by the year 2010, demand of fish will increase by 13.5%-18.5% or to about 105-110% millions metric tons (FAO, 2000). Further increase in capture fisheries are not anticipated under the current global condition (Ounham *et al.*, 2001). Faturoti (1999) noted that recent trends all over the world pointed to a cleared in landing from capture fisheries which are all indicator that fish stock have approached or even exceeded point of maximum sustainable yield. The food and agriculture organization recommended that an individual takes 3 series per capture of animal protein per day for sustainable growth and development. However, the animal protein consumption in Nigeria is less than 8g per person per day which is a far cry from the FAO polonium recommendation. The rapid growth of Nigeria population has lead to insufficiency in supply of animal protein source food consequently also lead to tremendous efforts resulting in increasing animal production. Fish is a major source of animal protein source and an essential food item in diet of many people in Nigeria. Fish is also a good source of Thiamine, Riboflavin, Vitamin A and D, Phosphorus, Calcium, and Iron. It is also very high in polyunsaturated fatty acids which are important in lowering blood diolestral level, it is therefore suitable for complementing high carbohydrate diets typical of low income group in Nigeria (Areola, 2008). Apart from being food, fish is also an important source of income to many people in developing countries including Nigeria. FAO (1996) confirms that as much as 5% of the African population have 35million people depending wholly or partly on fisheries sector for their livelihood.

Traditionally, Nigeria can be classified as a country of fishermen existing in the Niger Benue river system i.e the Lake Chad, the Kianji Lake and the vast lower Niger region.

However, the importance of fish in the diet of Nigeria further significantly increased after the Sahara drought of 1971 to 1979. This drought which greatly decimated the cattle population put the price of livestock virtually in affordable in the majority of Nigeria. This trend thus triggered an increase in the demand for fish alternative source of animal protein (Anadu *et al.,* 1993).

Fish farming has become a worldwide practice and has been for years. Increase aquaculture production is clearly needed to meet this demand in the third millennium because capture fisheries are at capacity of showing perception decline due to over fishing, habitat destination and pollution (World Bank, 2005). Aquaculture therefore remains the only viable alternative for increasing fish production in order to meet the protein demand of people (Omotoyin, 2007). One of the aquaculture is the increase in the production aid growth rate of fish that will meet the demand of increase population.

Catfish of the family Claridae comprise the most commonly cultivated fishes in Nigeria, the growth of aquaculture in Nigeria is now largely being boosted by a steady rise in catfish culture, inadequate availability of seed stocking and feed use to be major problems. The favoured catfish species in Nigeria aquaculture includes *Clarias gariepinus, Heterobranchus bidorsalis and Clarias nigrodigitatus. Heterobranchus* species is the more commonly cultured fish in the South eastern parts of Nigeria. Africa catfish is popular in the market and has great potentials to boost the rapidly growing Nigeria aquaculture.

Clarias gariepinus is generally considered to be one of the most important tropical fresh water fish species for aquaculture whose aquaculture potential have been documented (Dada and Wanah, 2003). Bruton (1979) pointed out that *C.gariepinus* has also high fecundity rate, grows faster, tolerates high density and environmental extremes. It also acdepts wide range of natural and artificial food and adapts to a variety of feeding modes in expanded niches.

Clarias gariepinus is generally considered one of the most important tropical species of the aquaculture. It has an almost pan-African distribution ranging from the mili to West Africa and from Algeria to Southern Africa. They also occur in Asia Minor (Isreal, Syria and South of Turkey).

Clarias gariepinus at various geographical locations bears different values. It is called *Clarias lazera* in Northern and central Africa, *Clarias gariepinus* in South Africa (Viveen, *et al.*, 1985). *Clarias gariepinus* is characterized with nated skin and dougate with fairly long dorsal aid anal fins. The dorsa fin has 61-80 soft rays and anal fin has 45-65 soft rays. They have strong pectoral fins with spines that over serrated on the outer side (Tangels, 1986). It posses nasal and maxillary barbells and somewhat smallish eyes, their coloring is dark frey or black dorsally and green coloured ventrally. Adult possess a dark longitudinal lies on either side of the head. However, this is absent in young fish the head is large, depressed and heavily boned. The mouth is quiet large and subternuials (Shoelton, 1993 and Teugels 1986). In *C.garipinus* , exchange of respiratory gases i.e oxygen and carbohydrate takes place through the gills. Like other mudfish, it has accessory breathing carborescent organs which enable the fish not only live in stagnant pools but to travel over damp ground. *Clarias gariepinus* differs from other catfish in having an auxiliary breathing organs in this special pochet attached to the second and fourth gillarches and are responsible for the ability of *Clarias gariepinus* to live out of much longer than other catfish (Haylor, 1993.).

Earthworm

Earthworms also called night crawlers are very important animal that aerate the soil with their burning action and enrich the soil. Soil can have as many as 1000, 000 worms per acre. Earthworms are more than just fish bait. They are the main contributors to enriching and improving soil per plants, animals and even humans. Earthworms create tunnels in the soil by burning which aerates the soil to allow air water and nutrients to reach deep within the soil. Earthworms eat the soil which has organic matter such as decaying vegetation or leaves. Plants cannot use this organic matter directly. After organic matter digested the earthworm release waste from their bodies called casting. Earthworm has been found to be a good source of protein (Sogbesan and Ugumba 2008, Kostecka and Pax=czka 2006, Guererro 1983, Hilton 1983, Tacon *et al.*, 1983) and its usage as fish bait is well known in fishing (Omorinkoba, *et al.*, Segun, 1987). Earthworms with an important high protein component are used to feed pigs, rabbit and as dietary supplement for fish species (Mason *et al.,* 1992, Sabine 1986, Stafford and Tacon 1985, Akiyama *et al.,* 1984). The high reproductive rate and biomass production of earthworm species make it ideally suited to worm meal production.

Biology of Earthworm

Earthworms are classified in the kingdom Animalia, phylum Annelida or Annelids and class Citellata, Annelida in Latin meaning a little rings, scientific name *lumbricus terrestris.* The earthworm while primitive has well developed nervous circulation, digestive, excretory, muscular and reproduction system. The most noticeable external feature is the ringing or segmentation of the body which involves nearly all of the internal structure.

The first section of the earthworm consists of the mouth and the prostomium, a lobe which serves as a covering for the mouth and as a wedge to force open tracks in the soil into which the earthworm may brew. Small like structures called setae are located on segments. The worms lack of protruding structures other than setae facilitates efficient burrowing. In addition, various glands secrete a lubricating mucus which aids movement through the earth and helps to stabilize burrows and cast. Earthworms breathe through their skin. Have no lungs if the skin dries out, they cannot breath and will die. It has five pairs of ear. The rest of the inside of an earthworm is filled with intestines which digests its food. Mature worms have clitellum the enlarged segments in the middle of the earthworm the reproductive parts of worms. Terretris are hermaphrodites, it takes two worms to mate and reproduce. Earthworms are omnivorous and cell utilize many materials in the soil as food including plant remains and occasionally animal remains. Lumbricus can outstand considerable starvation and lumbricus terrestris at least a water loss of up to 70% of the body weight, some species can withstand total immersion in water for many weeks.

Benefits of Earthworm

Having established their efficiency in converting organic substances to composts, they are widely used in vermicomposting for waste management, production of soil amendment and other uses. The conversion of organic waste into vermicomposting started in the United State and United Kingdom in the 1980s (Guerrero, 2009). Whole or portions of earthworms are traditionally used as fish bait in the United State. Their commercial production or permaculture for fish bait was stated in the 1950. (Guerrero, 2009). Worms are excellent source of animal feed protein essential amino acids, fats, vitamins, and mineral for livestock's and fish chemical analysis of the body tissues of earthworm show the following composition, protein 60-70% fat, 7-10%, carbohydrates 8-20% and minerals 2-3%. It is recommended for processing into vermiheal, a dried and pulverized feed preparation. They can be used in removing soil pollutants through bioremediation. Heavy metals and other pollutants can be taken up by the earthworms and removed from the soil, a process called *vermireme diatom.*

They serve as pharmaceutical products for the treatment of human diseased. There are many reports that these worms and body extracts have been used for the treatment of numerous human disease in China and other Asian countries. Studies conducted by Ang-lopez (2006) revealed that earthworms are used as sulphuric medicine in Philippines. They also confirmed the anti-blood clothing action of a crude extract from marshed earthworms used by an indigenous group in western Asia to thin the blood in the elderlis bact. In 1986 an enzyme called lumbrocuse which dissolves blood cloths in the human blood streams was isolated by a Japanese scientist. The breathing has been up into use through the manufacture and commercialization of dietary products.

They can be processed into human food. They have been used as such by natives of Africa, Japan, China, New Guinea and New Zealand. In 1999, Guerrero and Martin reported that meat ball dishes prepared from pure earthworm and 50% earthworm meal and 50% pork were equally palatable as pure pork. A food supplement was developed from Africa, night crawler with the same anticoagulant properties as in imported products.

Disadvantages of Earthworm

The annelid worms are not wholly beneficial (Darwin, 1881) reported that they start under large stones, pavements and buildings where the soil underneath is moist. When their burrows collapse, these stones and structures tilt and sink.. Additionally, earthworm cast destroys the aesthetic in lawns and mossy landscape in Bonsai as well as deprive of sunlight the covered vegetation. Various agriculture problem have also been reported this justifies the promotion knowledge of vermis in the Philippines. They are also found damaging the roots of germinated seeds (Marqez, 2005). Belonging either to the genus pheretima or metaphor, these worms are considered non-native or invasive alien species (Joshi 2006).

They can degrade rice fields due to soil perforation. According to Hentein *et al.,* (1985). Soilo engineers are not always welcome and constructing dikes to contain the water. This effort is counteracted by the soil engineers which include the earthworms.

LITERATURE REVIEW

Fish perform all their bodily function in water because fishes are totally dependent upon water to breath, feed, from, excrete waste, maintain salt balance, to reproduce and withstand the physical and chemical qualities of water is critical to successful aquaculture to a great extent, water determines the success or failure of an aquaculture operation (Ladon, 2000). The average growth rate for aquaculture has been 8.9% per year since 1970 compared to only 1.2% per capture fisheries and 2.8% for terrestrial formed meal production over the same period. In 2002, the total contribution of aquaculture towards total world fish requirement was 29.9% (FAO, 2004). The reason for exceptional growth rate in aquaculture is mainky due to marine stock depletion.

In 2001, the fisheries scientists Reg Watson and Daniel Pauly expressed concerns in a letter to nature that China was ever reporting its catch from wild fisheries in 1990 (Watson, *et al.,*). Aquaculture is a known food production enterprise in Africa and has become established in a number of countries. However, in order to realize the full potential of aquaculture technologies that increase intensification of production making it accessible to the poor and majority of the Africa population through the use of cultural resource systems such as food plain, rivers and small water bodies and develop production and marketing strategies that allow farmers to respond better to changing consumer demand. Aquaculture will contribute effectively in meeting the high demand of protein in the diet of the average Nigeria (Anadu, *et al.,* 1993). Fish nutrition has always been a major aspect of research in aqua-feed operations. For fish culture project, the optimum dietary requirement at a reduced production cost is essential in order to achieve maximum profit. The major prerequisite for successful fish farming is the availability of suitable artificial feeds formulated from locally available cheep ingredients that will supply adequate nutritional requirement for fishes cultured (Lovell, 1980). One of such ingredient is fish meal, which has been used extensively as a valuable source of rice protein in aqua feed. This is because of it hither to unrivaled properties in terms of biological value digestible energy and excellent array of amino acid component when compared with other commercially available protein source

(Lovell, 1981; Eyo, 2003). However, its protein contrition by weight (50-75%) in aqua-feed formulation is slightly lower than those contributed by poultry feather meal (60-84%) and blood meal (80-86%) (Adikwu, 1991; NRC 1993, Eyo 2003), it is believed that fish diet represent the greatest single high cost item in fish farm operations (Olomola 1990, Falaye 1992, Mohauty and Dashim 1993, Olvera-Nora 1996) and contributing between 40-60% the recurrent cost. This increases the cost of producing and reduced the profit margin and high price tag for consumers. Additionally, fish meal is scarce and expensive (Eyo, 1985).

The major *clarias* species are the most preferred farmed fish species in africa because of the fast growth rate and higher acceptability of the consumer (Sogbesan, 2006). *Clarias gariepinus* is very popular to fish farmers for high market price, fast growth rate, good food conversion ratio, resistance to diseases infection and ability to withstand adverse paid conditions especially low oxygen content and high turbidity. The culture of *Clarias gariepinus* dry as seed for fish production is becoming increasingly essential as the fish is contributing to the food abundance and nutritional benefit to the family health, income generation and employment opportunities (Bamidele, 2007).

The qualitative nutritional requirement of fish provide relevant information and nutrient feeds of fish species in order to supply adequate amount of these nutrient in formulated diet for optimum fish performance (Falaye, 1992). With the exception of water and energy the dietary nutrient requirements of all aquaculture species can be considered under five different nutrient groups, protein, lipids, carbohydrates, vitamins and minerals. The science of aquaculture nutrition and feeding is concerned with the supply of these dietary nutrient to fish or shrimp either directly in the form of an exogenous artificial diet or indirectly through the increase production of natural live food organisms within the water body in which the fish or shrimp are cultured (FAO, 1987), feed alone has been estimated to account for between 40-70% the cost of intensive aquaculture operation (Pathmasothly, 1983, Olvera Nora, 1996).

Therefore reducing feed cost is a major challenge in aquacultutre nutrition protein is the most expensive ingredient in a balance fish ratio. This is because protein is an important component in the diet of man and prominent completion for essential raw materials for animal feed industries. Experimental studies showed that fingerlings of different species of *Clarias gariepinus* have different growth performance and different feed utilization efficiency under different culture system. It was observed that hybrids exhibits a high degree of cannibalism and a resulting high individual growth rate with a corresponding low production yield due to a high mortality rate (Vander, Waal 1978). The feeding of *Heteroclarias* fingerlings on earthworm is readily available free from mains of completion and had been accredited to its high quality protein with amino acid profile showing its biological value to be superior to soybean and groundnut cake.

Dietary protein is the only source of nitrogen for constructing amino acids and proteins in fish. The protein requirement of fish depends on the composition and ratio of amino acids. Fish are fed higher percentage of protein in their diets than land animals but they have lower energy daily requirement of 100g of body weight for maximum growth of channel catfish decreased significantly as size increase from 1.64kg for 3g fish to 0.45kg for 260g fish (Mangalik, 1986). Soybean meal is currently the major protein source for catfish feeds in the United States. The protein has a favourable amino acid profile for channel catfish (NRC, 1993) but substituting fish meal into soya beans meal-grain diets for catfish improves growth.

The growth rate in fishes is highly variable and depends upon a number of environmental factors such as temperature amino of dissolved oxygen ammonia, salinity photoperiod, degree of composition, quality of food taken, age and the state of Maturity of the fish, temperature is one of the most important environmental factors and along with other factors influences growth rate. Thus, optimum food consumption for maximum growth is temperature dependent. For example, level depends on temperature and by itself is also an important factors affecting growth rate of fishes. Possibly, the fish is deprived of extra aerobic energy required for growth and reproduction if dissolved oxygen falls in high concentration, well slow down the growth rate.

Energy is one of the most important parts of the diet and feeding standard for many animals are based on energy needs, feed intake for catfish may be more a function of how much feed they are allowed to have rather than energy concentration in the strictly regulated by dietary energy, balance of dietary energy is important when formulating catfish feed (Jantrarotai, 1994).

Moreover, if dietary energy content is too high, catfish may not eat as much as expected resulting in low intake of essentials nutrients. The absolute energy requirement for catfish are unknown, the estimates that are available have been made by measuring weight gain or protein gain of catfish feed diets known contents of energy (Hossain, *et al.*, 1998), Hentein, *et al.,*). Energy requirements for catfish, which have generally been expressed as a ratio of digestible energy (DE) to crude protein range from 31.0 t0 50.2kg^{-1}. Based on current knowledge, a DE/P ratio from 35.6 to 39.8kg^{-1} is adequate for used in commercial catfish feeds, increase the DE/P ratio of catfish diets above this range will increase fat deposition band reduce processed yield and in contrast if the energy value is too low the fish will grow slowly (Nematipour, *et al.*, 1992a).

2.0 MATERIALS AND METHOD

Aquarium and Treatment

Three circular aquarium ,for 30L capacity, 50cm x 30cm x 26cm were used for the trials under laboratory conditions, the aquariums were obtained from Gwagwalada market and transported to the biological science garden, University of Abuja. There were 3 treatments with different stocking densities designated A, B, and C, each aquaria were stocked with 15 catfish fingerlings respectively. The catfish stocked in each aquaria vary in size, ranging from 0-10cm and 10-20g to avoid cannibalism. No prophylactic treatment was given before acclimation. Fishes were acclimated for seven days in the biological science garden.

The initial weight, length, mean length and mean weight were recorded and the fishes were starved for 24hrs to empty their gut conten in preparation for the experiment. The aquariums were covered with mosquito net to prevent fingerlimgs from jumping out, intrusion of insects and other bodies (Lizards, geckos etc).

Formulation of Fish Feed

Large amount of fully grown earthworms *Lumbricus terrestis* were obtained during the rainy season when they range freely and brought into the laboratory. The earthworms were washed and cleaned using blotting paper. They were sacrificed by introducing them into boiling water squashed. Ingredients such as groundnut cake 20g, cornflower 20g, rice bran 20g, eggs 70g and brewer’s yeast 30g were added to the earthworms and mixed together, pap was used as a banding agent. The mixture was pelleted wet; the pellets were put in trays and sun dried. The fingerlings were fed 4% of their body weight twice daily, morning 8am and evening 6pm. Tank

A was fed Coppen fish feed, Tank B was fed experimental diet1 (Earthworm and fish meal 70%, 30% respectively and Tank C was fed experimental diet 2 (Earthworm and fish meal 50%, 50%). The fish weight was taken using a weighing balance OHAUS 2000 model. The fingerlings were weighed in one per each. The standard length of the fish was taken to the nearest cm with the aid of a measuring ruler.

Methodology for Proximate Analysis

Proximate analysis is a method for the quantitative analysis of the different macronutrients. It is also the portioning of compounds in a feed into categories based on their chemical properties. This categories includes lipid and nitrogen free extracts (digestible carbohydrates).

Moisture

This is essential for controlling moisture in powdered food aid sample to avoid contamination during storage.

Crude Lipids

This is applicable for the determination of crude fat in dried storages and mixed feeds.

Crude Protein

This is applicable to fish, fish products and fish by products. It is used to determine the protein level in food.

Ash

This consists of oxidizing all organic matter in a weighed sample of the material by incineration and determining is the weight of the products and other materials with low carbohydrate content.

Physiological Parameters

Some physiological parameters and environmental factors like temperature, dissolved, oxygen, hydrogen ion concentration, Ammonia and nitrate. Temperature was measured using the mercury in glass thermometer, dissolved oxygen was measured by collecting water sample from aquarium to determine the dissolved oxygen content using the water analysis kit Ph, Ammonia and nitrate was measured using the comb II strips.

Growth Parameters

1.Mean Weight Gain %. Calculated as

$$MWG = \frac{\text{Final mean weight}}{\text{Initial mean weight}} \times 100$$

2. Mean Length Gain %. Calculated as

$$MLG = \frac{\text{Final mean length}}{\text{Initial mean length}} \times 100$$

3. Specific Growth Rate. Calculated as

$$SGR = \frac{1NWT - LnWt}{T} \times 100$$

Where WT = Final Weight

Wt = Initial weight

T = Time interval (Solomon 2006)

Ln = Natural log

4. Food Conversion Efficiency. Calculated as

$$FCE = \frac{\text{Weight gain}}{\text{Feed intake}} \times 100$$

5. Mean Growth Rate. Computed using Standard Equation

$$MGR = \frac{W_2 - W_1}{0.5\,(W_1\,W_2)} \times \frac{100}{1} \times 1$$

Where W_1= initial weight

W_2= final weight

t = period of time

0.5 = constant

6. Survival rate (SR); This was calculated by the total amount of fish stocked and total amount of fish harvested in percentage.

$$SR = \frac{\text{total number of fish harvested}}{\text{Total number of fish stocked}} \times 100$$

(Akinwole *et al.*, 2006)

7. Length – weight relationship

$W = aL^b$……………… (1)

a. Log W= Log a + b Log L……… (2)

Where W = weight of the fish (g)

L = Standard length of Fish (cm)

a = Constant

b = an exponent.

LeCren (1951)

b. Condition Factor

$$K = \frac{W \times 100}{L} \text{ ………. } 3$$

Worthington and Richard (1930)

Where k = condition factors

W = weight (g)

L = standard length (cm).

3.0 RESULTS

TABLE 1: PRODUCTION PARAMETERS FOR TREATMENT (A)

Parameters	Initial week	Wk one	Wk two	Wk three	Wk four	Wk five	Wk six	Wk seven	Wk eight	Wk nine	Wk ten	Wk elev.	Wk twelve	Total
Gross total weight (g)	15.22	20.82	26.15	29.19	36.23	39.27	45.31	50.38	55.42	61.45	67.51	73.49	79.61	600.05
Mean weight (g)	1.01	1.38	1.74	1.94	2.41	2.61	3.02	3.32	3.69	4.09	4.5	4.89	5.3	39.9
Gross total length (cm)	28.9	31.48	37.21	42.31	49.37	54.43	59.49	65.51	70.56	76.61	81.42	87.41	92.55	777.25
Mean length (cm)	1.92	2.09	2.48	2.82	3.29	3.62	3.96	4.36	4.7	5.1	5.42	5.82	6.17	51.75
Weight gain (g)	0	0.37	0.36	0.2	0.47	0.2	0.41	0.3	0.37	0.4	0.41	0.39	0.41	4.29
Length gain (cm)	0	0.17	0.39	0.34	0.47	0.33	0.34	0.4	0.34	0.4	0.32	0.4	035	4.25
Gross specific growth rate (g)	0	1.94	0.7	0.22	0.33	0.1	0.14	0.09	0.07	0.07	0.05	0.04	0.04	3.79
Food conversion eff. %	0	9.25	0.09	0.05	11.75	0.05	10.25	7.5	9.25	10	10.25	9.75	10.25	88.44
Mean growth rate	0	0.28	0.057	0.063	0.019	0.019	0.011	0.007	0.006	0.005	0.003	0.003	0.002	0.471
Survival rate	100	100	100	100	100	100	100	100	100	100	100	100	90	1290
Total														2860.2

TABLE 2: PRODUCTION PARAMETERS FOR TREATMENT (B)

Parameters	Initial week	Wk one	Wk two	Wk three	Wk four	Wk five	Wk six	Wk seven	Wk eight	Wk nine	Wk ten	Wk elev.	Wk twelve	Total
Gross total weight (g)	17.57	21.22	29.61	30.42	36.51	41.38	58.57	63.61	69.68	59.43	55.38	62.42	70.89	616.69
Mean weight (g)	1.16	1.41	1.97	2.02	2.43	2.75	3.9	4,24	4.64	3.96	3.96	4.16	4.72	41.32
Gross total length (cm)	22.14	28.2	34.44	39.52	43.58	49.62	52.67	58.64	66.31	69.2	72.31	77.43	85.52	699.58
Mean length (cm)	1.47	1.88	2.29	2.63	2.9	3.3	3.51	3.9	4.42	4.64	4.82	5.16	5.7	46.62
Weight gain (g)	0	0.25	0.56	0.05	0.41	0.32	1.15	0.34	0.4	-0.68	-0.27	0.47	0.56	3.56
Length gain (cm)	0	0.41	0.41	0.34	0.27	0.04	0.21	0.39	0.52	0.22	0.18	0.34	0.54	4.23
Gross specific growth rate (g)	0	1.19	1.03	0.05	0.28	0.15	0.38	0.07	0.07	-0.11	-0.04	0.07	0.06	3.2
Food conversion eff. %	0	6.25	1.4	1.25	10.25	0.08	28.75	8.5	10	-17	-6.75	11.75	14	68.48
Mean growth rate	0	1.191	0.011	0.031	0.015	0.005	0.005	0.004	0.007	0.003	0.003	0.005	0.004	1.304
Survival rate	100	100	100	100	100	100	100	100	100	90	90	80	80	1240
Total														2724.98

TABLE 3: PRODUCTION PARAMETERS FOR TREATMENT (C)

Parameters	Initial week	Wk one	Wk two	Wk three	Wk four	Wk five	Wk six	Wk seven	Wk eight	Wk nine	Wk ten	Wk elev.	Wk twelve	Total
Gross total weight (g)	14.25	19.43	23.47	27.51	32.42	38.48	47.32	50.61	56.76	61.41	67.49	73.51	78.51	591.08
Mean weight (g)	0.95	1.29	1.56	1.83	2.16	2.56	3.15	3.37	3.76	4.09	4.49	4.9	5.23	39.34
Gross total length (cm)	24.58	29.61	34.68	39.34	43.41	48.54	53.31	59.21	65.11	74.12	78.16	85.21	90.11	725.39
Mean length (cm)	1.63	1.97	2.31	2.62	2.89	3.23	3.55	3.94	4.34	4.74	5.21	5.68	6	48.11
Weight gain (g)	0	0.34	0.27	0.27	0.34	0.4	0.59	0.22	0.39	0.33	0.4	0.41	0.33	4.29
Length gain (cm)	0	0.34	0.34	0.31	0.27	0.34	0.32	0.39	0.4	0.4	0.47	0.47	0.32	4.37
Gross specific growth rate (g)	0	1.92	0.58	0.32	0.25	0.21	0.21	0.05	0.08	0.05	0.06	0.51	0.36	4.6
Food conversion eff. %	0	4.25	10.25	10.25	15.25	14.25	10.5	17.25	12.75	15.25	14.75	15.25	14.5	154.5
Mean growth rate	0	0.053	0.012	0.059	0.039	0.028	0.023	0.005	0.007	0.004	0.004	0.003	0.002	0.239
Survival rate	100	100	100	100	100	100	90	90	90	80	80	80	75.5	1185.5
Total														2757.4

TABLE4: PHYSIOCHEMICAL PAARAMETERS FOR TREATMENT (A)

Parameters	Initial week	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
WATER TEMPERATURE	27	26	26	27	27	26	27	26	27	26	27	27
DISSOLVED O2	5.42	5.6	5.3	5.24	5.3	5.1	4.98	5.9	5	5.97	6	6
pH	8	7.3	7.9	8.1	8.3	8.6	8.2	7.7	7.6	7.8	8.3	8
AMMONIA mg(l)	0.02	0.26	0.36	0.42	0.43	0.49	0.54	0.55	0.55	0.56	0.54	0.57
NITRITE	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02

TABLE 5: PHYSIOCHEMICAL PARAMETERS FOR TREATMENT (B)

Parameters	Initial week	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11	Wk 12
WATER TEMPERATURE	27	26	26	27	27	27	27	26	26	26	26	26	26
DISSOLVED O2	5.94	6.8	6.11	6.22	6.9	6	5.81	6.29	6.25	5.67	5.43	6.31	6.25
pH	8.01	7.41	7.6	7.5	8	8.4	8.5	8	8	8.71	7.85	8	8
AMMONIA mg(l)	0.01	0.27	0.36	0.45	0.51	0.63	0.78	1.01	0.78	0.74	0.63	0.54	0.81
NITRITE	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04

TABLE 6: PHYSIOCHEMICAL PARAMETER FOR TREAMENT (C)

Parameters	Initial week	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
WATER TEMPERATURE	27	26	26	26	26	27	27	27	26	26	27	27
DISSOLVED O2	5.4	5.6	6.01	6.41	5.04	6	5.8	5.9	5.9	5.8	5.8	6
pH	8.2	7.6	7.5	8.4	8.3	8.1	7.8	7.1	8	8.4	8	7.9
AMMONIA mg(l)	0.01	0.25	0.34	0.41	0.54	0.62	0.74	0.8	0.8	0.9	0.94	8
NITRITE	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03

TABLE 7: LENGTH – WEIGHT RELATIONSHIP FOR TREATMENT (A)

Gross total weight	15.2	20.82	26.15	29.19	36.23	39.27	45.3	50.38	55.42	61.5	6
Log gross total weight	0	1.94	7.07	2.27	3.35	9.99	1.47	9.4	7.39	7.11	5
Gross total length	28.9	31.48	37.21	42.31	49.37	54.43	59.5	65.51	70.56	76.6	8
Log gross total length	0	5.31	5.19	2.65	2.39	1.27	9.19	8.54	5.75	5.67	3

TABLE 8: LENGTH – WEIGHT RELATIONSHIP FOR TREATMENT (B)

Gross total weight	**17.6**	**21.22**	**29.61**	**30.42**	**36.51**	**41.38**	**58.57**	**63.6**	**69.7**	**59.4**	**5**
Log gross total weight	**0**	**1.17**	**1.03**	**5.58**	**2.26**	**1.29**	**3.07**	**6.4**	**6.18**	**1.08**	**4**
Gross total length	**22.1**	**28.2**	**34.44**	**39.52**	**43.58**	**49.62**	**52.67**	**58.6**	**66.3**	**69.2**	**7**
Log gross total length	**0**	**1.5**	**6.2**	**2.84**	**1.21**	**1.34**	**5.28**	**9.51**	**9.53**	**2.94**	**2**

TABLE 9: LENGTH – WEIGHT RELATIONSHIP FOR TREATMENT (C)

Gross total weight	**14.25**	**19.43**	**23.47**	**27.5**	**32.42**	**38.48**	**42.3**	**50.6**	**56.7**	**61.41**	**6**
Log gross total weight	**0**	**1.92**	**5.86**	**3.28**	**2.54**	**2.12**	**2.13**	**5.98**	**8.77**	**5.54**	**5**
Gross total length	**24.58**	**29.61**	**34.68**	**39.3**	**43.41**	**48.54**	**53.3**	**59.2**	**65.1**	**74.12**	**7**
Log gross total length	**0**	**7.98**	**1.47**	**2.61**	**1.52**	**1.39**	**9.69**	**9.3**	**7.36**	**8.93**	**3**

TABLE 10: ANALYSIS OF LENGTH – WEIGHT RELATIONSHIP

Tanks	No of Weeks	A	b	r	K	Sign. O
A	12	3.4	4.3	0.212	0.022	+3.1
B	12	1.4	1.92	0.608	0.030	±2.09
C	12	2.6	1.63	0.364	0.026	±2.29

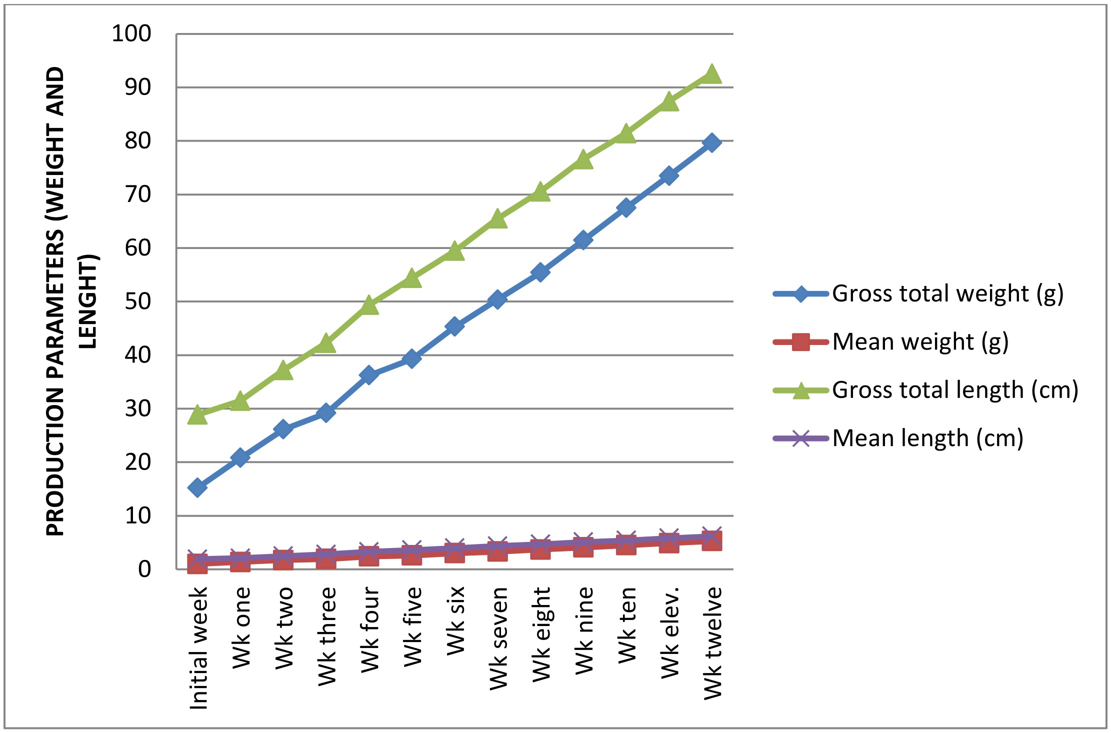

Fig 1: PRODUCTION PARAMETERS FOR TREATMENT (A)

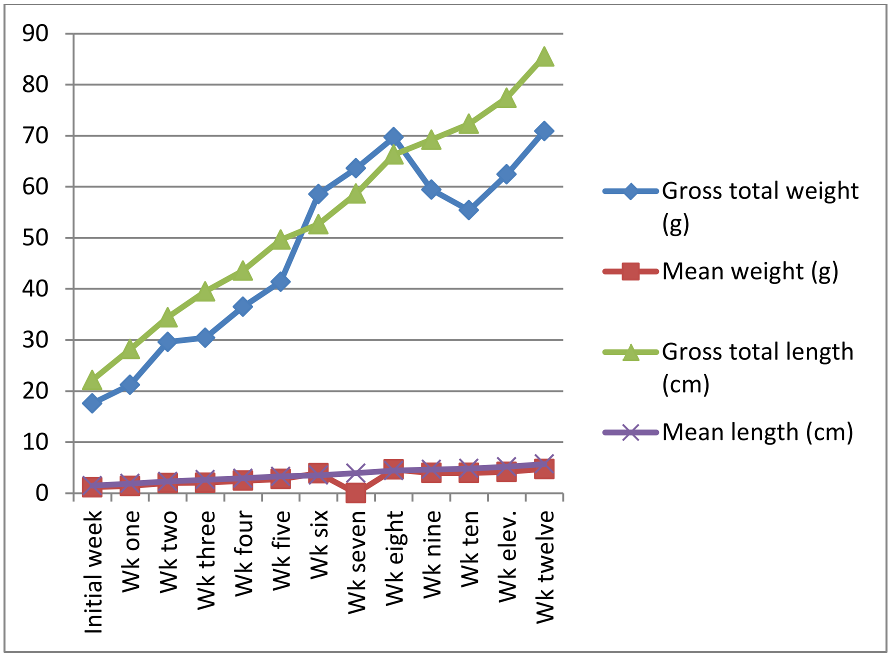

Fig 2: PRODUCTION PARAMETERS FOR TREATMENT (B)

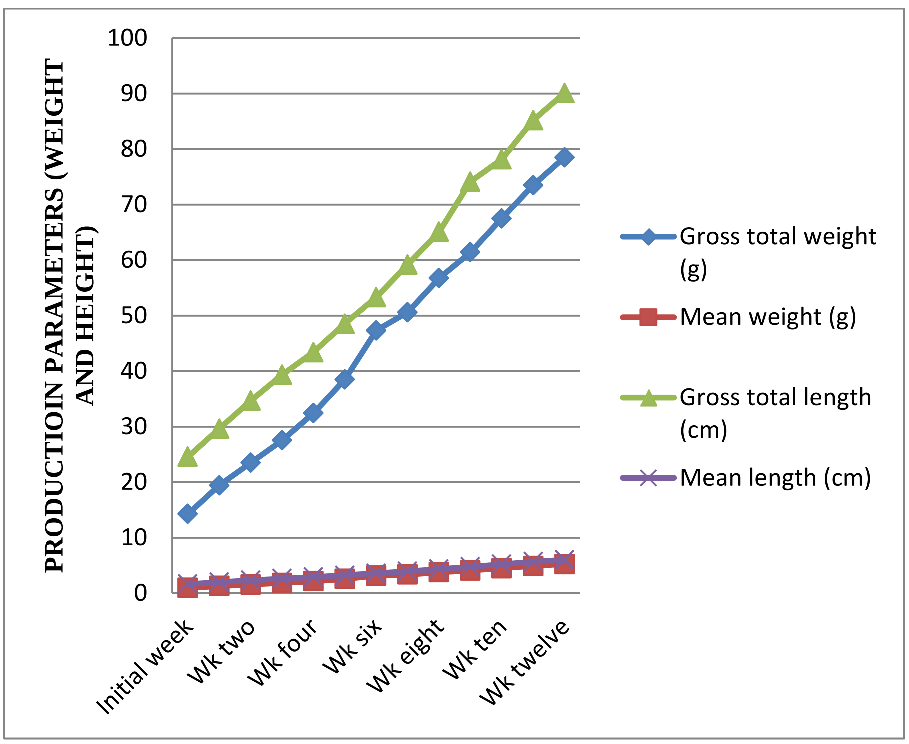

Fig 3: PRODUCTION PARAMETERS FOR TREATMENT (C)

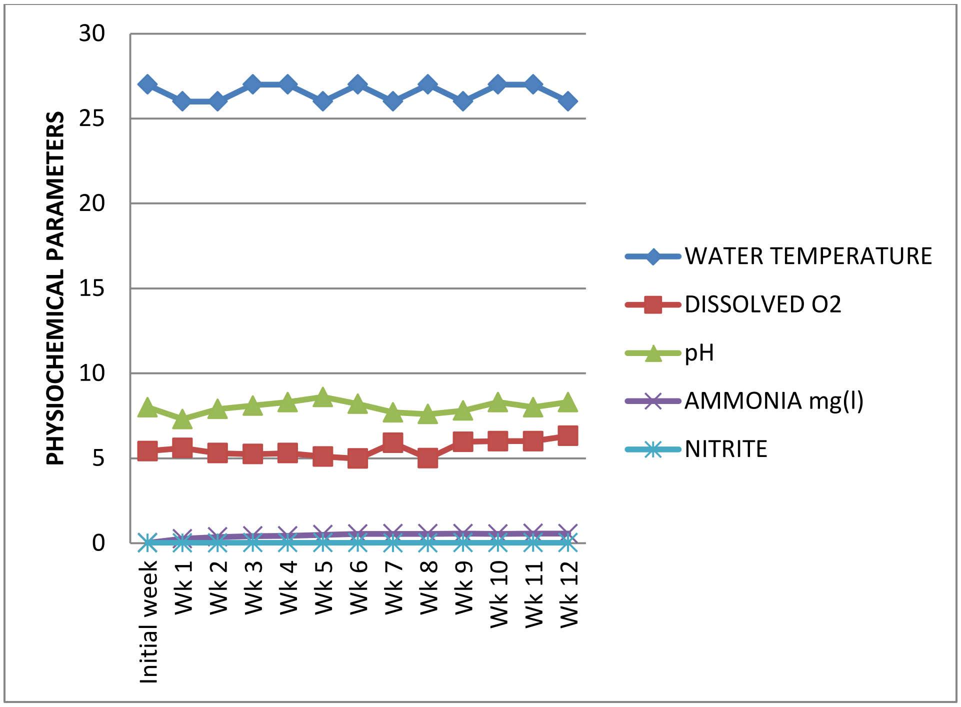

Fig 4: PHYSIOCHEMICAL PARAMETERS FOR TREATMENT (A)

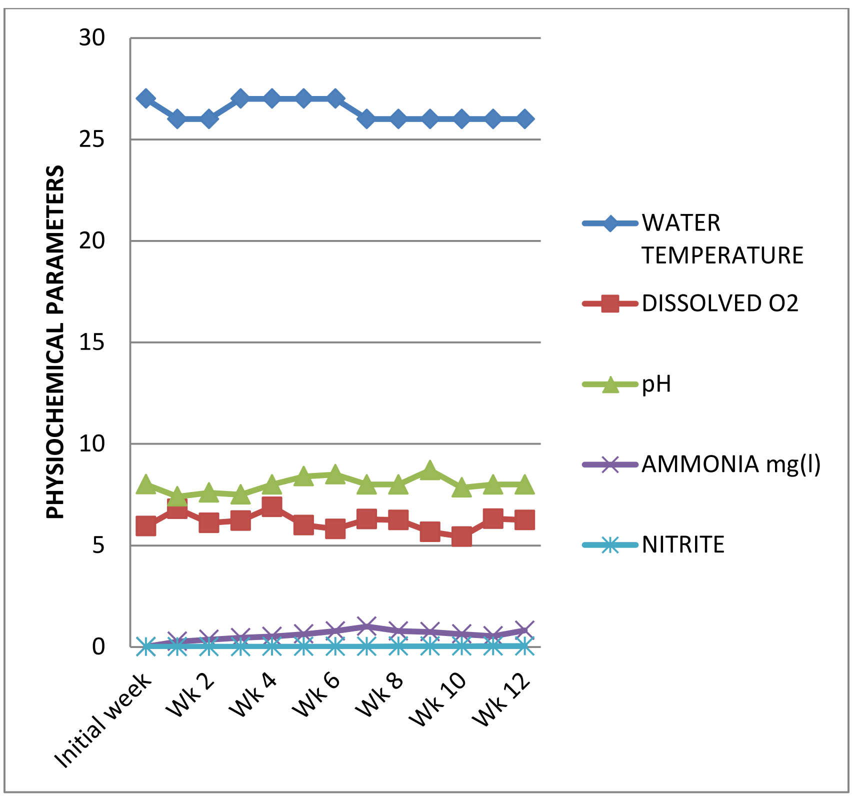

Fig 5: PHYSIOCHEMICAL PARAMETERS FOR TREATMENT (B)

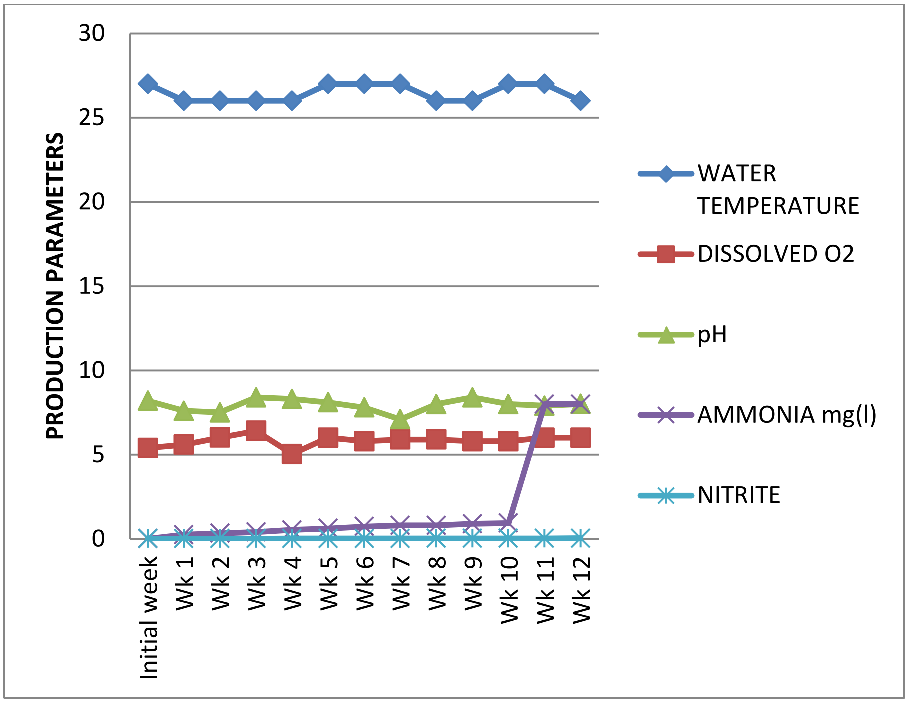

Fig6: PHYSIOCHEMICAL PARAMETERS FOR TREATMENT (C)

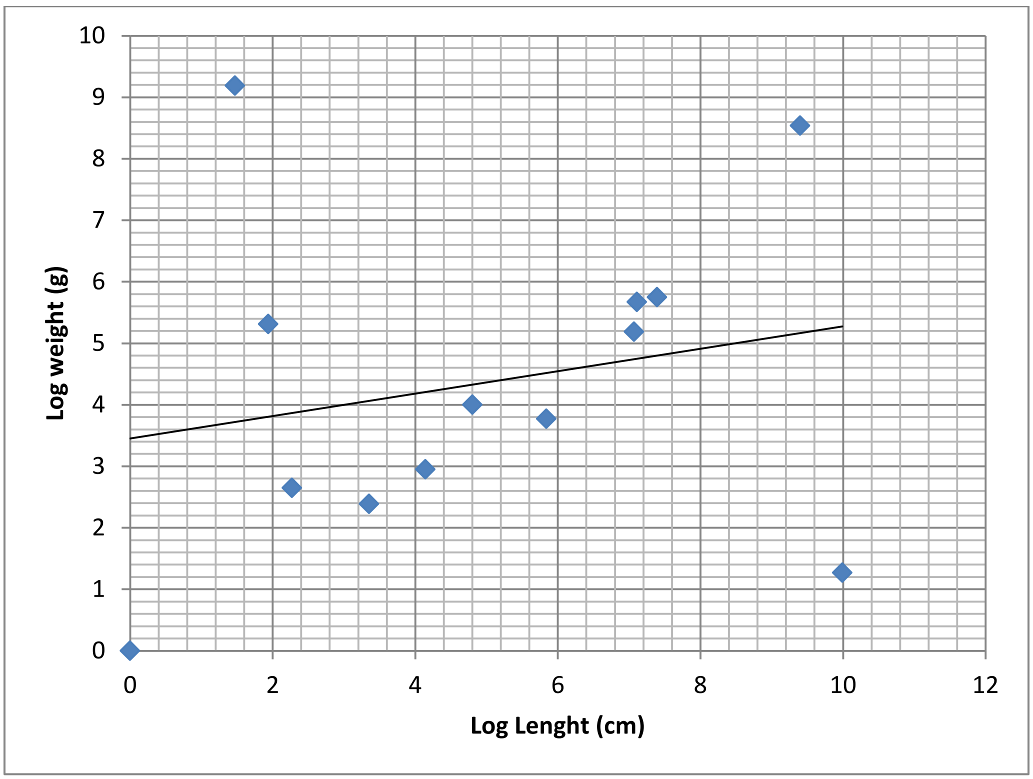

Fig 7: LENGTH – WEIGHT RELATIONSHIP FOR TANK (A)

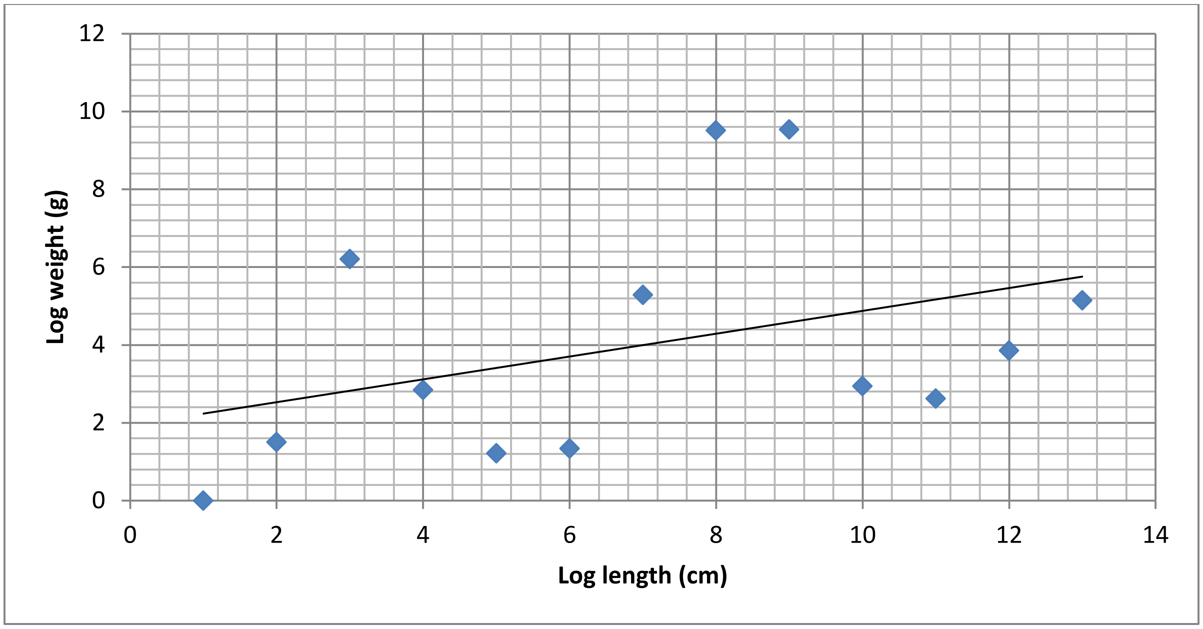

Fig. 8. LENGTH-WEIGHT RELATIONSHIP FOR TANK (B)

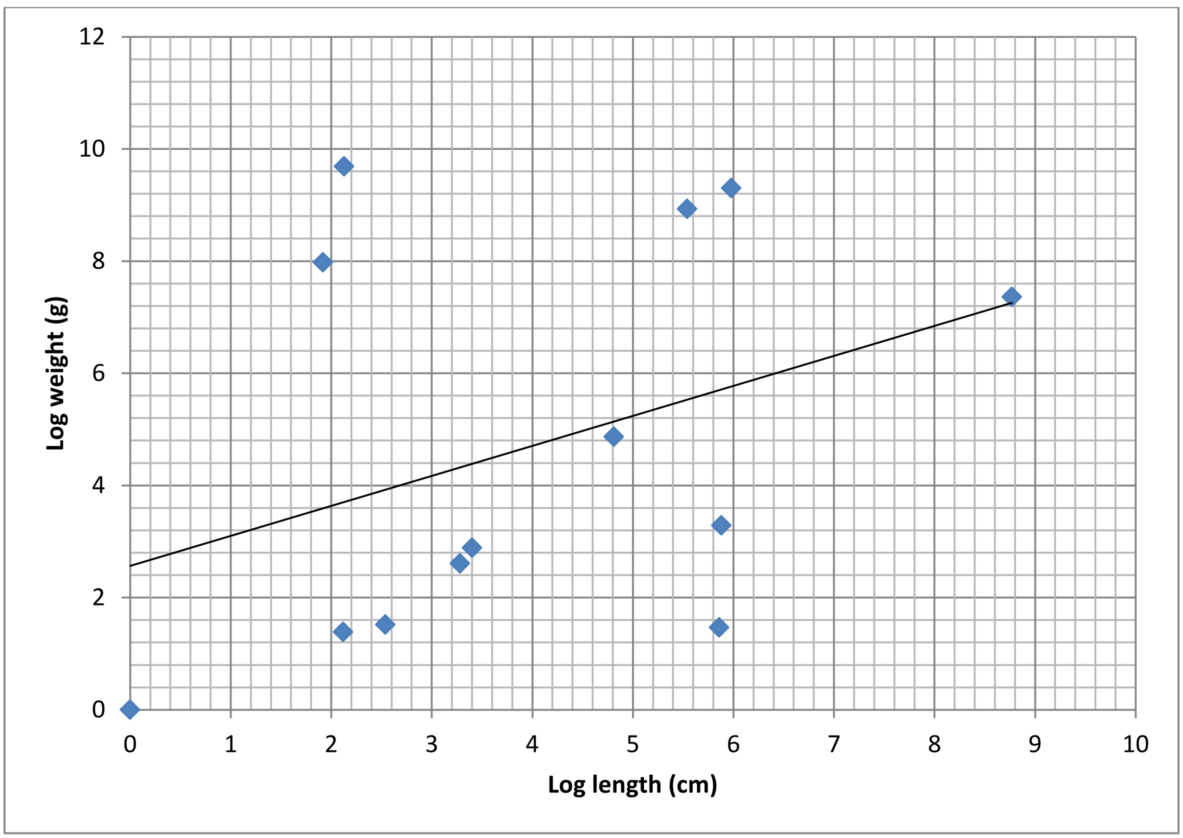

Fig 9:LENGTH-WEIGTH RELATIONSHIP FOR TANK (C)

4.0 DISCUSSION, CONCLUSION AND RECOMMENDATION

Physiochemical parameter such as atmospheric temperature, water temperature, pH, dissolved oxygen and biological oxygen (mg/l) were determined for abnormal concentration of any of these physiochemical parameters may have been the cause of the fish death. However, numeration and density stress are additional parameters for fish death thus high survival rate and cannibalism were observed in treatments with higher stocking densities.

The atmospheric and water temperature recorded during the study period ranged between 26% to 32^0 and 25^0 to 28% respectively, water and atmospheric temperature readings in all the treatment (A, B, and C) was within a permissible between range thus shows that the readings lose within a required or tolerable ranged for the culture of catfish. Swann *et al.,* (1990) recorded the normal range of temperature for culture of catfish, *Clarias gariepinus* and *Heteroclarias* were between $23^0 – 32^0$ c.

The pH (hydrogen ion concentration) record for the thus treatments ranged from between 67 and 73 have resulted to the different stocking densities, the results demonstrated that concentration of dissolved oxygen in all the three treatments were alkaline and within the permissible between ranges (6.0 – 9.0) for culture of catfish. High level can be influenced by the selection of some of the water qualities parameters (Akinwole and Fatiroti, 2006).

TEMPERATURE: The temperature readings in all the treatments were within the same range ($26\text{-}27^0$) this shows that the reading were within the tolerable range for the culture of catfishes as recommended by (Swarm *et al.,* 1990), the acceptable range of temperature for *Clarias gariepinus* is between $23\text{-}32^0$ c.

NITRITE: Over the period of production, the nitrite level did not reach significant that could affect the fish's health or growth. It was higher in treatment C (0.003mg/l) while lower in the remaining treatments. Nitrite levels greater than 0.06mg/l are considered toxic for the culture of catfish *Clarias gariepinus* as recommended by the Federal Ministry of Environment (2006).

AMMONIA : high concentration of Ammonia occurred towards the end of production period which could be attributed to increase in biomass. The concentration was within tolerable range (Eding *et al.,* 2001) which stated that the value less than 8.8mg/l are considered tolerable for the culture of catfish *Clarias gariepinus.*

Discussion

Carbohydrate either of cereal or tuber in fish feed acts as both structural and energy component which have some influence on the rate of growth of fish provided all other physiological requirement are satisfied. The growth pattern revealed that *Clarias gariepinus* performed best in diet C_{66}. In the present study, the best growth performance and nutrient utilization was recorded in fish fed 56% level of whole earthworm.

This implies that high inclusion levels of "whole earthworm" in the diet of catfish *Clarias gariepinus* enhanced growth rate.The difference in growth observed between the experimental diets are indication of the variation in the feed utilization. The acceptance by catfish *Clarias gariepinus* indicates that replacement of earthworm could be more better than any other fish meal. Mean while tank C has mean weight gain (0.33g), mean length gain (0.32cm) table 1, 2 and 3. The specific growth rate for the three tanks are: A (0.04), B (0.06) and C (0.36).

Percentage survival was higher in treatment A (90%), B (80%), and C (75%). The highest mortality was recorded in treatment C, this may be due to handling stress as most of it occurs after the weekly samplings and the reduced oxygen level towards the end of the production period.

The performance of growth in *Clarias gariepinus* was statistically analyze using the one way ANOVA. The analysis shows a significant difference p=0.170; p-value 999; df=129; f crit 1.94; appendix 4 treatment B no significany difference (df=129; f=128; p-value=1.000 crit= 1.94, p>0.5% Appendix 5) treatment C had no significant difference (df=129, f=148, p-value=1.000, f crit=1.94, p>0.05 Appendix 6)

Length-weight relationship

The length – weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group (Beyer, 1987).

The difference in weight for all sampled batches may be due to the individual condition factor. The maximum weight was recorded in tanks B 47.43g (slope) values were given all maximum values for b were recorded as 4.3, 1.92 and 1.63 respectively.

Thus when b is not equal to 3, algometric pattern of growth occur, which could be positive if > 3 or negative if < 3. The pattern, tank B negative algometric pattern and tank C negative algometric pattern also.

CONCLUSION

Based on the result obtained in this study, inclusion of whole earthworm meal in the diet of catfish *Clarias gariepinus* enhanced growth and survival of the fish, hence fish farms can therefore take advantage of this ingredient as a replacement for more expensive formulating feed for fish in aquaculture.

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APPENDIX 1

One Way ANOVA of Survival rate of three tanks

Hypothesis

H_0= there is relationship among the means

H_1= there is no relationship among the means

STATISTICAL ANALYSIS FOR TREATMENTS A DATA

VAR00003					
	Sum of squares	df	Mean Square	F	Sig.
Between Groups	2582.844	12	215.237	.170	.999
Within Groups	148552.538	117	1269.680		
Total	151135.382	129			

$F_{0.05, 12, 112=}$ **1.94**

Since F= 0.170 is not at least $F_{0.05, 12, 112=}$ **1.94** at 0.05 level of significance. H_0 is not rejected; hence we accept H_0 and assert that there is mean relationship among the observed parameters at a is 5% level of significance.

APPENDIX 2

One way ANOVA of Survival rate of three tanks

STATISTICAL ANALYSIS FOR TREATMENTS B DATA

One-way ANOVA

VAR00003					
	Sum of squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1814.330	12	151.194	.128	1.000
Within Groups	138018.775	117	1179.648		
Total	139833.105	129			

$F_{0.05,12,112}$=1.94

Since F= 0.128 is not at least $\boldsymbol{F_{0.05,\ 12,\ 117=}}$ **1.94** at 0.05 level of significance. H_0 is not rejected; hence we accept H_0 and assert that there is mean relationship among the observed parameters at a is 5% level of significance.

APPENDIX 3

One way ANOVA of Survival rate of three tanks

STATISTICAL ANALYSIS FOR TREATMENTS C DATA

One-way ANOVA

VAR00003					
	Sum of squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1971.061	12	164.255	.148	1.000
Within Groups	129590.386	117	1107.610		
Total	131561.447	129			

$F_{0.05,12,112}$=1.94

Since F= 0.148 is not at least $\boldsymbol{F_{0.05,\ 12,\ 117=}}$ **1.94** at 0.05 level of significance. H_0 is not rejected; hence we accept H_0 and assert that there is mean relationship among the observed parameters at a is 5% level of significance.

APPENDIX 4

Table Composition of Formulated Feeds: Earthworms percentage

Items	Weight (g)	**Percentage**
Fish Meal	**400g**	**28.6**
Earthworm	**400g**	**28.6**
Corn	**250g**	**28.6**
Rice bran	**200g**	**14.3**
Groundnut cake	**120g**	**8.6**

APPENDIX 5

Proximate Analysis of the Three Tanks

	A	**B**	**C**
Crude protein	**45**	**39.94**	**39.02**
Moisture	**8.3**	**8.05**	**5.35**
Crude fibre	**1.5**	**11.25**	**11.00**
Ash	**9.5**	**6.15**	**6.75**
Crude lipid	**12**	**12**	**10**