The Growth Rate And Survival Of *Clarias Gariepinus* Fingerlings In Tap, Borehole And Stream Waters

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ABSTRACT: *Clarias gariepinus* fingerlings with initial mean weights and total lengths of 0 - 20g and 0 - 15cm were stocked in six glass aquaria with a circumference of 48 x 30 x 24cm each. There were three treatments namely A (containing tap water) used as control, B (borehole water) and treatment C (stream water) were stocked with 12 *Clarias gariepinus* fingerlings in each aquarium and reared for 60 days. The aim is to calculate the growth and survival of *C. gariepinus* fingerlings. The physiological parameters monitored were within tolerable ranges e.g. temperature, pH, dissolved oxygen, conductivity, ammonia, and nitrite concentration. The mean total length and weight A (19.76cm), B (17.55cm) and for C (15.55cm) while their mean weights were 44.83g, 28.92g and 25.46g for A, B and C respectively. The mean total length and mean weight of *Clarias gariepinus* showed no significant difference ($p< 0.05$) Also there was no significant difference in the excluding the mean weight gain and survival rate which favored tap in relation to a higher growth and survival.
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1. INTRODUCTION

Nigeria is blessed with an estimated inland water mass of about 12.5million hectares capable of producing over 512,000 tons of fish annually (lta, 1980). Available statistic shows. However, that our inland water bodies are currently production less than 50% of their estimated fishing potential. The greatest obstacles to increased inland fish production is the haphazard methods of exploitation due to non enforcement of established inland fisheries laws and regulations in the country coupled with the inadequate stocking of small man – made reveries (lta, 1986)

Fish is an important component of total human food and to a lesser degree of animal feed it has been found nutritionally to be better than meat in terms of the quality of protein content with good amino acid profile. It has also been found rich in essential amino acids and minerals, and low in saturated fatty acids. Thus, the culture of fish has become an innovative technology aimed at producing large quantity of fish food the ever increasing human population in Nigeria.

One of the major constraints of aquaculture development is non availability of healthy and viable fingerlings which can be tended, nurtured, groomed and fed to marketable or table size (lndohiboyeobu and Ayinla, 1991).

Fish is responsible for about 55% of the protein intake sources of Nigerian populace. The national fish demand of at least 1.5 million metric tons annually is under – supplied to an extent that a demand – production gap of 1.0 million metric tones exist. Aquaculture which promises the most renewable and sustainable option in protein food source supplies 2% of the national demand currently. This is because aquaculture development in Nigeria has so far been constrained generally by inappropriate technologies on the production essentials of the three F_s namely feed, fish and filtration. These gaps have discouraged the needed investment in fish farm production from the private sector.

Aquaculture is important with regards to improving the diet of people, generating employment in rural areas, and saving foreign exchange through fish import substitution (Okoye, 1986).

Although fish pond culture activities in Nigeria is nearly 50 years old, the practice is still undertaken at subsistent level by private individuals, with very few at commercial levels and at the experimental or demonstration level by some government agencies. The availability of cheap, balanced, very affordable fish feed, and seeds of indigenous cultural species cannot be overemphasized in aquaculture. These are not yet enough for our aquaculture industries. Perhaps, the biggest challenge facing this industry is lake of trained personnel in virtually all specialized aspect of aquaculture.

It has been stated by Teugels (1986) that the natural habitat for *Clarias gariepinus* is fresh water bodies such as streams, lakes and rivers etc. such water sources are not readily available everywhere

for the production of *Clarias gariepinus* fish species on a commercial scale. this make the use of other available water source such as bore hole and tap waters optional. It is for this reason that this research is conducted to determine and compare the growth performance and survival of *Clarias gariepinus* in tap, bore hole and stream waters. This is aimed at knowing which of the water sources will give the greatest fish productivity and survival.

2.0 LITERATURE REVIEW

2.1 Geographical distribution

Clarias gariepinus or African sharp tooth catfish is a species of catfish of the family of *claridae*, the air breathing catfishes (Burchell, 1822). They are found throughout Africa and the Middle East where they inhabit fresh waters such as tropical swamps, lakes and rivers, some of which are liable to seasonal dryness. The African catfish has been moved all over the world in the early 80s for rearing purposes and is therefore found in countries far outside its natural habitat like Brazil, Vietnam, and India. In the Northern and central parts of Africa, it has been described as *clarias lazera*, in the western part as *clarias senegalesis*, in the Eastern part as *Clarias mossambicus*, and in the Southern part as *Clarias gariepinus* (Vivien et ai., 1986).

Clarias gariepinus which is generally considered to be one of the most important tropical catfish species for aquaculture, has an almost pan – African distribution, ranging from the Nile to the west Africa and from Algeria to southern Africa. They also occur in Asia Minor (isreal, Syria, and south of Turkey). By contrast, *Clarias gariepinus* has a more restricted distribution ands found in Mauritania, in most west African basins, and in the Nile. In general, *Clarias gariepinus* live in most river basins sympatrically with *Clarias anguilaris*. (Deggreet and janssen, 1996).Also, according to Bard et al., (1976), the genus *Clarias* is widespread in Africa and south east and it's utilization for fish culture purposes has significantly increase during the last few years.

2.2 THE BIOLOGY OF *CLARIAS GARIEPINUS*

Taxonomy

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterigii
Order	;	Siluriformes
Family	:	Claridae
Genus	:	*Clarias*
Species	:	*C. gariepinus*

The family *claridae* is divided into two genera – *Clarias* and *Heterobranchus* – each having three species. The former, has single rayed dorsal extending almost to the tail; the later has a long tong – based, rayed dorsal and an adipose dorsal fin (*Reed et al.,* 1967).

Although more than 100 different species of the genus Clarias have been described in Africa, a recent systematic revision based on morphological, anatomical, and biological studies has been carried out by Tengels (1982a,1982b,1984), who recognized 32 valid species. The large African species which are of interest for aquaculture belong to the subgenus *Clarias*.

In earlier systematic studies on the lager African catfish species, Bouleuger (1911) as well as David (1935) recognized five (5) species within the subgenus. Both authors used morphological criteria such as form of vomerine teeth, ratio of vomerine to premaxillary teeth band and the number of gill rakers. The five species are

Clarias anguillaris
Clarias senegalensis
Clarias mossambicus
Clarias lazera and
Clarias gariepinus

In 1982, Teugels revised the subgenus *clarias* and found only two species (*C.gariepinus and C. angularis*). If the number of gill arch was considered; for *C. anguillaris* relatively high to (20 to 100).

According to Holden and Reed (1972) species of *clarias* are not easily identified because they all look very similar. Each individual must be examined in same detail, and even for trained fisheries biologist. However, three species of *Clarias* have been described from west Africa - *Clarias anguilaris, Clarias submerginattus* and *Clarias lazera. Clarias anguillaris* ; D66 – 77,A52 HAS 12 (in juveniles) to 28 gill rakers on the lower arm of the first gill arch. *Clarias submaeginatus* , D82 -88, A66 – 72, has only 8 – 9 gill rakers. *Clarias lazera,* D62 – 82, A50 – 65, has 35 (in juveniles) to 135 gill rakers.

Reed et al., (1967) mentioned the three species as *C. lazera, C. anguilaris, and C. submerginatus. C. lazera* has the pelvic fins midway between the tips of the snout and the root of the caudal fin, or slightly near the snout and the root of the caudal fin, or slightly near the snout. The head is long and body is 3.0 to 3.5 times as long as the head. The colour varies considerably, but is usually blackish on the dorsal side, and white or slightly yellowish on the ventral side. The flanks are grayish olive. The fins are black, except for the ventrals and pectorals which are almost grey or transparent. *C. anguilaris* has the pelvic fins nearer to the tips of the snout than they are to the root of the caudal fin. The head is long and the body 3.1 to 3.8 times as long as the head. The colour is variable but is usually dark

grey on the sides, almost black on the dorsal side, and whitish on the small black spots in an irregular pattern but this is more marked in young and medium – sized specimens.

C. submarginatus can be easily separated from the other two species, by the 3 crescent shaped bands on the caudal fin, the outer two dark bands are separated by a lighter on the ventral side. The head is short and it's length can contain 4.4 to 4.8 time in the length of the body.

2.3 STRUCTURE

Clarias or mudfish as they are appropriately named have been long bodies with dorsally – flattened head enclosed by bone plates. They have large terminal mouth and four pairs of simple barbells (nasal, maxillary, outer mandibular). The barbells serve as tentacles. Close to the nasal barbells, two olfactory organs are located. Catfish recognizes it prey mainly by touch and small using its barbells. This is relevant during feeding at night and in highly turbid waters (Reed et al., 1967). The name catfish arise from the barbells found around the mouth for they resemble the whiskers of a cat. These barbels are the most noticeable feature of the family. The nostrils are far apart, the anterior one tabular and the posterior one equipped with a long tentacle. Both dorsal and anal fins are very long, almost reaching to the caudal fin which is a single rounded lobe. Each of the pectoral fins have a spine. The pelvic fins are midway between the tip of the snout and root of the caudal fin, or slightly nearer to the snout. The dorsal fins has 62 – 82 and the anal fins has 50 – 65 rays (Holden and Reed, 1972, and Reed et al., 1967). The vomerine teeth are all mostly granular, forming a band which is 1.3-2.5 times the width of the band teeth on the premaxillary. There are 31 (in juveniles) to 135 long and fine gill rakers on the whole of the of the first gill arch. It has accessory air-breathing organs on the head and can survive for many hours out of water provided the condition is moist. It is fond of 'walking' from water during the rains or when the condition in the water are bad. It can also jump (Marioghae, 1991). According to Reed et al., 1967, viveen et al., 1986, Degraaf and janssen, 1996, the body is covered with a smooth scale less, slimy skin. The skin is generally darkly pigmented on the dorsal and lateral part of the body. The colour is uniformly marbled and changes from grayish olive to blackish according to the substrate of its habitat and on exposure to light, the skin colour becomes lighter. During stress they show a mosaic-like pattern of light and dark spots. The colour varies considerably, but usually blackish on the back and white or slightly yellowish on the belly and the flanks are grayish olive. The fine are black except for the ventral and pectorals which are almost grey or transparent. The barbles are generally black. *Clarias gariepinus* grows the a maximum total length of 1m or more, and a weight of 7.0kg (marioghea, 1991)

2.4 SEXUAL DIMORPHISM IN CLARIAS GARIEPINUS

In most cases the sex of a fish cannot be determined from external characters and it becomes necessary to observe or examine the internal organs. In a few instances there are differences in the shapes of the anal fin of the males and females. In some families like the *claridae*, only the males usually have genital papilla (Reed et al., 1967.) color differences between males and female is sometime apparent, particularly during breeding activities. This is specially marked in cichlids. According to Vivien et al., (1986), in both sexes of *C. gariepinus* the primogenital opening Is situated at a papilla just behind the anus. The adult male can be distinguished from the female by the elongated backward projecting form of this papilla. In female the papilla takes the form of oval eminence. Ripe females may also add edges to their median fine (Degraaf and Janseen, 1996). Bruton (1979a) observed 540mm and 580mm for model size of breeding females and males respectively.

2.5 NATURAL FOOD AND FEEDING

Clarias gariepinus is a slow – moving omnivore predatory fish which feeds on a variety of food items from microscopic zooplanktons to fish half it's length or 10% of it own body weight. In order to feed on this wind variety of food organisms in different situations, *C. gariepinus* is equipped with a wide array of anatomical adaptations for feeding under low visibility (Bruton, 1979b) including:

A wide mouth capable of considerable vertical displacement for engulfing large pray or large volumes of water during filter feeding.

A broad band of recurved teeth on the jaws and pharyngeal teeth preventing prey from escaping.
An abundant network of sensory organs on the body, head, lips and circumpolar barbells. These barbells are extensively for prey detection and fixation.

Hecht and Applebaum (1988) found that *C gariepinus* with barbles are 27% more efficient at catching prey than those without. This indicates that tactile behavior is important in the prey – catching process.

A wide, rounded caudal fin, typical of fish which ambush their prey.

Long gill rakers on the five bronchial arches.

A short and dilatable esophagus which opens into a distinct muscular stomach (Mechanical digestion), and a simple thin – walled intestine. Slow searching is the normal predatory tactic of *C-gariepinus* grasping their prey by suction ; a negative suction pressures being created by a sudden increase

of the buccopharyngeal chamber *C gariepinus* has the ability to switch feeding from one type of prey to another. In lake sibaya (South Africa), catfish ignore (or cannot catch) fish prey during daylight and feeding mainly on invertebrates, which are abundant and relatively more easy to catch. By contrast at night, when fish prey become more vulnerable, they switch their feeding habits to fish preys (Bruton, 1979b)

2.6 NATUTAL REPRODUCTION.

Clarias gariepinus show a seasonal gonadal maturation which is usually associated with the rainy season. The maturation process of *C gariepinus* is influenced by annual change in water temperature and photo periodicity, and the final triggering of spawning is caused by a rise in the water level due to rainfall (Degraaf et al., 1995). Spawning usually take place at night in the shallow inundated areas of rivers, lakes and streams. Courtship is usually preceded by "highly aggressive" encounters between males. Courtship and mating take pleas in shallow water between isolated pairs of males and females. The mating posture, a form of amplexus (the male lie in a unshaped curve around the head of the females) is held for several seconds.

During courtship which can last several hours the females catfish lays her eggs in several batches, the partner fertilizes the egg at the same tome each batch of eggs by releasing a cloud of sperm on the eggs. Within some seconds, the females distributes the fertilized eggs over a wind are by wiping them with her tail. The eggs will finally adhere to the flood vegetation. After spawning the shoal of catfish migrate back into deeper water. There is on parental care of the eggs. After a few weeks, the African catfish will often have developed a new batch of eggs and is prepared to spawn again. A second spawning can be induced by rainfall or by inflow of water from an upstream source. In this way, several spawning can take place per year. Depending on water temperature, the eggs will hatch after 24- 36 hours. The so called yolk sac larvae hid underneath the vegetation. The development of eggs and larvae is rapid and the larvae are capable of swimming within 48 0 72 hours after fertilization. Probably, due to high mortality rates among the eggs and fingerlings in nature, fry and fingerling of catfish are difficult to find. Therefore, egg and fry raring in hatcheries remains the only available option for fish culturists.

2.7 WATER QUALTY PARAMETERS.

Water quality parameter includes all physical, chemical and biological factors that influence the beneficial use of water. In fish cultures, any characteristics of water that affects the growth, survival reproduction, production, or management of fish in any way is referred to as a water quality variable. For the achievement of optimum fish production the water quality of the medium is of great importance. It is not only necessary to ensure that a proper range of these environmental factors (biotic and biotic) is maintained, but also that they properly managed and regulated on a continuous basis so that they are within a desirable range for fish growth and survival (Omaha, 1991).

There are many water quality variables in fish pond culture. All other being equal, a pond with good water quality will produce more and wealthier fish than a pond quality. Water quality determines to great extent the success or failure of a fish cultural operation (piper et al., 1982). Water quality parameters which are of prime importance are mainly temperature, turbidity, oxygen, carbon di oxide, nitrogen, ammonia, pH, alkalinity, hardness, etc.

2.7.1 Temperature

This is considered as one of the most important factor in aquatic environment because it affects all metabolic, physiological, activities and life processes of different trophic level of pond ecosystem. In addition, it also affect the speed of chemical change in soil and water (Dhirendea,2002).water temperatures plays an important role in influencing the periodicity, occurrence and abundances of phytoplankton as it had a direct relationship with total plankton (Tripathi and Pandey, 1990). The optimum temperature range for "cold warm water" and "warm water" fishes are 14 – 18^{o} c and 24 – 30^{o}c respectively. The maintenance of this ranges of temperature is of great importance because the body temperatures of the fish varies with and almost the same as that of the environment (Onuha and Nwadukwe, 1987 ; Durpree and Huner, 1984). 5^{o} sudden change in temperature may stress or kill the fish

2.7.2 Turbidity

This term refers to the suspended solids particles, plank tonic organisms and humic substances produced through decomposition of organic matter. In aquaculture ponds, turbidity from plank tonic organism are often desirable to an extent where as that caused by suspended particles is undesirables (Mc combie, 1953). However, heavy blooms limit heat and light penetration, than reducing the productive zone. Optimum secchi-disc visibility of fish pond is considerably to be 30 - 40cm. in pond with secchi – disc visibility of 10 – 20cm dissolved oxygen concentration may fall so low at night that fish are stressed or even killed (Romaine and Boyd, 1978).

2.7.3 Dissolved Oxygen

Chakroff (1978) stated that fish like all animal need oxygen to survive. In the absences of deliberate poisoning, dissolved oxygen is the single most important water quality parameter in pond culture systems. Fish differ in their sensitivity to low oxygen between species, the various life stages (eggs, larvae and adults) and the different life processes such as feeding, growth and reproduction. It was observed that dissolved oxygen content of pond water in the range of 5mg/litre to saturation level favour fish culture (Ovie and Adeniji, 1990). The concentration of dissolved oxygen in natural water is influenced by the rates of diffusion to and from the atmosphere, photosynthesis by aquatic plants and respiration by aquatic biological community.

2.7.4 Carbon oxide

The primary sources of CO_2 in fish pond are derived from respiration by fish and the microscopic plants and animal that comprises the fish pond biota. The problem with the potential toxicity of CO_2 can be related to the daily fluctuating patterns of dissolved oxygen and CO_2 concentrations. CO_2 concentrations are highest when dissolved oxygen concentrations are lowest. Fresh water fish pond should contain a low concentrations of free CO_2 (<3mg/liter), although it can tolerated high concentrations of CO_2 (Boyd, 1978). Experiment has shown that 1.0mg/liter of hydrated lime can remove 1.68mg / liter of free CO_2 (Adhikari, 2006)

2.7.5 Ammonia

Fish are very sensitive to unionized ammonia and the optimum range is 0.02 – 0.05mg/litre in the pond water. When ammonia accumulated to toxic levels, fish cannot extract energy from feed efficiently. If the ammonia concentration get high enough, the fish will become lethargic and eventually fall into a coma and die However ammonia can have a so called "sub-lethal" effects such as reduced growth, poor feed conversion, and reduced disease resistance at concentration that at lower than lethal concentrations. Sources of ammonia in fish ponds include fish excretion, protein in feeds, and diffusion from sediments (Cole and Boyd, 1986).

2.7.6 Hydogen sulphide

Fish lose their equilibrium and subjected to sub lethal stress at concentration of 0.01mg / liter of hydrogen sulphide. Frequent exchange of water can prevent building up of hydrogen sulphide. Further increasing water pH through liming can also reduce the hydrogen sulphide toxicity.

2.7.7 pH

pH is the measure of hydrogen ion concentration in water (Chakroff, 1978). pH ranges from 0 – 14. A pH value between 0 and 7 is termed acidic, while pH values above 7 are termed basic. A pH value of 7.0 indicates neutral solution. pH has direct effect on fish growth and survival of food organisms. Hence to achieve good fish production pH of the water should be maintained at an optimum range of 6.7 to 8.6 (Ovie and Adeniji 1990). While Chakroff (1979) stated that fish grow best in pH 6.5 to 9.0. It also exerts considerable influence on toxicity of ammonia and hydrogen sulphide as well as solubility of nutrients and thereby water fertility. Charkroff (1978) also stated that fish are sensitive to acidic water and therefore will die if the pH of pond water falls below 4 for a very long period of time.

2.7.8 Alkalinity

This is the capacity of water to neutralize acids without an increase in pH. Total alkalinity is the sum of the carbonate and bicarbonates alkalinities. The carbonate buffering system is important to fish growth regardless of production method used. Without a buffering system, free carbon dioxide will form large amount of weak acid (carbonic acid) that may potentially decrease the night time pH level to 4.5 pond water with low alkalinity <20mg / liter $CaCO_3$ and >300mg / liter is unproductive. The ideal range of total alkalinity for fresh water fish pond is 50 – 300mg / liter as $CaCO_3$.

2.7.9 Conductivity

This refers to the total concentration of all dissolved ions in the natural water which is expressed in micro – ohms per centimeter.

Fish are very sensitive to sudden changes in conductivity. Fish living in water at one concentration of conductivity should not be suddenly placed in water with a much higher or lower conductivity. Small fish and fry of most species are more susceptible than adult fish to sudden change in conductivity.

2.8.0 Hardness

This is the measure of calcium and magnesium, but other such as aluminum, iron, manganese, strontium, zinc, and hydrogen ions are covered. Calcium and magnesium are essential in the biological processes of fish. Fish can absorb calcium, magnesium directly from the water or food. Hardness values of at least 30mg / liter should be maintained for optimum growth of gratis organisms. Charkroff (1978) stated that hardness should be between 50 and 300 ppm in the pond for best fish growth. Water that contains few salts is called "soft" water. Hardness is related to pH, but unlike pH, hardness stays constant throughout the day.

Table 1: Optimum water quality requirements for a fish pond.

S/No	Parameters	Optimum Level	S/No.	Parameter	Optimum
1.	Colour (colour unit)	Clear water < 100 colour unit	7.	Alkalinity (mg / I)	50 – 300
2.	Transparency (cm)	30 – 40	8.	Chloride (mg / I)	31 -50
3.	Clay turbidity (mg / I)	< 30	9.	Salinity (ppt	5 -10
4.	Solids (mg / I) (a) Total (b) Suspended	 < 500 30 - 200	10.	Dissolved oxygen (mg / I)	5 – 10
5.	Temperature (^{0}c) (a) Warm water (b) Cold water	 25 – 32 10 – 12	11.	Total dissolved co_2	<3
6.	pH	6.5 -8.5	12.	Ammonia nitrogen (mg/l) Ionized Unionized	 0 -0.1 0 -1.0
13..	Hardness(mg / I)	30 – 180			
14.	Nitrite nitrogen (mg/I)	0 – 0.5	20.	Nitrite nitrogen (mg/I)	0.1 – 3.0
15.	Total nitrogen (mg/l)	0.5-4.5	21.	Total phosphorus (mg/l)	0.05– 0.5
16.	Potassium (mg/l)	0.5-10	22.	Calcium (mg/l)	75 - 150
17.	Silica (mg/l)	4 – 16	23.	B.O.D. (mg/l)	<10
18.	C.O.D. (mg/l)	<25	24.	Iron (mg/l)	0.01–0.30
19.	Hydrogen sulphide (mg/l)	<0.002	25.	Residual chlorine (mg/l)	<0.003

Source: Pronob Das et al., (2011). Management of Water Quality in Fish Ponds.

2.8.1 STREAM, BOREHOLE, AND TAP WATERS

'Soft' or 'hard' water relates to the percentage of dissolved minerals in the water. Rain water is naturally soft and contains very little dissolved matter. But as it seeps through the ground, it picks up various minerals from the soil and rock as it pass through. Hard water is often found associated with chalk and limestone areas. Soft waters are associated to impermeable rocks such as granite. In general, surface waters such as streams are often softer than ground waters such as borehole as there has been less contact with the minerals present in the earth (Zagorodni, 2006).

The higher concentration of various metals present in borehole water (e.g. Iron, Cadmium, Zinc, Aluminum, and Boron) also accounts for its hardness, and usually causes increased pH. Soft waters like tap exhibit stronger tendency towards instability than hard waters (*Excell et al.,* 1988). This means that all aquaria becomes more acidic over time due to nitrification, respiration, and photosynthesis. But in soft water aquaria, this trend can be very rapid. Since few fishes tolerate rapid change in pH, frequent pH tests becomes necessary. The carbonates and bicarbonates present in hard waters balances the drop in pH. But soft waters lack these minerals and thus are liable to rapid pH changes which fish don't like because it cause them to adjust body chemistry of their blood to prevent physiological problems and stress conditions.

Fish live in intimate contact with its environment which is the source of both water and ions (Adey and Loveland, 1991). The main site of intimate contact is the gills. Underneath the gill are chloride cells which are sensitive to a stress hormone called "cortisol". The response to stress is not aimed at the cardiovascular system, but the hydromineral balance and energy metabolism. This can lead to reduced growth and lower immune system.

3.0 MATERIALS AND METHOD

An eight week long experiment to study the survival and growth rate of *clarias gariepinus* under different medium namely tap, borehole, and stream waters. This was conducted in the biotechnology unit of the department of biological sciences located in the southwest corner of the mini campus, University of Abuja, FCT.

3.1 **AQUARIA AND TREATMENTS**

Thirty six mixed sexes of *clarias gariepinus* fingerlings of eight weeks old, were obtained and transported from a fish farm in a container with oxygenated water at 5pm – 6pm to avoid mortality due to high stress. The fingerlings were acclimatize for seven days while being fed with 3mm Coppens fish fed a 4% net body weight with an average weight and length of 10 + 2g. Water levels maintained at 35cm (25 liters), and twelve fingerlings were stocked in each tanks labeled as follows A (tap), B(borehole) and C (stream water) respectively. Treatment A is labeled as the treatment control. Stream water was sieved through a mesh net to remove sediments and suspended particles present in it. Mosquito nets were used to prevent fingerlings from jumping out, intrusion of insects and other foreign bodies e.g. lizards, geckos, etc. Water samples are renewed at

two days intervals. Where the tanks are cleaned by scrubbing, siphoning accumulated food particles, and disinfecting using 3ml/L potassium permanganate afterwards they are rinsed with clean water.

3.2 FEEDING AND MEASUREMENT

The treatments, were fed with 3mm Coppens fish feed at 4% body weight daily twice daily between 6 to 8 am and 4 to 6pm.

Table 2: Analytical components of Coppens fish feed

Major components	% composition
Crude protein	45
Crude fat	12
Crude fiber	1.5
Ash	9.5
Phosphorus	1.2
Calcium	1.7
Sodium	0.4
Trace elements	**Amount (mg/kg)**
Iron	75.0
Iodine	5.0
Cobalt	1.0
Copper	5.0
Manganese	20.0
Zinc	80.0
Selenium	1.3
Additives	**Amount**
Vitamin A	10,000 IU/kg
Vitamin D_3	2,000 IU/kg
Vitamin E	200 mg/kg
Vitamin C	150 mg/kg

Mortality is daily monitored, while growth rates are calculated weekly by measuring their weight and length . Using an automated top loading balance (model : Ohaus precision plus), and a plastic ruler stretched between the snout and tail of the fish.

3.3 PHYSIOCHEMICAL PARAMETERS

The physiochemical parameters were monitored daily for the first week of the experiment to determine the maximum duration at which water quality reached its lethal level includes water and air temperature. An interval of two days was found to be appropriate for water renewal.

Equipments used were laboratory glass thermometer; a pH meter (PHS-3C), conductivity using conductivity meter; dissolved oxygen using an oxygen meter, ammonia and nitrite using the urinalysis test strip kit.

3.4 FOOD UTILIZATION PARAMETER

3.4.1 Specific growth rate (SGR)

This was calculated from using body weight over a given period of time intervals according to the method of Brown (1957).

$$SGR(\%) = \frac{\log W_2 - \log W_1 \times 100}{T-t}$$

Where W1 = initial weight (in grams) at time t, W2 = final weight (in grams) at time T, T = final time (in days), t = initial time (in days).

3.4.2 Mean growth rate (MGR)

This was computed using the standard equation;

$$MGR = \frac{W2 - W1 \times 100}{0.5\,(W1 - W2)} \quad \frac{}{t}$$

Where, W1 = initial weight (in grams), W2 = final weight (in grams), t = period of experiment (in days)

3.4.3 Food conversion efficiency (FCE).

This was computed using the equation;

$$FCE\ (\%) = \frac{\text{Weight gain}}{\text{Food in take}} \times 100$$

3.4.4 Percentage weight gain

This is expressed by the equation;

$$\% WG = \frac{W_t - W_o}{W_o} \times 100$$

Where W_t = Weight at time t, W_o = Initial weight.

3.4.5 Weight gain

This was calculated as the difference between the initial and final mean weight values.

3.4.6 Survival rate

This was calculated as the total number of fish harvested divided by total number of fish stocked at the initial time. Survival rate is expressed in percentage.

$$S.R.(\%) = \frac{\text{Total fish number harvested} \times 100}{\text{Total fish number stocked}}$$

3.4.7 STATICTICAL ANALYSIS

Analysis of growth data using a one way analysis of variance (ANOVA).

4.0 RESULTS.

Table 3: Production Parameters for Treatment A (Tap water).

Production Parameters	WEEKS								
	0	1	2	3	4	5	6	7	8
Gross weight (g)	145.13	164.75	195.36	241.36	294.28	338.16	395.22	457.56	537.96
Mean weight (g)	12.09	13.73	16.28	20.11	24.52	28.18	32.94	38.13	44.83
Weight gain (g)	0.00	1.64	2.55	3.83	4.41	3.66	4.76	5.19	6.70
Total length (cm)	143.40	148.60	159.40	169.60	187.10	193.36	207.30	219.00	237.12
Mean length (cm)	11.95	12.38	13.28	14.13	15.59	16.11	17.28	18.25	19.76
Length gain (cm)	0.00	0.43	0.90	0.85	1.46	0.52	1.17	0.97	1.51
Specific growth rate (%)	0.00	0.789	0.528	0.437	0.08	0.173	0.161	o.130	0.126
Mean growth rate (%)	0.00	0.282	0.304	0.314	0.300	0.270	0.249	0.231	0.216
Food conversion eff./ (%)	0.00	28.25	38.70	49.01	45.68	31.09	35.19	32.83	36.61
Survival rate (%)	100	100	100	100	100	100	100	100	100

Table 4: Production Parameters for Treatment B (Borehole water).

Production Parameters	WEEKS								
	0	1	2	3	4	5	6	7	8
Gross weight (g)	130.36	126.88	146.50	153.77	192.31	225.0	224.91	215.84	231.36
Mean weight (g)	10.80	11.54	13.32	15.38	19.23	22.50	24.99	26.98	28.92
Weight gain (g)	0.00	0.74	1.78	2.06	3.85	3.27	2.49	1.99	1.94
Total length (cm)	131.75	130.21	138.90	131.80	141.40	149.80	142.29	133.44	140.40
Mean length (cm)	10.90	11.84	12.63	13.18	14.14	14.98	15.81	16.68	17.55
Length gain (cm)	0.00	0.94	0.79	0.55	0.96	0.84	0.83	1.50	0.87
Specific growth rate (%)	0.00	0.411	0.445	0.297	0.347	0.195	0.109	0.068	0.030
Mean growth rate (%)	0.00	0.170	0.250	0.263	0.290	0.275	0.250	0.227	0.207
Food conversion eff.	0.00	14.19	35.07	35.15	62.59	42.51	27.67	22.12	22.47
Survival rate (%)	100	91.67	91.67	83.33	83.33	83.33	75.0	66.67	66.67

Table 5: Production Parameters for Treatment C (Stream water).

Production Parameters	WEEKS								
	0	1	2	3	4	5	6	7	8
Gross weight (g)	129.98	141.05	141.05	178.02	211.31	241.32	244.76	237.60	254.60
Mean weight (g)	10.83	11.75	12.37	14.84	17.61	20.11	22.26	23.76	25.46
Weight gain (g)	0.00	0.92	0.62	2.47	2.77	2.50	2.15	1.50	1.70
Total length (cm)	129.96	140.90	146.50	159.50	163.40	167.76	158.29	148.80	155.50
Mean length (cm)	10.87	11.74	12.21	13.29	13.62	13.98	14.39	14.88	15.55
Length gain (cm)	0.00	0.87	0.47	1.08	0.33	0.36	0.41	0.49	0.67
Specific growth rate (%)	0.00	0.505	0.160	0.377	0.266	0.165	0.105	0.058	0.054
Mean growth rate (%)	0.00	0.207	0.164	0.238	0.254	0.2.44	0.226	0.205	0.190
Food conversion eff.	0.00	17.70	11.00	41.60	38.90	29.58	22.27	15.32	17.89
Survival rate (%)	100	100	100	100	100	100	91.67	83.33	83.33

Table 6: Physiochemical Parameters for Treatment A (Tap water) (Weekly Mean Values)

Physiochemical Parameter	**WEEKS**							
	1	2	3	4	5	6	7	8
Atmospheric temperature (°C)	27.6	27.9	28.5	29.2	28.5	27.8	26.6	27.5
Water temperature (°C)	24.9	25.3	26.1	26.4	25.3	24.7	23.8	24.1
pH	7.3	7.9	7.8	8.1	8.3	8.5	8.6	8.4
Dissolved Oxygen (mg/l)	6.80	6.12	5.31	5.05	4.81	4.56	4.06	3.89
Conductivity (micro/ohms/cm)	23.0	26.7	21.8	25.7	23.0	25.9	23.8	26.1
Ammonia (mg/l)	0.01	0.43	0.55	0.68	1.03	1.42	1.83	2.11
Nitrite (mg/l)	0.001	0.02	0.02	0.03	0.04	0.04	0.05	0.06

Table 7: Physiochemical Parameters for Treatment B (Borehole water) (Weekly Mean Values)

Physiochemical Parameter	**WEEKS**							
	1	2	3	4	5	6	7	8
Atmospheric temperature (°C)	27.6	27.9	28.5	29.2	28.5	27.8	26.6	27.5
Water temperature (°C)	24.9	25.2	26.2	26.4	25.3	24.6	23.8	24.1
pH	7.4	7.8	7.8	7.9	8.1	8.3	8.5	8.4
Dissolved Oxygen (mg/l)	6.52	6.19	6.03	5.81	4.96	4.47	4.19	3.98
Conductivity (micro ohms/cm)	19.3	25.5	28.0	29.5	28.1	27.4	28.2	29.8
Ammonia (mg/l)	0.01	0.39	0.44	0.58	0.74	0.82	0.90	1.41
Nitrite (mg/l)	0.001	0.01	0.02	0.02	0.03	0.04	0.05	0.05

Table 8: Physiochemical Parameters for Treatment C (Stream water) (Weekly Mean Values)

Physiochemical Parameter	**WEEKS**							
	1	2	3	4	5	6	7	8
Atmospheric temperature (°C)	27.6	27.9	28.5	29.2	28.5	27.8	26.6	27.5
Water temperature (°C)	24.8	25.4	26.3	26.6	25.7	26.4	24.0	24.3
pH	7.4	7.6	7.8	8.1	8.3	8.4	8.7	8.6
Dissolved Oxygen (mg/l)	6.83	6.62	6.40	6.15	5.86	5.57	5.28	4.95
Conductivity (micro olms/cm)	23.5	27.0	25.6	26.0	24.2	28.0	24.7	28.2
Ammonia (mg/l)	0.01	0.25	0.31	0.36	0.40	0.49	0.55	1.58
Nitrite (mg/l)	0.001	0.01	0.01	0.02	0.02	0.03	0.04	0.05

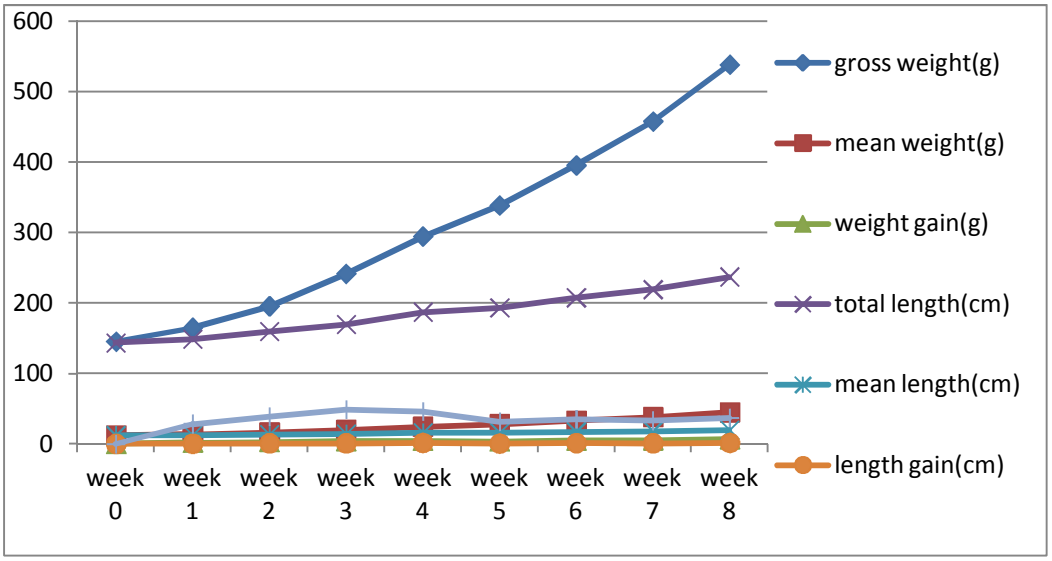

Figure 1: Production parameters for treatment A (Tap water).

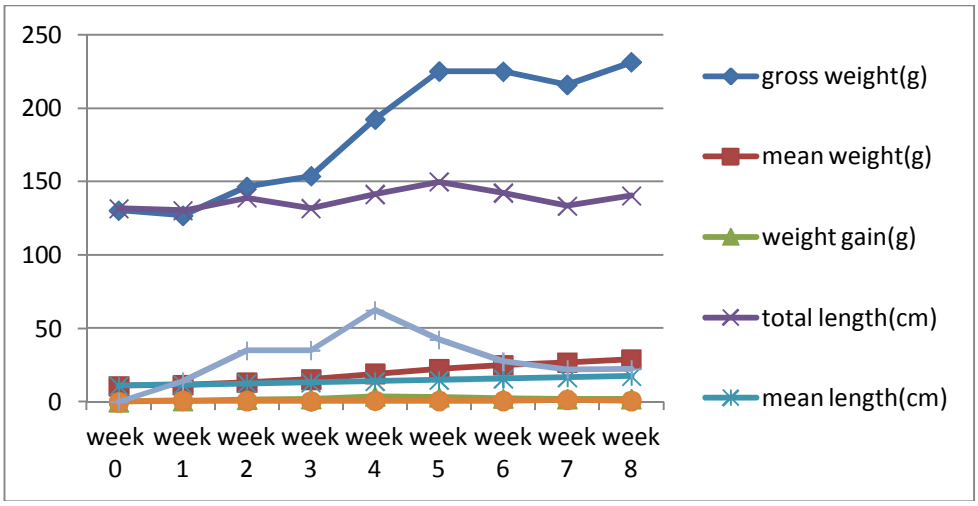

Figure 2: Production parameters for treatment B (Borehole water)

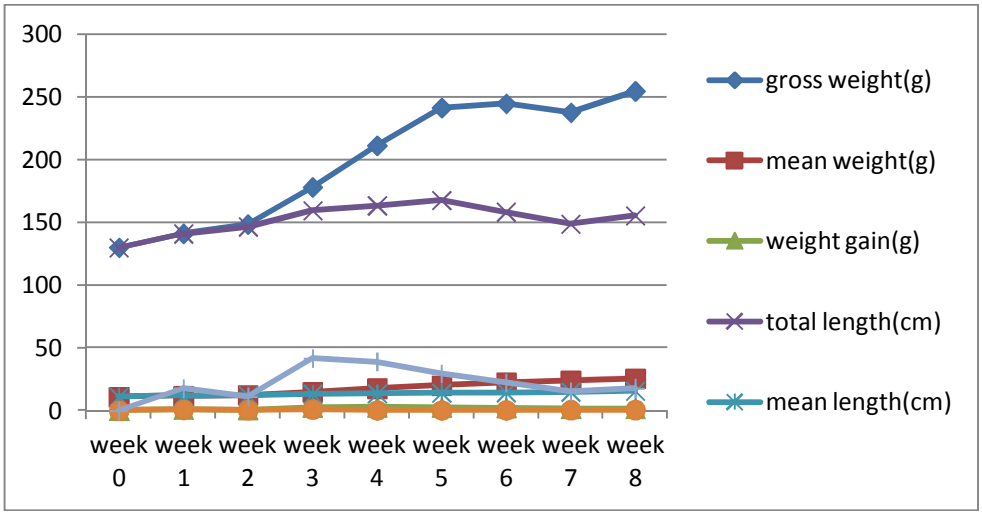

Figure 3: Production parameters for treatment C (Stream water)

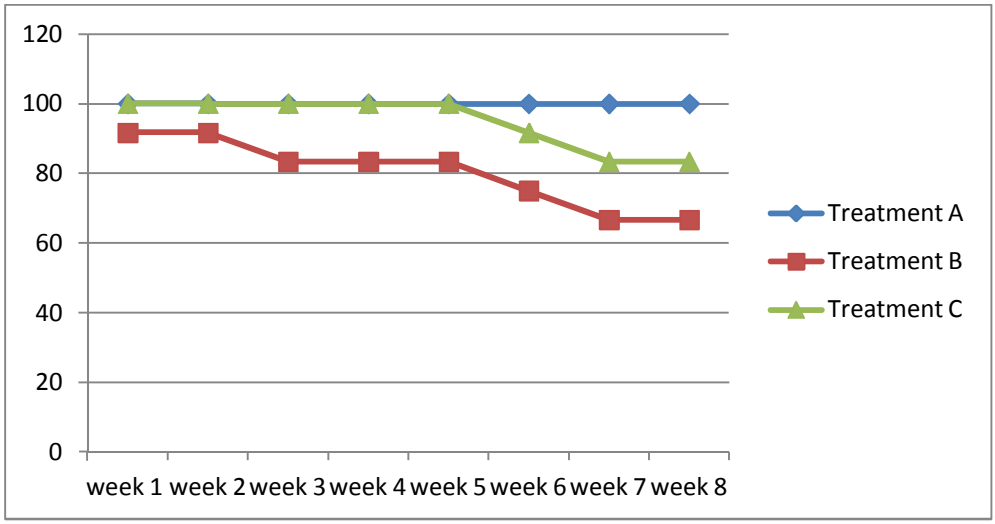

Figure 4: Survival rates (%) for treatments A,B and C.

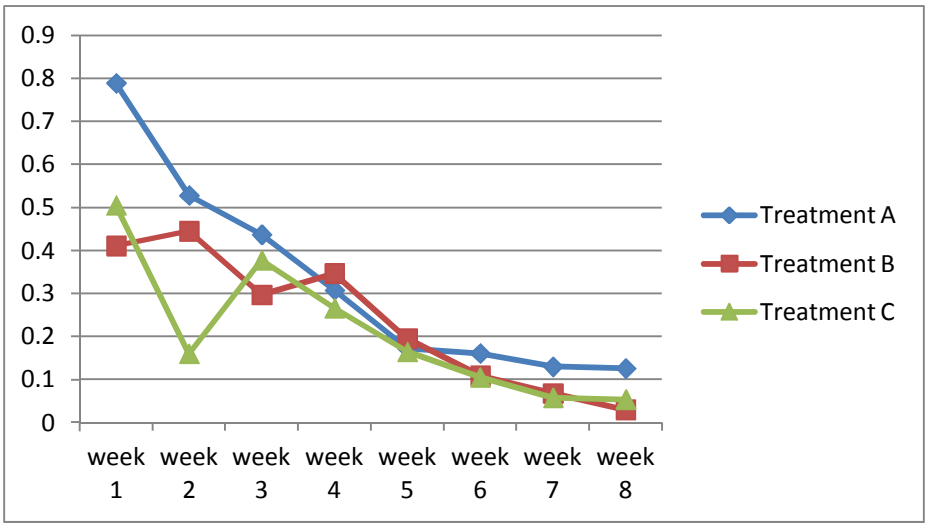

Figure 5: Specific growth rates (%) for treatments A, B and C.

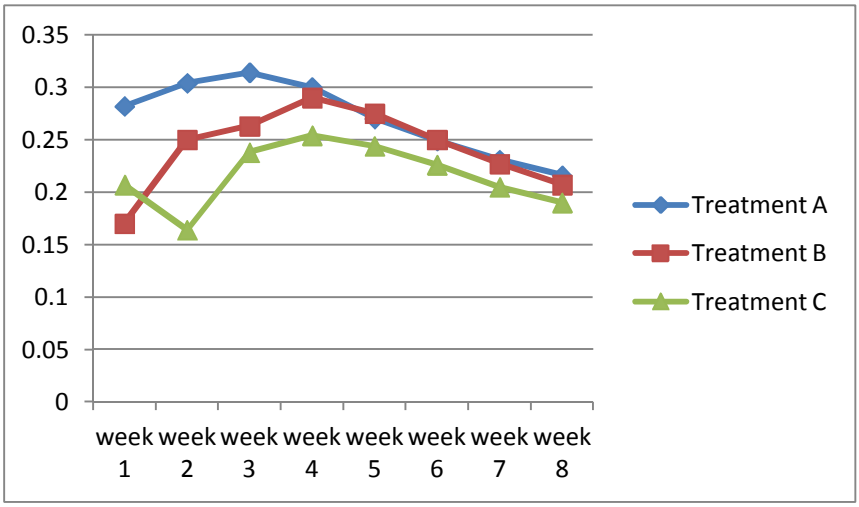

Figure 6: Mean growth rate for treatments A, B and C.

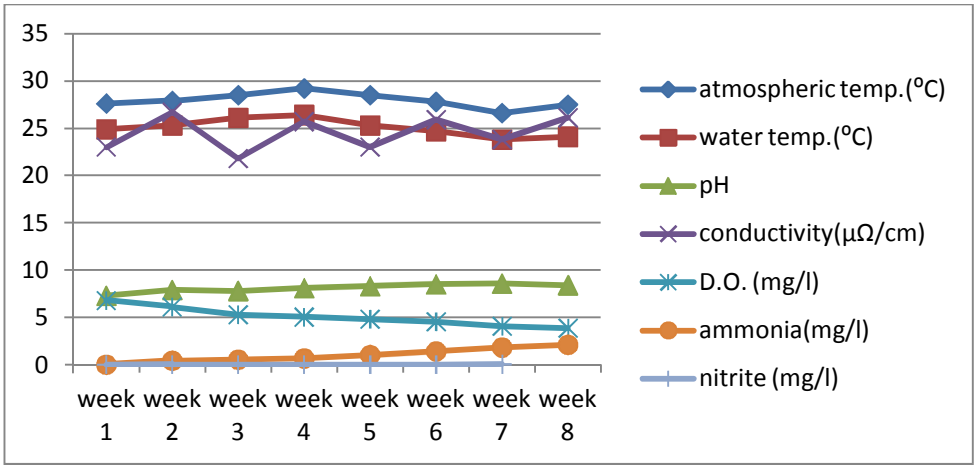

Figure 7: Physiochemical parameters for treatment A (Tap water).

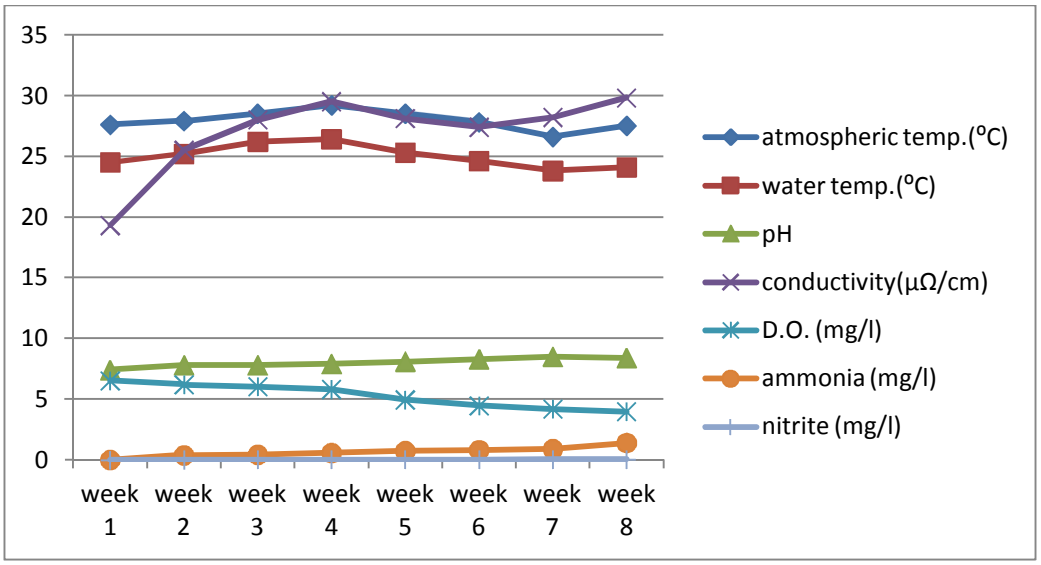

Figure 8: Physiochemical parameters for treatment B (Borehole water)

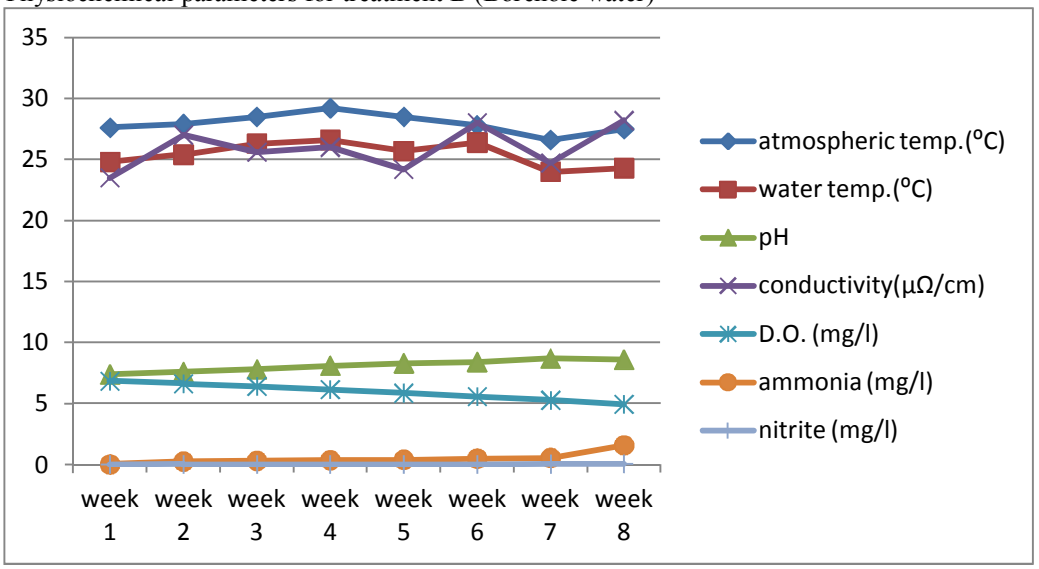

Figure 9: Physiochemical parameters for treatment C (Stream water).

4.1 Analysis

Adverse concentration of water quality parameters especially dissolved oxygen and unionized ammonia were noticeable and serves as the cause of mortality.

Both water and air temperatures recorded during the experimental period were within tolerable range (26.6^0C to 29.2^0C) for the culture of warm water fish as recommended by (Onuoha and Nwadukwe, 1987) . (Table 6, 7, and 8) and (Figure 7, 8, and 9) for all treatments.

The pH value varied from 7.3-8.4, 7.4-8.4, and 7.4-8.5 for treatments A, B, and C, which indicates alkaline and were within tolerable range of 6.5 to 9.0 as stated by Chakroff (1979) and 6.7 to 8.6 by Ovie and Adeniji (1990)

Throughout the experimental period, the nitrite level never attained adverse lethal level, which ranged from 0.001 to 0.06, 0.001 to 0.05 and 0.001 to 0.05 for treatments A, B, and C respectively. These values were within the tolerant range of 0.00 to 0.5 as recommended by Pronob Das et al., (2011).

Ammonia exceeded the optimum range towards the end of the experimental period. This progressive rise in the concentration of ammonia with time could be attributed to increase in biomass of the fish. The highest value of 2.11 was recorded in treatment A (0.01 to 2.11), B (0.01 to 1.41) and C (0.01 to 1.58). Dissolved oxygen decreased gradually and progressively with time as biomass (growth). This is mainly due to metabolic activities and decaying organic materials such as underutilized feed. The range of dissolved oxygen recorded

depreciate below the optimum range of 5-10mg/l accordingly to Pronob Das et al (2011). From the 5th week treatments A (6.80 to 3.89), and B (6.52 to 3.89,) and in the last week for treatment C. (6.83 to 4.95)

According to Brown (1957), the survival of *Clarias* is not dependent on dissolved oxygen due to its capability of obtaining oxygen by gulping air. While inadequate dissolved oxygen may not in itself be lethal, it may affect seriously the health of the fish and facilitate the spread of disease. Mayer (1970) indicated that the role of low dissolved oxygen levels in promoting bacterial infections is often unsuspected.

Conductivity fluctuated with time in all treatment especially in treatment A which varied from A (21.8 to 26.7), B (19.3 to 29.8), and C (23.5 to 28.2) micro olms per centimeter (μΩ/cm) .

Production in all treatments were minimal during the last few weeks and have affected fish performance, as indicated by the decreased slope of production parameters such as mean weight, mean lengths, mean weight gain, mean length gain, and food conversion efficiency. (Table 3, 4, and 5, and Figure 1, 2, and 3). The minimal production experienced during the last few weeks indicated that there was progressive decrease in the specific growth rates and mean growth rates (Figure 5 and 6 respectively). This is a result of the progressive deterioration of such as ammonia, dissolve oxygen, physical, and physiological stresses encountered by the fish during the stressful exchange of water.

The survival rates were A (100%), B (66.67%) and C (83.33%) (Table 3, 4, and 5, and Figure 4). When subjected to a one way analysis of variance (single factor ANOVA), the results showed a significant difference ($p< 0.05$) for the survival rate in all treatments. Mortality occurred during the last few weeks of the experiment especially, for treatment B which recorded the highest value.(66.67%). No mortality was recorded for treatment A (tap water) probably due to variations in its hardness of about 50mg/l which was moderately soft while the other water quality parameters were compared treatment C (stream water), which was richer in dissolved minerals, while treatment B (borehole) was is the hardest (>250mg / l) of all three water type afomentioned. However, the mortality recorded in treatment B, and C may also be attributed mainly to stresses that may have resulted from the weekly sampling which showed that the average weight gain was 3.638g, 2.013g, and 1.626g for treatments A, B, and C respectively while the average length gain was A (0.868cm), B (0.809cm), and C (0.52cm). When subjected to a single factor analysis of variance, a significant difference was observed ($F= 9.4$, $df=24$, $P<0.05$), with treatment A having the highest productivity. However, no significant difference was observed in length gain ($F=1.879$; $df=24$; $P>0.05$) among treatments.

Also, no significant difference in mean weights ($F=2.328$; $df=24$; $P>0.05$) and mean total lengths ($F=1.905$; $df=24$; $P>0.05$).The specific growth rates, mean growth rates and food conversion efficiencies showed no significant difference when subjected to single factor analysis of variance i.e. A ($F=0.387$; $df=24$; $P>0.05$), B ($F=0.694$; $df=24$; $P>0.05$) and C, ($F=1.322$; $df=24$; 0.285) respectively.

The fact that all other production parameters, apart from the mean weight gain and survival rate showed no significant difference could be attributed to the same type of quantity of feeding; uniform time of feeding and sanitary conditions maintained in all treatments. But the significant difference observed in the mean weight gains and survival rates in all three treatments suggest that treatment A (tap water) produced better fish growth and survival rather than treatments B and C.

5.0 CONCLUSION.

Clarias gariepinus fingerlings were reared in rectangular plastic aquaria in tap, borehole and stream waters and fed with coppens fish feed twice daily for an experimental period of 60 days. The survival rates were 100% 66.67% and 83.33% for treatment A, B, and C respectively, while the final mean weights were 44.83g (A), 28.92g (B) and 25.46g (C).

The statistical analysis revealed no significant difference ($P>0.05$) in all production parameters except the mean weight gain and survival rate ($P<0.05$) thus suggesting that treatment A produced better growth and survival rate than the other two treatments. A significant difference of ($P>0.05$) revealed that treatment A provided the highest value .Water quality parameters such as Dissolved oxygen and ammonia were minimal, on the whole, the physiochemical parameters were within optimum range for ideal fish production and therefore did not affect growth rate and survival of *Clarias gariepinus* fingerlings . Findings showed that *Clarias gariepinus* fingerlings could be reared in all water mediums , but tap water provided the highest productivity and survival rate for the production of *Clarias gariepinus* fingerlings.

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LIST OF APPENDICES

1. One-way Anova: for mean weights						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Mean weight (g)a	9	230.81	25.64556	128.6116		
Mean weight (g)b	9	173.66	19.29556	47.21775		
Mean weight (g)c	9	158.99	17.66556	30.34103		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	319.9794	2	159.9897	2.328021	0.119108	3.402826
Within Groups	1649.363	24	68.72347			
Total	1969.343	26				
2. One-way Anova: for mean weight gains						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Weight gain (g)a	9	32.74	3.637778	4.010944		
Weight gain (g)b	9	18.12	2.013333	1.36465		
Weight gain (g)c	9	14.63	1.625556	0.904403		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	20.514689	2	10.25734	4.900007	0.016426	3.402826
Within Groups	50.239978	24	2.093332			
Total	70.754667	26				
3. One-way Anova: for mean total lengths						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Mean length (cm)a	9	138.73	15.41444	7.291878		
Mean length (cm)b	9	127.71	14.19	5.067625		
Mean length (cm)c	9	120.53	13.39222	2.345244		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18.67529	2	9.337644	1.905027	0.170653	3.402826

Within Groups	117.638	24	4.901582			
Total	136.3133	26				

4. One-way Anova: for mean length gains						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Length gain (cm)a	9	7.81	0.867778	0.241494		
Length gain (cm)b	9	7.28	0.808889	0.155561		
Length gain (cm)c	9	4.68	0.52	0.100775		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.623622	2	0.311811	1.87902	0.17453	3.402826
Within Groups	3.982644	24	0.165944			
Total	4.606267	26				

5. One-way Anova: for specific growth rates						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Specific growth rate for A (%)	9	2.424	0.269333	0.066805		
Specific growth rate for B (%)	9	1.902	0.211333	0.02863		
Specific growth rate for C (%)	9	1.69	0.187778	0.027587		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.031711	2	0.015855	0.386647	0.683486	3.402826
Within Groups	0.98417	24	0.041007			
Total	1.01588	26				

6. One-way Anova: For mean growth rates						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Mean growth rate for A (%).	9	2.166	0.240667	0.009271		
Mean growth rate for B (%).	9	1.932	0.214667	0.007804		
Mean growth rate for C (%).	9	1.728	0.192	0.005983		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.010675	2	0.005337	0.694393	0.509134	3.402826
Within Groups	0.184472	24	0.007686			
Total	0.195147	26				

7. One-way Anova: for food conversion efficiencies						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Food conversion efficiency for A (%).	9	297.36	33.04	197.831		
Food conversion efficiency for B (%).	9	261.77	29.0856	317.186		
Food conversion efficiency for C (%).	9	194.26	21.5844	176.344		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	609.402	2	304.7011	1.32218	0.28528	3.402826

Within Groups	5530.89	24	230.4536			
Total	6140.29	26				

8. One-way Anova: for survival rates						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Survival rate (%) A	9	900	100	0		
Survival rate (%) B	9	741.67	82.40778	129.2307		
Survival rate (%) C	9	858.33	95.37	54.02933		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1496.827	2	748.4136	12.25167	0.000215	3.402826
Within Groups	1466.08	24	61.08668			
Total	2962.908	26				

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