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Growth Performance and Survival of Wild African Killifish (Fundolopanchaxdeltaensis) in Indoor Aquarium.

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Abstract: *A preliminary study was carried out to determine the growth performance, condition and survival of aNigerian Killifish,Fundolopanchaxdeltaensis, in Indoor Aquarium, fed diets of varying protein levels(45% protein diet, 33% protein diet). The experiment was carried out for a total of forty-two (42) days and divided into three treatments(treatment A, treatment B and treatment C), which were carried out in triplicates. The experimental Fish were weighed(gm) and measured(cm) and thenrandomly stocked into the triplicate treatments. The Fish were fed compounded treatment diets(treatment A - 45% protein diet, treatment B - 33% protein diet and treatment C - control fed with live feed), thrice daily, five times weekly, for the forty-two days at five (5%) percent of their body weight. Data was collected weekly and at the end of the experiment forPhysico-chemical parameters of the tank media. Also, Growth was assessed using standard methods to ascertain weight increment, length increment and specific growth rate (SGR), over time. Fish condition and survival were determined using Fulton's condition factor "K" and Percentage Survival, respectively. The results revealed that,physico-chemical parameters of water (pH, temperature and DO) were in good condition through the duration of the experiment and in all treatment tanks. Growth, weight gain/increment was best for fishes fed 45% protein diet (treatment A), ranging between 4.05g and 4.13g. The fishes fed 33% protein (treatment B) diet did better than those fed natural diets (control Treatment C) having weight gain ranges between 1.67g and 1.92g and 1.74g and 1.9g respectively. The higher weight increment for those fed 45% protein were significantly higher 5.63 ± 0.148a than the treatment B 4.61 ±0.147b and treatment C 4.22 ±0.147b. Length increment was however different in pattern from the weight increment as, the Treatment "C" fish (live feed) recorded better increments 3.33cm to 6.46cm as opposed to Treatment A 3.25cm to 6.33cm and treatment B 3.66cm to 6.33cm. The length difference was significantly 5.66 ± 0.132a better than that of Treatment A 5.64 ± 0.132b and B 5.63 ± 0.132b. The experimental condition was favorable for all treatments through the experiment (above 1), but the highest (best) condition was observed in Treatment C, at week 6 (7.771688). The overall survival for each treatment was high through the weeks, except for treatment B at week 4, which was as a result of laboratory accident. It could be deduced that the fish fed 45% protein diet generally did better for growth, condition and survival. Thus it can be deduced that, this aquarium fish species could be successfully bred or cultured in indoor aquarium tanks using the 45% protein diets. It is therefore recommended that more work should be carried out to highlight other basic requirements of these fish species and these fish species are also recommended for addition as new, local aquarium species for local use and export purposes.*

Keywords: *Growth performance, condition and survival, Nigerian KillifishIndoor Aquarium, Nigerian Killifish, Fundolopanchaxdeltaensis, Diets(45% protein diet, 33% protein diet*

I. Introduction

The term Ornamental fish is a generic term used to describe some aquatic animals used in beautifying aquariums of different sizes and types. These aquatic animals are referred to as ornamental as a result of their attractive colours, external features,/characteristics (fins, scales, limbs, etc.) and even movement and feeding mechanisms. These aquatic organisms include fishes (finned), non-finned fishes (crustaceans (e.g. crab, hermit crab, and shrimps) Mollusc (e.g. snail, clams, scallops)), invertebrates (such as corals), bigger mammals(eg Sharks and Dolphins), and also live rock (Ukaonu*et al.,* 2011)

The ornamental fish trade world wide and its associated industries have great economic importance and serves as a major source of income and especially Foreign exchange to countries where it is practiced such as America and some Asian Countries (Andrews 1992). Several species and millions of specimens are traded annually in the ornamental fish trade. According to Priede (1987), the total number of known aquarium fish species worldwide exceeds 30,000. Riehl and Baensch (1989) reported that, only 4000 of these species classify as freshwater ornamental species.However only few of the Fresh water ornamental fishes are marketed.

The killifish, are a group of fresh water fishes with Ornamental characteristics, as they possess unic shapes and colours, and thus very attractive. They are Cyprinodonts from the family Aplocheidae (Costa, 1998). They are oviparous(egg-laying) fishes that have a life span of between two to three years. They are carnivorous,feeding mainly on aquatic worms, insects and crustaceans. They are freshwater species that dwell in

water with pH ranging from 6.5-7.2. The adult killifish can obtain a size of 8.0cm TL (Fish base, 2007).They are mainly found in streams. There are about 1,270 different species worldwide (Graf *et al*, 2013). Members of this Family of Fishes are endemic to foreign rivers and countries are popular as aquarium fishes. In Nigeria, there are up to 20 killifish species with Niger Delta area having over 6 species. The *Fundulopanchaxdeltaensis* is a Niger delta Killifish species. Though this species are known locally to have ornamental potential as they posses beautiful colours, information for rearing them in Indoor Aquarium, especially concerning their nutritional (crude protein) requirement for growth and survival is not unavailable. This is one of the factors militating against its being exploited in Nigeria, even in the face of few ornamental species existing.

Several studies have been carried out on various aspects of growth determination, survival and condition of several Aquarium and food fish species globally, for the sustainable culture/production of these species. In Nigeria, several of such studies have been carried out on various fishes by; Dada and Akinwade (2004), Okoye and Nnaji (2004), Babalola (2004), Ibim and Sikoki (2014), among many others.

Some aspects of growth determination, survival and condition of some species of the Killifish have also been studied(Ofori- Mensah *et al.* (2013), on the gulf killifish *Fundulusgrandis*; Akbarzadeh*et al*.(2014), on the killifish (*Aphaniusdispar*) and Burger *et al.,* (2015).

However, there is paucity of information on the growth and survival of the Nigerian killifish (*Fundulopanchaxdeltaensis*).This work is aimed at ascertaining the Aquarium keeping potentials of a local Nigerian fresh water ornamental Killifish species, *Fundulopanchaxdeltaensis;* by elucidating its Crude protein/nutritional requirement for growth, and survival in indoor Aquarium tanks.

The relevance of this study therefore is to encourage the production of the Nigerian Killifish ,*Fundulopanchaxdeltaensis*species, in order to add another species to the regularly traded aquarium fish species in Nigeria, thereby enhancing the Aquarium Industry/business development.The objectives of this study therefore is, to establish the Growth, Survival and Condition of the Nigerian killifish*Fundulopanchaxdeltaensis* species.

II. Literature Review

Several works have been carried out on various aspects of growth determination, survival and condition of several fish species worldwide. In Nigeria, Dada and Akinwade (2004) studied the Growth performance of *Heteroclarias* species fed maggot meal at varying inclusion levels. They reported that, the best growth and feed conversion efficiency were obtained with 75% dietary inclusion of maggot meal. Okoye and Nnaji (2004), studied improving growth and food utilization, substituted fish meal with grasshopper meal for the Nile Tilapia fingerlings. It was reported that, the best growth and food utilization were recorded with 10% grasshopper meal and 30% fish meal,as against 25% grasshopper meal and 15% fish meal. In general, at 10% inclusion, the fingerlings performed even better than the control (40% fish meal and no grasshopper meal). Furthermore, Babalola (2004) fed*Clariasgariepinus*larva with Moina, artificial diet and Nutrasexyla supplemented artificial diet to improve growth and survival. The results showed that the best growth performance and survival rate was obtained with a combination of moina and artificial diet supplement with nutrasexyla. Feeding of moina and artificial diet supplemented with nutrasexyla alone led to a lower growth performance of 25.60-27.04% d^{-1}.Ogbe *et al.* (2004) also studied the growth performance of *Clariasgariepinus*fingerlings fed earthworm meal (*Lumbricusterrestis*) as replacement for fishmeal. It was noted that, there was no significant difference (P>0.05) in mean weight gain (MWG), specific growth rate (SGR), food conversion ratio (FCR), protein efficiency ratio (PER) and survival among the fish fed treated with experimental meals. Sogbesan*et al.* (2004), studied the growth response, feed conversion rate and cost benefits of hybrid catfish fed maggot meal based diets in outdoor tanks. They reported that, the inclusion of maggot based meal diet is recommended as feed of hybrid catfish to 75% inclusion growth and profit incidence. Nlewadim and Madu (2004) on the growth response and survival of F_1 hybrid fry of *Heterbranchuslongifilis*and *Clariasgariepinus*reared in glass aquaria and plastic basins reportedthat average length increase was higher in aquaria glass tanks than in plastic basins althoughthere was depressed and irregular weight increases in both rearing troughs andno significant difference in both rearing systems. Alatise*et al.* (2004) using*Heterobranchuslongifilis*fingerlings fed varying levels of dietary freshwater mussel (*Aspathariafinuate*) reported the body weight gain, specific growth rate and feed conversion ratio values of 6.38g, 1.06%/day and0.62 respectively, highest in diet with 25% replacement closely followed by diet with 50% replacement. Beyond 75% inclusion level there was no significant growth.Ibim and Sikoki (2014) carried out a study on the growth performance and proximate composition of *Oreochromisniloticus*fed cobalt chloride incorporated diet. Results revealed that the cobalt chloride incorporated diet significantly (P>0.05) enhanced growth. Regarding the Killifish species, Ofori- Mensah *et al.* (2013)carried out a research on growth and survival of juvenile gulf killifish *Fundulusgrandis* in recirculating aquaculture systems and reportedhighest survival in the treatment with lower stocking density (94.6%) than in treatment with higher stocking density (83.9%). Akbarzadeh*et al.*,(2014)working on responses of the killifish (*Aphaniusdispar*) to long-term exposure to elevated temperatures: growth, survival and microstructure of gill and heart tissues noted that,the percentage

of body weight gain and specific growth rate were significantly lower in fish kept in thermal stress compared with the control group. Fish condition (Condition factor, CF) did not differ significantly between both groups at the end of the experiment. Burger *et al.,* (2015), on freshwater reared killifish reportedthat Growth and survival were: mean ± SD weight gain of 6.69± 3.18 g/fish and mean survival of 54.3± 17.3% in the smaller size class, and weight gain of 6.63± 1.64 g/fish and survival of 43.1± 10.7% in the larger size class.Although several such studies have been carried out on the growth and survival of a wide variety of fishes and a few killifish species as reported, there is paucity of information on the growth and survival of the Nigerian killifish (*Fundulopanchaxdeltaensis*). Thus, this work is targeted at ascertaining the Aquarium keeping potentials of the Nigerian freshwater killifish (*Fundulopanchaxdeltaensis*), by elucidating its growth, survival and condition in homestead aquarium tanks. This add to the number of aquarium fish species reared in Nigeria increasing availability of Aquarium fishes for sustainably enhancing Aquarium sector development in Nigeria.

III. Materials and Methods

***3.1 Experimental Procedure*.**

3.1.1Experimental Design: The experiment was carried out in the Ornamental fisheries wet lab, Department of fisheries, University of Port-Harcourt for a period of 42 days. Nine (9) glass aquarium tanks of 91cm x 76cm set up in the laboratory were stocked with 20 juvenille*Fundulopanchaxdeltaensis*killifish.The tanks were labelled to depict treatment types A, B and C in triplicate. Thefishes in treatment tanks A_1, A_2 and A_3 were fed with 45% crude protein Diet. Those in treatment tanks B_1, B_2 and B_3 were fed with 33% crude proteinDiet, whiletreatment tanks C (control tanks) were fed with live (Control) feed (earthworm cutlets).

3.1.2. Experimental Feed and Feeding. Formulated feed (Multifeed) of 45% and 33% Protein content were used to feed the experimental fishes for the duration of the experiment simultaneously in Triplicate experimental tanks A and B respectively. The Control Triplicate experimental tanks were stocked in fertilized tanks to feed on natural feed organisms.

Fishes fed experimental diets were fed at 5% of their body weight thrice daily. Weekly, the feeding rate was adjusted as required.

3.2. Data Collection

3.2.1. Growth Determination

Growth was estimated using growth parameters of weight and length of fish, and the Specific growth rate (SGR) determined at the onset of the experiment and every 7-day interval, until the termination of the experiment.

3.2.1.1. Fish weight. This was determined using weighing scales and recorded in gramswere carried out by taking a random sample of 10 fishes. Average weight was determined. The Weight Gain/Increment was calculated thus;

weight gain = Initial – Final weight

3.2.1.2. Fish Length.This was determined by measuringthe randomly selected and previously weighed 10 fish samples, using a metre rule and measurements recorded in centimetres (cm).

The Length Increment was calculated thus;

Length Increment/gain = Initial – Final length

3.2.1.3. Specific Growth Rate. This was calculated using the following formula

Specific growth rate (SGR)=

$$\frac{\text{Ln (Mean Final Weight)- Ln (Mean Initial Weight)}}{\text{Period of culture (days)}} \times 100$$

3.2.2 Determination of Fish Condition.

The condition of the fishes wereassessed to ascertain their well-being during the experimental period. This was determined using Fulton's Condition Factor (K)with the formula;

$$K = \frac{\text{Final mean body weight (g)}}{L^3 \text{ (cm)}} \times 100$$

3.2.3Determinationof Survival.

The survivability of the fishes in the experiment was assessed by ascertaining the Percent Survival. This was determined using the Formula below:

Percentage (%) survival = Number of survivors/total nos of fish stocked x 100/1

3.3 Water quality Analysis

Water quality was analysed to determine thePhysico-chemical Parameter determination. Water samples of the four study stations were collected during the sampling period, to determine essential physical and chemical parameters of the study area. Parameters that were determined include: Water temperature, the pH, Salinity/conductivity

3.4 Statistical Analysis

The Data collected were subjected to A One-way Analysis of Variance (ANOVA), using a statistical package SPSS version 16.0 for windows.

IV. Results

4.1Waterquality Parameters

Table 1; Water Quality Parameters of Experimental tanks

PARAMETER	A1 27.1	A2 27	A3 27	B1 27.2	B2 27.1	B3 27.4	C1 27.5	C2 27.1	C3 27
Ph	6	6.2	5.9	6	6	6	6.2	6.1	6.1
DISSOLVED OXYGEN (mg/L)	1.2	0.9	1.0	1.0	1.0	1.0	1.0	1.2	0.9

Mean water quality characteristics monitored throughout the study period are summarized in Table 1.Water temperature mean values varied between 27°c and 27.5°c during the experimental period. The pH mean values varied between 5.9 and 6.2 during the experimental period. Values of dissolved oxygen varied between0.9mg/L and 1.2mg/L during the experimental period.

4.2 Feed Composition

Gross composition of the two experimental feeds A(45%CP) and B(33% CP) are as stated in table 1, as reported by the data by the Producers, Multifeeds.

Table 2. Gross Composition of Experimental feeds A- 45%Protein and B-33% Protein

Feed Type	Protein	Lipid	Fibre	Moisture	Ash	Vitamins	Phosphorus
feed A	45%	12%	2.5%	-	8.5%	C-100mg/kg	0.9%
feed B	33%	12%	2.5%	-	8.5%	C-100mg/kg	0.9%

4.3. Growth

4.3.1. Weight Increment

4. 3.1.1. Mean weight increments for all treatments.

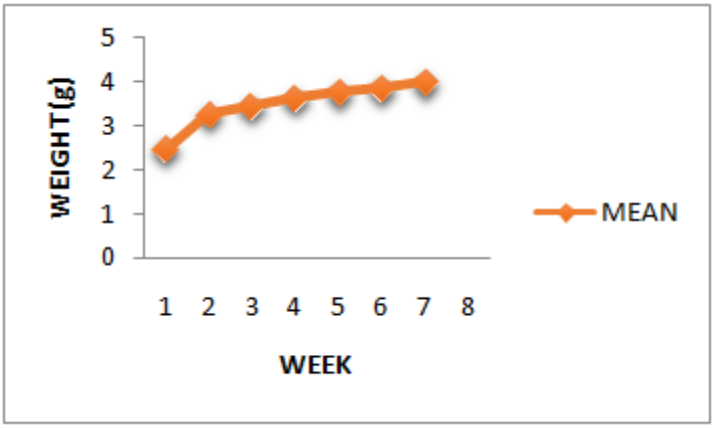

Figure:1 Mean Weight Increments for all Treatments.

Weekly variation in mean weight increments of *Fundulopanchaxdeltaensis*Fishes for all treatments(A(45%CP),B(33%CP), and C(control) is shown in figure 1. According to the result, there was a slightly sharp growth increment from week 1 to week 2 and then a gradual but progressive growth from week 2 till week 6.

4.3.1.2: Weight increment of different treatments.

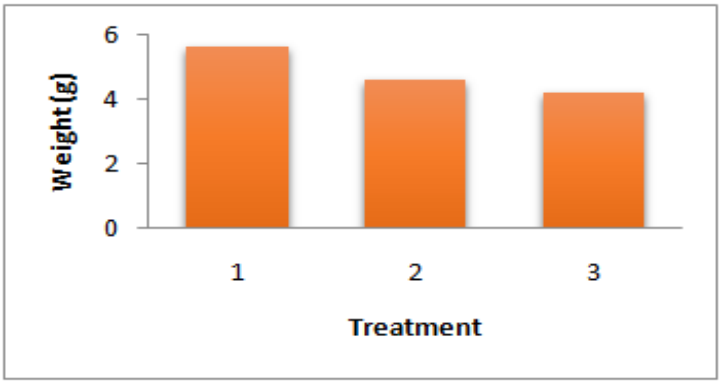

Figure:2: Variations in weight per treatment

Changes in weight per treatment are shown in figure 2. Observations showed that, treatment A(45%CP) showed the highest weight increment followed by treatment B(33%CP), and Treatment C(Control).

4.3.2 Length Increment

4.3.2.1 Mean length increments for all treatments

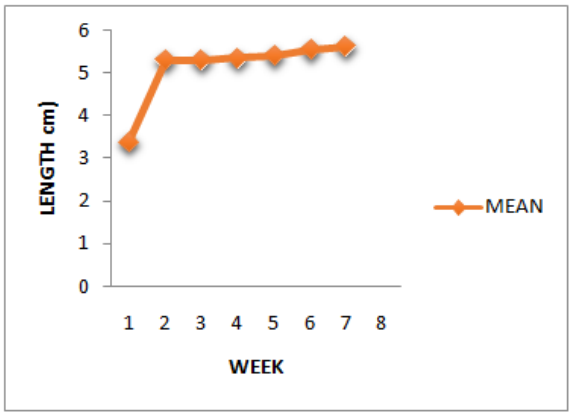

Figure 3: Weekly variation in length of Fundulopanchaxdeltaensis

The weekly variations in mean length are shown in figure 3. There was a very sharp increase in mean length between week 1 to week 2, then a gradual increase, as observed in the weight increment.

4.3.2.2 Length increment per treatment

Changes in length per treatment are shown in figure 4. Treatment C showed the highest length increment, followed by treatment B, and then treatment A.

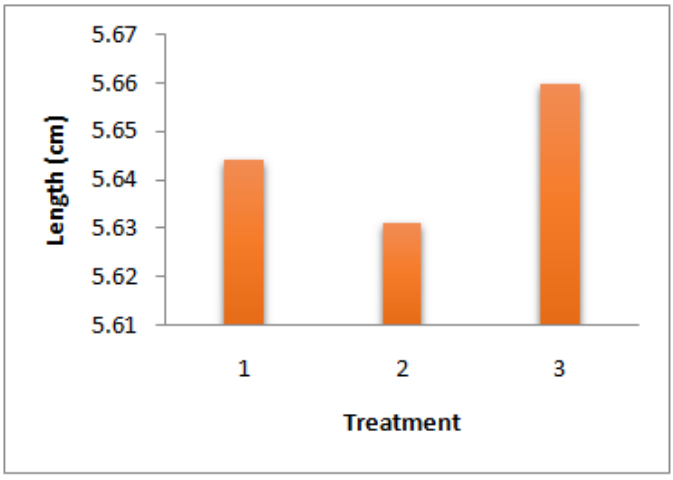

Figure 4: Variations in length per treatment.

4.3.3 Specific Growth Rate

4.3.3.1 Specific Growth Rate for Weight

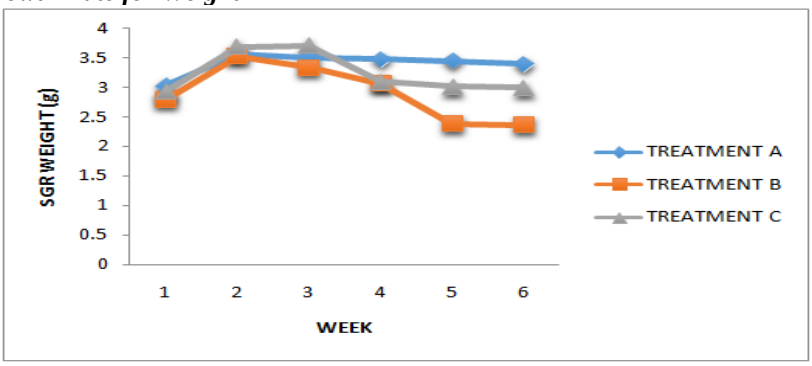

Figure 5: Weekly Specific Growth for Weight and Length

Weekly mean specific growth rate for Weight for all treatments is illustrated in figure 5. According to the graph, there was an increase in Specific growth rate for weight (SGR) from week 1 to week 2. From the third week, the Specific growth rate for treatment B dropped faster and lower than the other treatments. Though treatment C experienced a sharp drop, the SGR was still higher than that of treatment B. Treatment A exhibited a gradual drop which was better and higher than all other treatments.

4.3.3.2 Specific Growth Rate for Length

Weekly SGR for length as seen in figure 6 showed that, there was a sharp increase from week 1 to week 2, followed by a slow decline following the other weeks. This graph represents a typical SGR.

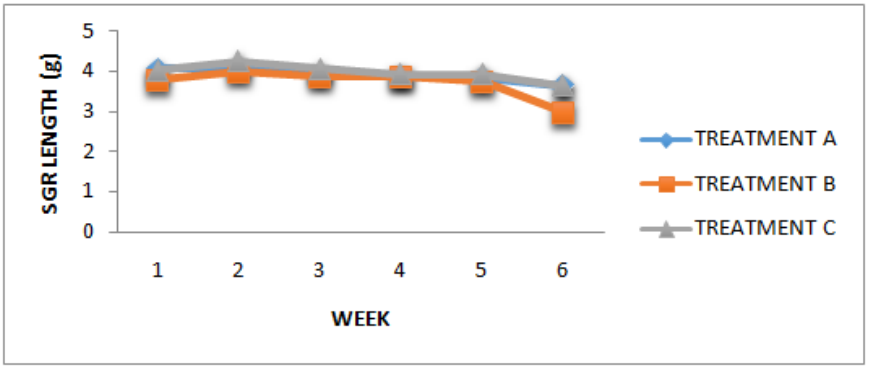

Figure 6: Weekly SGR for Length

4.4 Survival

The survival for each treatment for the duration of the experiment is shown in figure 7. It was observed that from week 1 of the experiment, survival rate steadily increased for treatment A and C from week 1 to the end of the experiment. However, treatment B had a steady improvement from the 1st to the 2nd week. There was a sharp decline from week 3 to week 4, which was followed by a sharp increase from week 5 and sustained gradually till the end of the experiment.

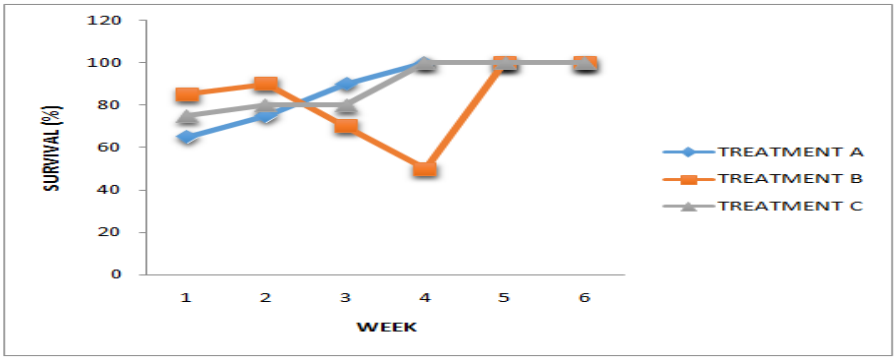

Figure 7: Survival

4.5 FishCondition

The condition of each treatment over the duration of the experiment is shown in figure 8.

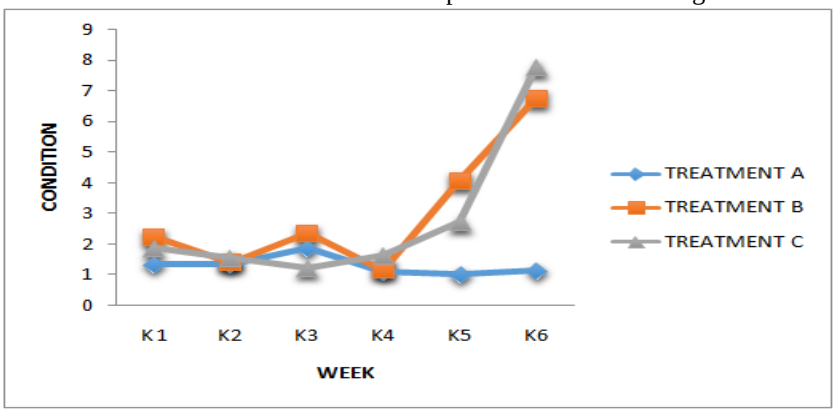

Figure 8: Condition Factor

Though all fishes in treatments A, B and C were in similar condition from weeks 1 to 4, there was a drastic increment in the conditions from week4 to 6 for treatments B and C.thus showing Treatment B and C to be in better condition than treatment A which dropped slightly in condition.

4.6. Statistical Analysis

Table 3: Statistical Analysisfor Specific Growth Rate, Condition and Survival of Fish Groups (A, B and C)

Treatment	Specific growth rate (SGR)	Condition factor(K)	Survival
A	0.73±0.16a	65.14± 7.74a	63.33±7.26b
B	0.58±0.48b	30.39± 0.75b	65.00± 2.88b
C	0.49±0.12c	30.76± 7.71b	70.00 ± 10.00a

Based on statistical analysis (table 3), the Specific growth rate (SGR) in treatment A was significantly higher than all treatments. However, treatment B was significantly higher than treatment C. The fish condition(K) was significantly higher in treatment A, however, treatment B and C were on the same level. The percentage fish survival was significantly higher in treatment C. Treatment B was significantly higher than treatment A.In Table 4, the Statistical Analysis ofthe weight increment of Treatment A was significantly (5.63±0.148a) higher than treatment B (4.61±0.147b) and C (4.22±0.147b).Also, as shown in Table 4, the length increment in Treatment C was significantly higher (5.66±0.132a) than Treatment A (5.64±0.132b) and B (5.63±0.132b) as shown in Table 3, below.

Table 4: Statistical Analysis of The Effects of Treatment on Length and WeightofFundulopanchaxdeltaensis

TREATMENT	LENGTH	WEIGHT
A	5.64± 0.132b	5.63± 0.148a
B	5.63± 0.132b	4.61± 0.147b
C	5.66± 0.132a	4.22± 0.147b

The effect of treatment in length and weight shows that, for length, treatment C was significantly different from A and B. In weight, treatment A was significantly different from B and C.

V. Discussion

The increase in Growthparameters (increments in length and weight, and specific growth rate (SGR)) of all the experimental fishes showed that there was a general rapid increase in the growth of all fishes in the experiment at the initial stage followed by a gradual slowing down of the growth. This is the natural growth trend observed in healthy growing fishes. Blazek *et al.,* (2013),reportedrapid growth, early maturation and short regeneration time in African annual fishes. They also reported that,all of the populations of *Nothobranchius*studied demonstrated rapid growth, especially in their first 28 days but the, growth rate gradually diminished after 14 days of age, and maximum growth rates were recorded during their second week of life.Furthermore, by 60 days of age, there was rapid deceleration of growth, to negligible growth.

The higher weight gain amongFish fed with 45% protein than the other treatments fed 33% protein and live feed may be attributed to rapid growth at juvenile stage, followed by a slower growth after attaining maturity. This could be likened to the findings by Blazek *et al.,* (2013),reported rapid growth at early maturation to later deceleration of growth. Also, Maldonado-Garcia *et al.,* 2012 reported significantly improvement fish

growth with increase in dietary protein as also reported in other fishes as Oreochromisniloticus (Kaushik et al., 1995), Bahnasawy (2009)monosex Nile Tilapia, *Oreochromisniloticus*; Wilkinson (2003) juvenile tilapia.

In the case of the increments in the length among all the fish groups, the control fishes were observed to have attained higher increments than the treatment A and B. This contrary length increment pattern observed for treatment C could be attributed to the presence of more male fishes because male fishes tend to naturally grow longer than female fishes, though information is lacking amongst Cyprinidontidae to prove this.

The specific growth rate pattern observed confirms the fact that, the higher protein content in the diet supports growth of the killifish. Though information is lacking amongst the Cyprinidonts to this effect, this situation for similar carnivorous species. Ibim and Sikoki (2014) reported higher SGR for African Catfish with higher protein inclusion in the fish diets. So was the case with the carnivorous Yellow snapper (Harengulathrissina) fed high protein (Vazquez et al., 2008),Dentex (Dentexdentex) and Senegalese sole (Soleasenegalensis) (Garcia *et al.*, 2012).

The survival improved for all treatments. This can be inferred to mean that the treatments were conducive to the survival of the fishes. However, the better survivals of the Control fishes could be attributed to the fact that the water parameters are close to natural asthere is less pollution of the aquatic environment, as the case with the treated tanks A and B environment. Thus the absence of compounded diets and the presence of natural food materials coupled with the fact that the fishes did not require adaptation to a new meal and environment at the same time was reason for the better survival.

The result of Fish Condition revealed that the fishes were in good condition as the *Fundulopanchaxdeltaensis* juveniles had Condition factor "K" above 1, throughout the experiment, irrespective of the fluctuations exhibited. Though there is paucity of information on the Condition of KilliFish species, brackish water fishes*T. zilli*in similar studies had *K values of 1.94(* Ibrahim*et al.*;2008) showing that the condition was good in the treatments throughout the experiment.

VI. Conclusion and Recommendation

It can be concluded that, 45% protein inclusion in diets gave better growth, condition and survival of *Fundulopanchaxdeltaensis*, and would thus improve the fishes in indoor aquarium tanks.Thus, the fishes could successfully bred or cultured in indoor aquarium tanks and be added to the number of ornamental fishes found, reared, kept and traded in Nigeria, as their family members are, in other countries around the world.

However, it is recommended that more studies be carried out to identify in-depth the other requirements that would enhance the utilization of this species in in-door aquarium tanks, and their market potentials to foreign countries involved in ornamental fish trade.

Secondly, the population structure and conservation needs should be investigated so as not to endanger the species, in event of exploitation.

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