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Full Length Research

Performance and survival of *Clarias garienpinus* from locally processed corn and soya bean meal as a replacement for fish meal

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ABSTRACT: An experiment to evaluate the effect of replacing fish feed was conducted to evaluate the growth performance of *Heteroclarias* in circular tanks each having a capacity of fifty litres of water. Fishes were divided into three groups in triplicates, with 10 fishes per tank. The fingerlings stocked were of the same size and length. Fishes in tank A were fed with laboratory prepared Soya bean and corn meal feed, while B had already manufactured feed (Coppens) and C already manufactured feed (Aquamass) was used. The fingerlings were fed 4% of their body weight twice daily, from 6.00 to 8.00am and from 6.00 to 8.00pm. Growth performances were monitored weekly for eight weeks. The results showed that treatment A (laboratory prepared feed) had the best growth performance with a mean weight (23.3±0.02 g) and length (20.00 mm) gain which exceeds that of treatment B which had a mean of 10.5±0.01 g and length of (19.3 mm). There was a significant difference (p>0.05) between growth rate and different feeds.

Key words: *Clarias garienpinus*, corn, growth performance, soya bean meal.

INTRODUCTION

Most fish farmers and ornamental fish hobbyists buy the bulk of their feed from commercial manufacturers. However, small quantities of specialized feeds are often needed for experimental purposes, feeding difficult-to-maintain pond fishes, larval or small juvenile fishes, brood fish conditioning, or administering medication to sick fish. In particular, small fish farms with a small amount of fish require small amounts of various diets with particular ingredients. It is not cost effective for commercial manufacturers to produce very small quantities of specialized feeds (De Koven et al., 1992). Most feed mills will only produce custom formulations in quantities of more than one ton, and medicated feeds are usually sold in 50-killogram bags (De Silva and Anderson, 1995). Small fish farmers, hobbyists, and laboratory technicians are, therefore, left with the option of buying large quantities of expensive feed, which often goes to waste. Small quantities of fish feed can be made quite easily in the laboratory, classroom, or at home, with common ingredients and simple kitchen or laboratory equipment. Fish feed consist of natural food and artificial feeds. When fish have balanced diet to eat, they grow fast and stay healthy, in most fish farms natural feeds are not used owing to the fact that they are not earthen and zooplankton and phytoplankton are not readily available. Most fish farmers now depend on formulated feed that are more expensive and are not seen to be cost effective in the running of small fish farms. Most of the constituent of these artificial feed may not even be nutritionally complete, and may not support fish growth adequately (Juli-Anne and Frank, 2015). However artificial feeds have in recent times become well-compounded mixtures of feed stuff and can be either in mesh or pelleted form and are largely employed in the practice of fish farming. The mash feed is suitable for fries and pelleted feed (0.8-1mm) for fingerlings, Juveniles (2-3 mm) and adults (4.5 mm) depending on the pellet sizes. It is an established fact that artificial feeds are expensive (Hertrampf and Piedad-Pascual, 2000).

Studies have shown over time that in fish farming the major factors traceable to the success or failure of the farm are; stocking rate, stocking density, the water temperature, quantity and quality of feed which is the highest contributing factor, and the feeding method and frequency (National Research Council NRC, 1993). There have been overtime recommended dietary crude protein requirements for fast and healthy growth of fishes of different species. This research study would be geared towards a comparative study to evaluate the effect of commercially available feed and that manufactured in the laboratory in other to ascertain the more viable of the two feeds, considering the time rate and growth rate in terms of weight gained and length. This study aims to develop an improved variety of fish feed that would be cheaper and more readily available to fish farmers in the running of their farms.

The concept of alternative/ artificial fish feed

Good nutrition in animal feed enhances a production system that will produce economically healthy, high quality products. In the running of fish farms, nutrition is a key factor as it accounts for 40-50% of the cost of production (Steven, 2009). With rising demand of fishery produce and the increase in technological knowhow, there has been a tremendous advancement in the commercially available fish diet, promoting optimal fish growth and health. Development of new species- specific diet formulations supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe and quality fish and sea food products (Louis and Steven, 2009).

Prepared or artificial diets may be either complete or supplemental. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. Most fish farmers use complete diets, those containing all the required protein (18-50%), lipid (10-25%), carbohydrate (15-20%), ash (< 8.5%), phosphorus (< 1.5%), water (< 10%), and trace amounts of vitamins, and minerals (Louis and Steven, 2009). When fish are reared in high density indoor systems or confined in cages and cannot forage freely on natural feeds, they must be provided a complete diet. In contrast, supplemental (incomplete, partial) diets are intended only to help support the natural food (insects, algae, small fish) normally available to fish in ponds or outdoor raceways. Supplemental diets do not contain a full complement of vitamins or minerals, but are used to help fortify the naturally available diet with extra protein, carbohydrate and/or lipid (Bolorunduro, 1995). Fish, especially when reared in high densities, require a high-quality, nutritionally complete, balanced diet to grow rapidly and remain healthy (www.ext.vt.edu, 2011).

MATERIALS AND METHODS

Fish feed formulation and preparation

The supplementary fish feed is formulated by combining and obtaining the necessary protein requirement for juvenile stage of fishes by using the pearson's method of formulation of fish feed (NAERLS, 2002). The protein requirements for *Clarias gariepinus* at this stage of development is put at 35-40% crude protein. This is arrived at by considering the percentage of crude protein in the choice of feed i.e. maize white (10.8%) crude protein and 40.7% for raw soya bean (NAERLS, 2002). The respective constituent of the meal are properly blend using an electric blender and mixed thoroughly upon the determined quantity using the pearson's method of estimation, other feed constituent are added in the following measures and in no particular order; fat 10%, carbohydrate 20%, minerals and vitamins 1.5% (multi- mineral premix), vitamins is applied generously, binding agent (agar) 2%, preservatives (antimicrobial and antioxidant) sourced from vitamin E 0.005% the dry weight of the entire feed, in the absence of glycine cray fish is added as an attractant to stimulate a strong feeding behaviour of the fishes (Hardy and Barrows, 2002). The feed is formulated dry with a final moist content of 7% and turned into pellet forms of 2 mm and 3 mm using a rotary grinder (Hardy and Barrows, 2002). 10 kg of feed is prepared using the Pearson's method of formulation to get 40% crude protein from Maize yellow and Soya bean combination.

To get 40% crude protein feed the formulation is as follows;

Maize yellow = 10.8% crude protein
Soya bean = 40.7% crude protein
Maize yellow = 10.8
Soya bean = 40.7
Total= 29.9
Maize white = $0.7 \times 100 \div 29.9 = 2.34$
Soya bean=$29.2 \times 100 \div 29.9 = 97.66$
The contributions from the feeds are then as follows;
Contribution from maize =
$2.34 \times 10.8 \div 100 = 0.25$
Contribution from soya bean =$97.66 \times 40.7 \div 100 = 39.75$

Therefore 0.25% + 39.75% = 40% crude protein that is to produce 10 kg meal containing 40% crude protein from soya bean and maize white would require 39.75% of soya bean accounting for 3.975 kg by mass and 0.25% of maize yellow accounting for 25 g by mass of the entire fish feed.

Feed preparation

There is no specific method for preparation of a formulated fish feed, however the preparation procedure that was employed involves the formation of dough- like mixture of the aforementioned feed constituent. The dough is started with blends of the dry ingredients, which is finely grounded and sieved to remove chaff. The dough is kneaded and water is added to produce the needed consistency for the fishes. After this heat is applied at a temperature of between 85-90ºc to produce dry feed and sustain the vitamin content since they deteriorate at temperatures above 92ºc. The heating is done to reduce moisture content and is done with the aid of a regulated hot plate upon drying extra oil is added to the dough to allow for easy floating. The prepared pellet is then stored in bags (cellophane) for onward usage (Hardy and Barrows, 2002).

Purchase of feed and fishes

The species of fish employed in this research is the *Clarias gariepinus* (Cat fish) and was purchased from the Agricultural Development Project (ADP) office/ farm in Gwagwalada Abuja. Fifty (50) of these fishes are purchased and in batches of tens in five (5) separate bowls that serve as the improvised pond. The already processed commercially available feed (Coppens and Aquamass) is purchased from the same institute and a proper comparative study to determine the more suitable of both feed is done and result taken for analysis.

Method of feeding the fishes

The fishes are fed by broadcast method for eight weeks twice a day (Morning and Evening) that is between 6 and 8 a.m. and between 6 and 8 p.m. with one quarter the mass of the fish weight. The feed is poured on the surface of the water and the fishes are allowed to come up and collect food, feeding is stopped when the fishes are seen to stop collecting the feed indicating their satisfaction. This style of feeding is employed in other to study the growth rate and development of the fishes. The bowls (improvised ponds) are divided into three pairs containing the same number of fishes and are fed at the same period of time. The fishes on purchase and transportation are first fed with commercially available feed (Coppens) for the first six weeks after which the feed is substituted with the laboratory prepared feed and a comparative study is done over the next eight weeks.

Statistical analysis

The statistical analyses employed are:

(a) Student T-test to determine if there is a mean difference in the weight and length of the fishes in comparison to the feed given and used in the study.

(b) Analysis of Variance (ANOVA): to determine if there is a mean difference in the weight and length of the fishes in comparison with the feeds used in the study. This analysis is done using the Statistical Programme for Social Sciences (SPSS) version 16 software.

Result analysis

Rearing facilities

The experimental device of these experiments is made out of (6) 50L bowl, in open system. The water supply was taken from the water tap located at the Senate building of University of Abuja main campus.

Feeding and measurement

Treatment C served as the control treatment using Aquamass feed (floating diet) containing 42% crude protein, 13% crude fat, 1.9% crude fibre and 8.9% ash was used as control feed for the first treatment. Treatment B also a comparative control employed Coppen meal containing 40% crude protein 13% crude fat, 1.9% crude fibre and 8.9% ash (Treatment A) maize 5 kg, soya bean 10-42%, blood meal 5-50%, fish meal 10-72%, wheat oil 20-20%, bone meal 0.1%, lysine 0.1% and methianine 0.1%. The fingerlings were fed 4% of their body weight twice daily, morning (6 to 8am) and evening (6 to 8pm). Samplings of fish for weight and length measurement were initially done using a scoop net. However due to difficulties in collecting the fish with the net, the water volume was reduced with a rubber siphon before the fishes were collected with the scoop net. Fish weight (g) was taken using a top loading balance (Model: Ohaus precision plus). The fingerlings were weighted in group once a week. The standard length of the fish was taken to the nearest mm with the aid of a measuring ruler. This was done once a week. Depleted water was replaced with fresh water to an effective depth of 20 cm after each cleaning.

Food utilization parameters

Specific growth rate (SGR)

This is calculated from data on changes of the body weight over the given time intervals according to the method of Brown, (1957) as follows;

$$\mathrm{SGR}\ \% = \frac{\mathrm{Ln\ W2} - \mathrm{Ln\ W1}}{\mathrm{T} - \mathrm{t}} x100$$

Where: W1 is the initial weight (gram at time t), W2 is the final weight (gram at time T) (Brown, 1957).

Food conversion ratio

$$\mathrm{FCR} = \frac{\text{Weight of food consumed per fortnight (g)}}{\text{Weight gained by fish per fortnight (g)}}$$

Weight gain (g)

Weight gain (g) is calculated as the difference between the initial and final mean weight values of the fish in the bowl.

Table 1. Treatment A (Soya bean and White Maize Laboratory prepared) production parameters.

Week	Gross total weight (g)	Mean weight (g)	Weight gained (g)	Total length (mm)	Mean length (mm)
1	50	20	0	80	15
2	60	25	70	100	17
3	88	27	50	125	18
4	104	27	45	131	18
5	125	29	44	150	20
6	130	29	30	153	25
7	142	29	31	165	26
8	148	30	32	170	27

Table 2. Treatment B (Coppens fish meal) Production parameters

Week	Gross total weight (g)	Mean weight (g)	Weight gain (g)	Total length (mm)	Mean length (mm)
1	100	10	0	19	15
2	125	10	20	25	17
3	150	10	21	31	17
4	160	10	18	50	18
5	170	10	12	53	21
6	181	10	5	65	24
7	180	12	5	70	26
8	192	12	10	89	27

$$\text{Weight gain } (\%) = \frac{\text{Final weight}}{\text{Initial weight}} \text{x}100$$

Survival rate (SR)

The survival rate, SR is calculated as total fish number harvested/total fish number stocked expressed in percentage.

$$\text{Survival } (\%) = \frac{\text{Total fish number harvested}}{\text{Total fish number stocked}} \text{x}100$$

Relative weight gain

$$\text{Relative weight gain (RWG)} = \frac{\text{W2} - \text{W1}}{\text{W1}} \text{x}100$$

Mean growth rate (MGR)

This is computed using the standard equation;

$$\text{MGR} = \frac{\text{W2} - \text{W1}}{0.5(\text{w1W2})} \text{x}100$$

Where; W1 = Initial weight, W2 = Final weight, t = Period of experiment in days, 0.5 = Constant.

Percentage weight gain (%WG)

This is expressed by the equation:

$$\%\ \text{WG} = \frac{\text{Wt} - \text{W0}}{\text{W0}} \text{x}100$$

Where; W0 =weight, Wt = Weight at time t.

RESULTS AND DISCUSSION

During the experimental period, the range of temperature value was between 25 to 29°C, the pH value of the water employed was between 6.5 to 9.01 and the dissolved oxygen value did not fall below 5.0mg/l (Tables 1 to 3 and Figures 1 to 3). In other to compare the production parameters of the feed employed in the course of this research the results are studied from the average of the three treatments. Each of the treatments as seen in (Tables 1 to 3 and Figures 1to 3) respectively for the laboratory prepared meal, Coppen and Aquamass feed. The highest value that is in terms of weight gained was obtained from the soya bean and corn meal laboratory prepared feed (50 g) and that of the already prepared meal corresponding to Aquamass was (30 g). However, Aquamass recorded the highest mean length at 28 mm with the locally processed feed recording its highest mean length at 27 mm. The mean weight of *Claries garipiens* varied based on the treatment (feed) administered. This is in response to the varying constituent of the feed employed. The mean weight gained over the eight weeks of culturing were 23.3± 0.02, 10.5± 0.01, and 27.1± 0.05 corresponding to laboratory prepared feed (Treatment A), purchased feed (Coppens) treatment B and purchased feed (Aquamass) Treatment C respectively. This is indicative of the fact that increased protein value in feed

Table 3. Treatment C (Aquamas fish meal) production parameters

Week	Gross total weight (g)	Mean weight (g)	Weight gained (g)	Total length (mm)	Mean length (mm)
1	110	27	0	151	25
2	112	27	30	158	25
3	147	27	30	165	25
4	149	27	28	170	25
5	153	27	29	183	26
6	167	27	27	207	27
7	159	27	25	200	27
8	169	28	26	223	28

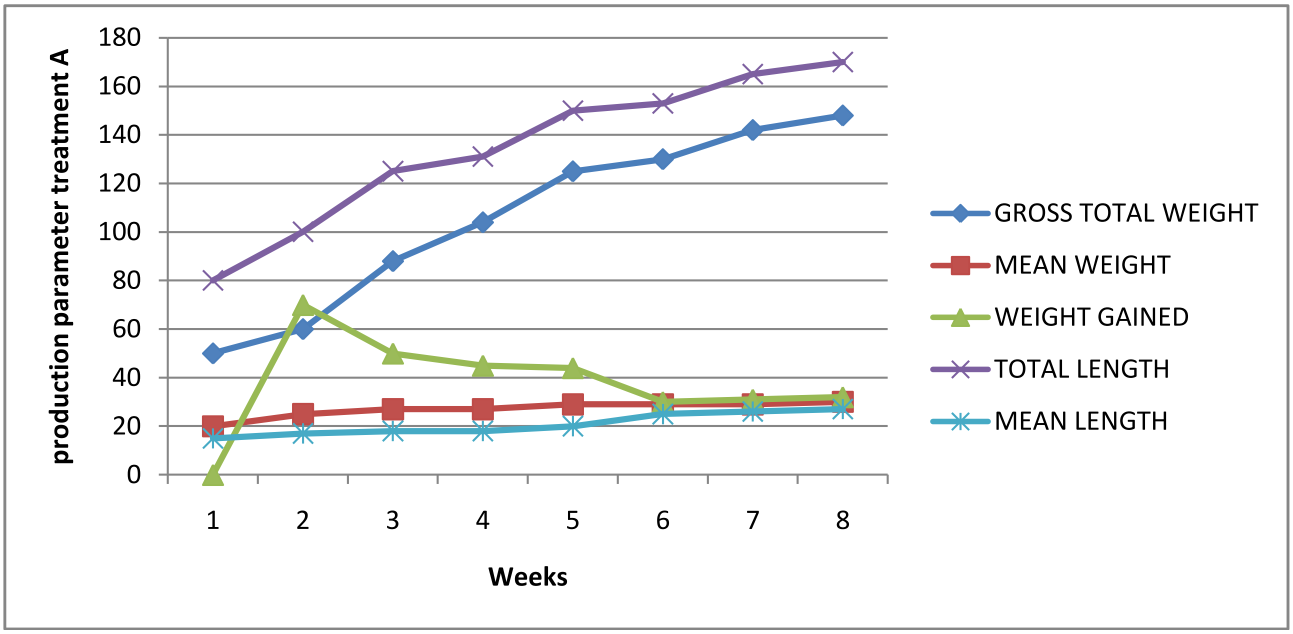

Figure 1. Graphical representation of production parameters of treatment A.

and high carbohydrate is good for fish feed production (Abu et al., 2010). The difference in growth observed between the treatments diets are indication of the variation in the feed utilization. This work is in consonance with Abu et al. (2010) who reported that supplementing manufactured feed with laboratory feed processed from cassava meal led to a good conversion rate and subsequently better production.

The ability of an organism to convert nutrients especially protein and carbohydrate will positively influence its growth performance. This is justified by the mean weight gain of 23.3±0.02 g of the soya bean and corn meal feed showing a good utilization of feed by the fish. According to De Silva and Anderson, (1995) a conversion ratio is between (1.2-1.8) for fish feed carefully prepared diets and the result from this research study falls within the range. The high survival rate recorded in this study indicates that feeding *Clarias gariepinus* with soya bean and maize meal does not lead to mortality of the fish. Cardoso et al., (2005) observed that natural feed (Cassava) enhances survival and healthy state of fish at all stages of their life.

Some earlier studies with rainbow trout as well as European seabass have suggested that the major problem connected with poor growth of fish fed fish meal-free, plant-protein- based diets is caused by poor feed intake (Cordoso *et al*., 2005). In European sea-bass fed diets containing very high levels of single protein sources such as soy protein concentrate or corn gluten meal, there was a decrease in voluntary feed intake (VFI), which was improved by supplementation with an attractant mix (De Silva and Anderson, 1995). But other data indicate that when the same protein sources replaced about 60% of fish meal, adequately supplemented with limiting amino acids such as lysine or methionine, there was no need for an attractant mix such as squid extract (De Silva and Anderson, 1995). It is thus of interest to note that the diets used here lead to increase in fish growth rate and improved their conversion rate in comparison to the

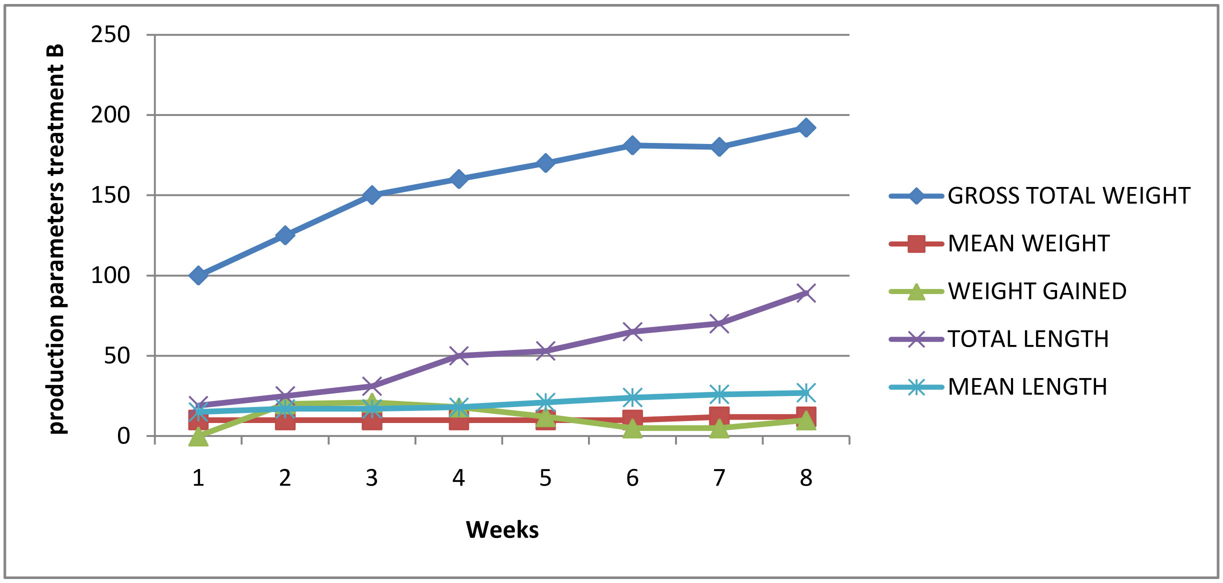

Figure 2. Graphical representation of production parameters of treatment B.

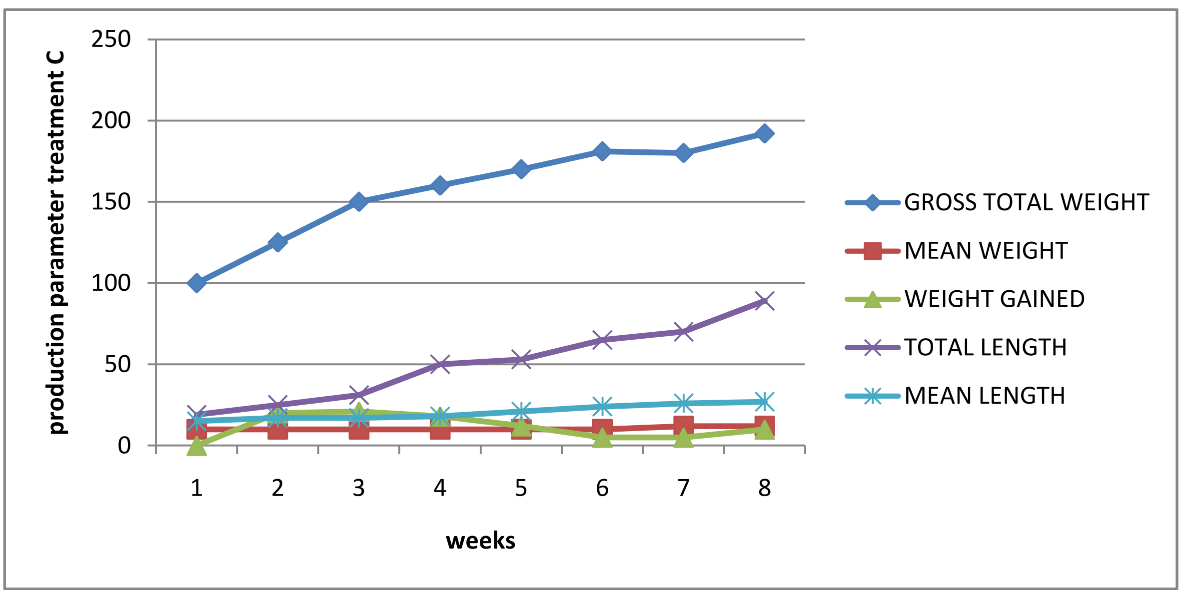

Figure 3. Graphical representation of production parameters of treatment C.

already manufactured feed.

Conclusion

Based on the results obtained from this study the use of soya bean and maize in the preparation of feed used in the feeding of fishes (*Claries garipiens*) cat fish enhanced growth and survival of the fish. Hence fish farmers can therefore take advantage of this ingredient as a replacement for more expensively available feed.

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APPENDIX

TO TEST THE DIFFERENCE IN MEAN OF TREATMENT A (LABORATORY PREPARED FEED) AND TREATMENT B AND C (PURCHASED FEED) .

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
C+M & C+H	12.61129	1	12.61129	21.31924	0.001716	5.317655
Error	4.73236	8	0.591545			
Total	17.34365	9				

Hypothesis

H_0: There is no significant difference in the effect of the meals on the growth rate of the fishes
H_1: There is significant difference in the growth of the fishes fed with the meals

Significance level:- $\alpha = 0.05$

Critical Value and Rejection region:-

Reject H_0 if p-value ≤ 0.05
F=21.31924, p-value=0.001716
From the above analysis, it can be seen that the p-value (0.001716) <0.05, thus we reject H_0 and conclude that There is significant difference in the effect of the meals.

DESCRIPTIVE STATISTICS

Treatments	***A***	***B***	***C***
Mean	1.182	Mean	3.428
Standard Error	0.308389	Standard Error	0.376183
Median	1.03	Median	3.59
Mode	#N/A	Mode	#N/A
Standard Deviation	0.68958	Standard Deviation	0.841172
Sample Variance	0.47552	Sample Variance	0.70757
Range	1.8	Range	2.05
Minimum	0.43	Minimum	1.97
Maximum	2.23	Maximum	4.02
Sum	5.91	Sum	17.14
Count	5	Count	5

From the descriptive analysis, the standard error of Treatment A and Treatment Band C are given below
Standard error of treatment A = 0.308389.
Standard error of Treatment B and C= 0.376183.
From the descriptive analysis, it can be seen that treatment A has a minimal standard Error than Treatment B and C and is therefore more effective.