EVALUATION OF GROWTH PARAMETERS IN POST LARVAE CATFISH IN RELATION TO FEED TYPES

ABSTRACT

The aim of this research is to evaluate growth parameters in post larvae catfish in relation to feed types. This study will analyze the trend for length of *Claria gariepinus* fed on commercial feed, maggot and zooplankton; analyze the trend of weight of *Claria* gariepinus fed on commercial feed, maggot and zooplankton; analyze the relationship between length and weight and; make forecasts for the length and weight of the fish fed on the specified feed types. Artificial reproduction of African Catfish (*C geriepinus*) was carried out using the hypophysation technique. Brood stocks were selected from centrally located parent stock holding ponds. Males and females were conditioned in separate ponds. The brood stocks were fed with 20% crude protein formulated feed, acclimatized for three weeks, then transferred into the hatchery holding tanks between 24^0 Celsius and 27^0 Celsius to stimulate ovulation after injecting the females with 0.5ml of ovalin. Fertilized eggs were incubated in continuous flow of water until hatching was completed. A commercial starter feed consisting of 8% ash, 6% fiber, 12% NFE, 1.5% calcium, 1.6% sodium, 1.5% phosphorous and sufficient amount of essential vitamins. Time series analysis and regression analysis were applied in the study. It was found that the length and weight of post larvae fed on mixed zooplankton was consistently lower than the other treatments. The length and weight of the fish fed on the three feed types were successfully modeled and forecasts made for future five periods while the relationship between length and weight was found to be significant on a linear regression model. This certainly adds value as the weight of post larvae catfish is measure with less difficulty and without causing injury or stress to the fish than measurement of length.

KEYWORDS: Growth parameters, Catfish, hypophysation, trend analysis, regression analysis, artificial reproduction.

1.0 INTRODUCTION

The African catfish (*Claria gariepinus*) is among the most common fish species for aquaculture production in Nigeria. In the last two decades *C. gariepinus* has developed into one of the most successfully cultured species in Nigeria. The suitability of the species for aquaculture arises from its high growth rate, tolerance of high stocking density and poor water quality; acceptance of both artificial and non-specialized feeds and high market demand.

The development of a successful aquaculture program requires a reliable and consistent supply of seeds. Meanwhile, the major concern of any seed production in the hatchery system is to produce the maximum number of quality fingerlings from the available suitable brood stock. Since the African catfish does not reproduce naturally under captivity, artificial reproduction methods had been developed. The most reliable method developed so far for Catfish seed production is through induced spawning in indoor hatchery (Haylor & Muir, 1998). The hatchery seed production involves the use of hormones (natural or synthetic) as the only reliable method to induce spawning, artificial fertilization, incubation of fertilized eggs and subsequently feeding live feed followed by dry feed (Brzuska, 2001). The success of this method heavily depends on larvae rearing (Nagoli & Balasubramaniam, 2008). For many fish species, the larvae period is considered critical in their life history. Successful larvae rearing depends mainly on the availability of suitable diets that are readily consumed, efficiently digested and provides the required nutrients to support good growth and health (Giri, Sahoo, Sahu, & Meher, 2003).

Fish, especially first-feeding larvae, often depend on live food. In general, fish species like catfish, carps, salmon, trout and some others have been reared successfully in aquaculture at larvae stage with fully digestive system at starting time of feeding. Irrespective of their nutritional value, live foods are easily detected and captured by the larvae due to their swimming movements in the water column, and they are highly digestible, due to their high nutrient concentration (Conceição, 2010).

The most widely used live food in aquaculture is the Brine shrimp *Artemia salina*. It is popular for mass production, its ease of transport, its ability to form cysts and viability over longer periods of time. The simplicity of cysts hatching establishes its market demand as the most convenient live feed used in larvae culture (Conceição, Yúfera, Makridis, Morais, & Dinis, 2010). *Artemia* is also very nutritious to the larvae because it contains more than 56% crude protein, 17% lipid and 3% carbohydrate (Ileleji, Garcia, Kingsley, & Clementson, 2010). Despite all these advantages of *Artemia* it also has disadvantages of being expensive, always in high demand and not readily available. These conditions makes *Artemia* feed unattractive and unavailable to the sub Saharan Africa farmers.

The other live food currently being used in Africa and other parts of the world are zooplanktons. They are valuable sources of crude protein, amino acids, lipids, fatty acids, minerals, enzymes and carotene. They improve flavor, color and texture of fish that feed on them (Kandathil Radhakrishnan, et al., 2020). Among zooplankton, *Daphnia*, *Moina* and rotifers have been used extensively as live foods for rearing fish larvae and fry (Sorgeloos, Lavens, Leger, & Tackaert, 1986). However, absolute use of live foods as diet for larvae rearing encountered issues associated with high cost and time consuming production techniques (Gonzalez et al., 2008) which can be slightly alleviated by weaning with dry feeds.

Suitable dry feeds for larval and fry rearing should satisfy the nutritional requirements of the species and should be readily accepted. A fundamental aquaculture species considers dietary protein essential since adequate dietary protein significantly influence growth, fish survival and feed cost (Giri, Sahoo, Sahu, & Meher, 2003). The utilization of dietary protein for growth depends on the quantity as well as quality of feed proteins. The main source of protein in aqua feeds remains fishmeal, as it contains a profile of high quality protein with balanced amino acid. The high demand for it, along with supply fluctuation made fishmeal expensive. As a result, relentless efforts have been made to substitute fish meal with other cheaper sources of protein. Several protein sources of both animal and plant origins are being tested as fishmeal replacements. Blood meal, soybean, wheat bran, maize and other formulated feed are in use by different aquaculture farms (Munguti, Kim, & Ogello, 2014).

Feed type, feeding frequency and feed quality are no doubt important to the growth of catfish (Dennis & Uchenna, 2016; Maina, 2020; Khanom, et al., 2022; Remilekun, Akinola, & Olubusola, 2022). For instance, a study of the effect of feeding frequency on the growth, food utilization and survival of African catfish (C. garienpinus) using locally formulated diet has revealed that post larvae fed twice daily has the best growth while those fed once a day has the least (Eyo & Ekanem, 2011) also; a study of Length-Weight relationship of C. garienpinus (catfish) fingerlings fed with local formulated feeds (guinea corn, maize, bone meal and groundnut) and coppen showed that catfish fed on coppen had the best growth performance (Omodu, Solomon, & Wilfred-Ekprikpo, 2017).

Considering the fact that Commercial Feed is the most available in sales outlets, and Maggots and Zooplankton are locally available possible alternatives, this study therefore aims to evaluate the performance of growth parameters namely length and weight in post larvae fish in relation to the three feed treatments (Commercial Feed, Maggots and Zooplankton). Furtherance to achieving the aim, the study will determine the effect of the different feeds on the specified growth parameters; examine the relationship between the growth parameters fed on the different diets, and forecast values of weight and length of post larvae of African catfish in the study population. Hence, the better parameter for use as growth indicator shall be identified.

2.0 METHODOLOGY

To acquire larvae of the African catfish (*C.gariepinus*) for this study, artificial reproduction of the catfish was carried out at the hatchery unit, Animal and Environmental Biology (AEB) Animal house, DELSU. Hypophysation technique (Olurin & Oluwo, 2010) was applied. Brood stocks were selected from centrally located parent stock holding ponds at the Department of Animal and Environmental Biology, Campus II, Delta State University, Abraka. Males and females were conditioned in separate concrete ponds. The brood stocks were fed with 29% Crude Protein formulated feed, acclimatized for three weeks, then transferred into the hatchery holding tanks. During the period, the temperature of water in the tanks was maintained between 24 to 27^{o}C to stimulate ovulation. One female catfish (1.3 kg weighted at the experiment) was injected with Ovalin, a synthetic hormone, at a dosage of 0.5ml. The ovulation control started within 12 hours after Ovalin stimulator injection. Fish was checked for ovulation by gently pressing the abdomen (Freund, Hörstgen-Schwark, & Holtz, 1995). The eggs obtained from striped female was fertilized in a bowl with milt obtained from one sacrificed male catfish. The fertilized eggs were placed in incubating tanks where continuous flow of water was allowed until hatching was finished in 26 hours (i.e. After 22 hours, fertilized embryos start to hatch) in warm water of 25 - 27^{o}C.

The treatments (diets) consist of three feeds namely; commercial feed, maggot and zooplankton. The commercial starter feed used for the study has the trade name Coppens Catco Crumble

Excellence. The nutritional information of the feed are moisture, 8%; crude protein, 49%; fats, 12%; ash, 8%; fiber, 6%; NFE, 12%; calcium, 1.5%; sodium, 1.6%; Phosphorous, 1.5% and sufficient amount of essential vitamins.

2.1 MAGGOT

The maggot used in the study are larvae of common housefly (Musca domestica). The choice of Musca domestica was based on its short life cycle, availability and nutritional and economic value. A matured female housefly of ten days lied up to five hundred eggs in several batches of seventy-five to one hundred and fifty eggs over three to four days. It took approximately one day for the eggs to hatch into larvae. The maggots were cultured in a substrate mixture of poultry manure and bones from abattoir (Plates.1a and 1b). The harvested sample was processed by oven drying in the laboratory at a temperature of 105^{0}C until 92.7% dry matter was attained. The feed was crushed, pelleted and used as juicy diet to feed fish larvae, or used as live feed directly on post larvae.

Plate 1a Maggots grown from poultry waste **Plate.1b** Maggots culture in bones from slaughter

2.2 ZOOPLANKTON CULTURE (*Moina* sp.)

Zooplankton were sampled from AEB fish pond using a net of mesh size 50µm.The zooplankton were acclimatized in the laboratory and cultured in five aquaria which held up to 30L of water each (Plate.2). From these, several subsamples were cultured separately until a pure culture of

Moina sp was achieved as in (Okunsebor & P.C., 2012). They were fed on green algae (*Chlorella* sp.). Each concentration was aerated gently to distribute the nutrient in the culture in line with (Ovie & Ovie, 2004). The aeration of the laboratory cultures of *Moina* sp. hastened the development of the egg-bearing females, the number of eggs per egg-bearing female and the biomass of *Moina.* In addition, aeration ensured that dissolved oxygen and pH levels were maintained at consistent higher levels and reduced levels in conductivity and ammonia as proposed by (Ovie & Ovie, 2004).

The batch culture method of producing *Moina* was adopted with a continuous series of cultures. A new culture was started daily in a separate container. When all the fungal, bacterial, and algal cells were consumed (usually about 5-10 days after inoculation), the *Moina* were completely harvested, and the culture was restarted. The Batch culture was used in maintaining pure cultures of *Moina* because it had less chance of the cultures becoming contaminated with competitors (e.g., protozoans, rotifers, copepods).

Plate 2: Culture of zooplankton (*Moina* sp.) with constant aeration in the laboratory.

2.3 LARVAE REARING

The rearing of the fish larvae was carried out in the indoor hatchery unit of the Department of Animal and Environmental Biology located in Site II of the Delta State University, Abraka. Immediately after reabsorption of the yolk sac on the third day after hatching, larvae were randomly distributed into 45 plastic tanks in a flow-through system at a density of 500 fish per tank. The tanks of 32 litres water holding capacity (38 cm in length x 27 cm in width x 22 cm in height) were adequately filled with 30 litres of clean water. At the onset of the feeding trials, 15 fry were removed from each experimental tank and batch weighed. This was repeated daily for 21 day period. Larvae were fed one of the treatment diets {Commercial Feed (CF), Maggot (MM), Zooplankton (*Monia* sp.) (ZP)} *ad libitum* in the morning and evening, using the completely randomized block design. They were considered satiated when they stopped searching for food and assembled in the corners of the aquaria. Temperature, dissolved oxygen (DO) and pH were measured daily while ammonia and nitrite values were measured and recorded weekly. Tanks were cleaned daily before feeding by siphoning off faeces and uneaten food. Dead larvae were siphoned and counted to estimate survival. During each evaluation, weight of fifteen fishes was taken and recorded using electronic sensitive weighing balance to the nearest 0.0001g and their length taken on a measuring board and recorded to the nearest 0.1cm respectively.

Plate.3: Fish larval rearing in the laboratory through a flow system.

Post larval rearing using three different experimental diets

After the completion of the 21 days rearing period for the fry, the post larval rearing commenced immediately. Here, the experiment lasted for twelve weeks at a stocking density of 150 fish per concrete tank. At the onset of the feeding trials, 15 fry were removed from each experimental tank and batch weighed. This was repeated weekly for 12 weeks. Three treatment diet namely Commercial feed (CF), Maggot (MM) and Mixed zooplankton (MZ) were used to feed the post larvae replicated thrice in a completely randomized design. Fish growth performance parameters measurement were conducted weekly through to the 12th week of culture. During each measurement, weight of fifteen fishes was taken and recorded using electronic sensitive weighing balance to the nearest 0.01g and their length taken on a measuring board and recorded to the nearest 0.1cm respectively. Temperature, DO, pH, ammonia and nitrite values of the various test tank water were recorded weekly.

2.4 METHOD OF DATA ANALYSIS

The methods of data analysis applied in this study are mainly the linear trend analysis for time series and the linear regression analysis for the relationship between two random variables. The both methods adopted in this study are based on the least squares methods of estimation of model parameters in order that the prediction error in minimized.

2.4.1 LINEAR TREND ANALYSIS:

Let y_t be a random variable indexed by time, t. The changes in y_t with respect to t is represented in the model:

$$y_t = a + bt + e_t \qquad (1)$$

where a and b model parameters representing the intercept and slope respectively and e_t is the error associated with the prediction of y_t, believe to be normally distributed with mean equal to zero and homoscedastic.

Using the least squares method as mentioned earlier, with n observations taken on the random variable, a and b are estimated as

$$a = \frac{\sum_{t=1}^{n} y_t}{n} - b\frac{\sum_{t=1}^{n} t}{n} \qquad (2)$$

$$b = \frac{n\sum_{t=1}^{n} y_t t - \sum_{t=1}^{n} y_t \sum_{t=1}^{n} t}{n\sum_{t=1}^{n} t^2 - (\sum_{t=1}^{n} t)^2} \qquad (3)$$

Using the estimates of a and b in Equations 2 and 3, the predictive model is given as

$$\hat{y}_t = a + bt \qquad (4)$$

Hence, for any given time, t, the random variable, y_t, can be predicted and the prediction error determined as

$$e_t = y_t - \hat{y}_t \qquad (5)$$

(Neter, Wasserman, & Kutner, 1995)

The performance of the model can be evaluated using the Mean Absolute Percentage Error (MAPE) given as

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|e_t|}{y_t} = \frac{1}{n}\sum_{t=1}^{n}\frac{|y_t - \hat{y}_t|}{y_t} \qquad (6)$$

(VedExcel, 2021)

2.4.2 LINEAR REGRESSION ANALYSIS:

Let X be an independent random variable taking values, $x_i \; \forall \; i = 1, 2, 3, \cdots, n$. Let Y be a second random variable denoted as the dependent variable taking values, $y_i \; \forall \; i = 1, 2, 3, \cdots, n$. The relationship between X and Y can be represented with the model:

$$y_i = a + bx_i + e_i \qquad (7)$$

Where a and b are the regression parameters denoting the intercept and slope respectively, e_i is the error or residual associated with the prediction of the ith dependent variable with the model on the assumption that the relationship between X and Y is linear, and the e_i is normally distributed with constant variance (Neter, Wasserman, & Kutner, 1995; Drapper & Smith, 1998). The parameters are estimated; therefore, by the following equations:

$$a = \frac{\sum_{i=1}^{n} y_i}{n} - b\frac{\sum_{i=1}^{n} x_i}{n} \qquad (8)$$

$$b = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i y_i}{n\sum_{i=1}^{n} t_i^2 - (\sum_{i=1}^{n} t)^2} \qquad (9)$$

Hence, the predictive equation is given as,

$$\hat{y}_i = a + bx_i \qquad (10)$$

And the total sum of squares of the predicted variable, y_i, is given as

$$\sum_{i=1}^{n}(y_i - \bar{y})^2 = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 + \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2 \qquad (11)$$

From Equation 11, the regression sum of squares and the error sum of squares are given respectively as,

$$SS_r = \sum_{i=1}^{n} y_i^2 - \sum_{i=1}^{n} \hat{y}_i^2 \qquad (12)$$

$$SS_e = \sum_{i=1}^{n} \hat{y}_i^2 - \frac{(\sum_{i=1}^{n} y_i)^2}{n} \qquad (13)$$

The performance of the predictive model of Equation 7 is evaluated with the following ANOVA table:

Table 1: ANOVA Table

Sum of Squares	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio
Regression	1	$\sum_{i=1}^{n} y_i^2 - \sum_{i=1}^{n} \hat{y}_i^2$	$MS_r = \sum_{i=1}^{n} y_i^2 - \sum_{i=1}^{n} \hat{y}_i^2$	
Error	$n-2$	$\sum_{i=1}^{n} \hat{y}_i^2 - \frac{(\sum_{i=1}^{n} y_i)^2}{n}$	$MS_e = \frac{\sum_{i=1}^{n} \hat{y}_i^2 - \frac{(\sum_{i=1}^{n} y_i)^2}{n}}{n-2}$	$F = \frac{MS_r}{MS_e}$
Total	$n-1$	$\sum_{i=1}^{n} y_i^2 - \frac{(\sum_{i=1}^{n} y_i)^2}{n}$		

The F – ratio in Table 1 above is the calculated F – value which is compared to tabulated F – value at α level of significance, 1 numerator degree of freedom and $n-2$ denominator degree of freedom. The calculated $F-$ value is henceforth denoted by F_{cal} the tabulated $F-$value is denoted by F_{tab} .

The hypotheses of interest are

$$\left.\begin{matrix} H_0: a = b = 0 \\ vs \\ H_a: a \neq b \neq 0 \end{matrix}\right\} \qquad (14)$$

The null hypothesis of Equation 14, H_0, is rejected in favour of the alternative hypothesis, H_a, if

$$F_{cal} \geq F_{tab} \qquad (15a)$$

Alternatively, a $P-$value, α_0, described as the probability of rejecting a true null hypothesis in the decision taken can be a guide in the decision making. If α is the level of significance; that is, the the acceptable probability of committing a type 1 error then the null hypothesis of Equation 14, H_0, is rejected in favour of the alternative hypothesis, H_a, if

$$\alpha_0 \leq \alpha \qquad (15b)$$

Equations 15 (a and b) is the rejection criterion.

3.0 DATA PRESENTATION AND ANALYSIS

Table 2: Data on the age, weight and length of post larvae catfish fed on Commercial Feed, Zooplankton and Maggot.

Age (Wks)	CF Wt	ZP Wt	MT Wt	CF Lt	M ZP Lt	MT Lt
0	0.07	0.06	0.07	4.60	4.56	4.56
1	11.51	11.37	11.09	7.29	5.74	7.01
2	24.04	23.56	22.71	9.85	9.06	9.46
3	37.60	36.56	35.71	13.41	10.38	11.90
4	52.32	50.56	49.71	15.97	12.67	14.35
5	69.06	65.89	64.71	18.53	15.02	16.80
6	87.56	81.89	81.71	21.09	17.34	19.25
7	108.26	99.22	100.71	23.64	19.66	21.70
8	130.71	117.21	120.71	26.20	21.97	24.15
9	155.22	136.70	142.04	28.76	24.29	26.60
10	180.88	156.70	164.04	31.32	26.61	29.05
11	206.85	176.70	187.04	33.88	28.93	31.50
12	233.85	198.37	210.04	36.44	31.25	33.95

In Table 2 above, the column labelled Age (Wks) contains the age in weeks of the selected post larvae catfish, the column labelled CF Wt contains data on weight of post larvae catfish fed on commercial feed, ZP Wt contains weight of post larvae catfish fed on Zooplankton, MT Wt contains weight of post larvae catfish fed on maggots while CF Lt, ZP Lt and MT Lt contain the length of post larvae catfish fed on commercial fed, zooplankton and maggots respectively.

Table 3: Data on Age, Average Weight and Average Length of Post Larvae Catfish fed on the three feed types

Age (wks)	Mean Weight	Mean Length
0	0.067	4.5733
1	11.323	6.6800
2	23.437	9.4567
3	36.623	11.8967
4	50.863	14.3300
5	66.553	16.7833
6	83.720	19.2267
7	102.730	21.6667
8	122.877	24.1067
9	144.653	26.5500
10	167.207	28.9933
11	190.197	31.4367
12	214.087	33.8800

In Table 3 above, the column labelled Age (Wks) contains the age of the selected post larvae catfish in weeks, Mean Weight and Mean Length contain the average (mean) weight and average (mean) length of the post larvae catfish feed on the three feed types considered in the study.

The relationship between time and the growth parameters (Weight and Length) of Post Larvae of *C. gariepinus* fed on Commercial Feed, Mixed Zooplankton and Maggot is given in Figure 1 below.

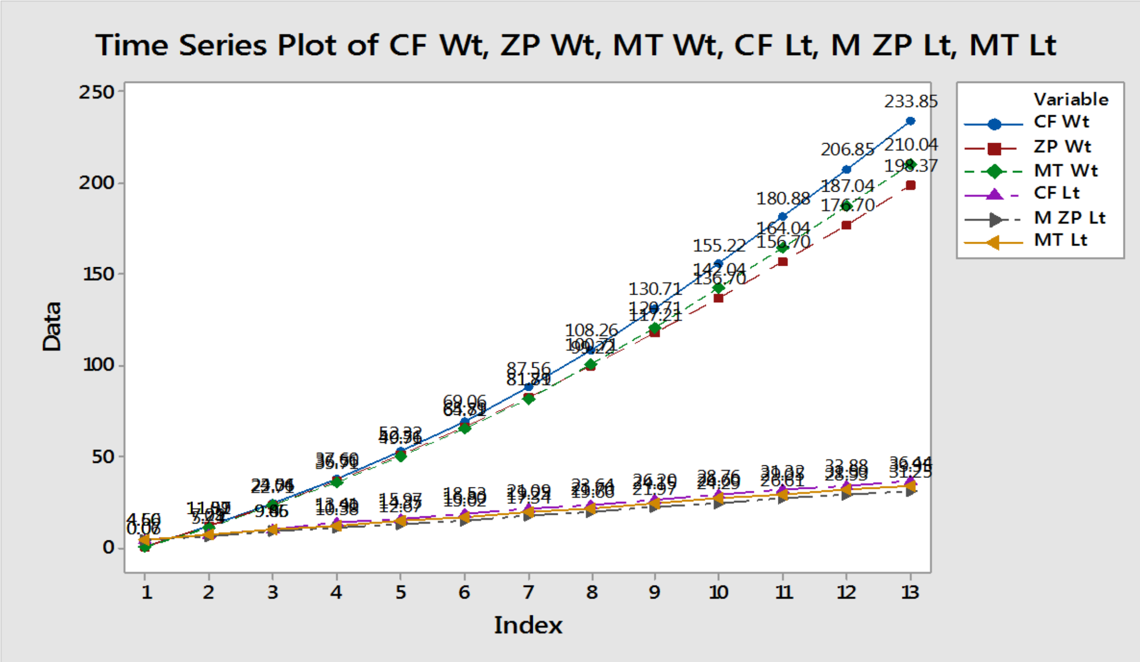

Fig 1: Relationship between time and the growth parameters (Weight and Length) of Post Larvae of *C. gariepinus* fed on Commercial Feed (CF), Mixed Zooplankton (ZP) and Maggot (MT).

The growth index for the length and weight for post larvae fed on mixed zooplankton was consistently lower than the other treatments and it is projected to further decrease with time in comparison to the length and weight of post larvae fed on commercial feed and maggots respectively.

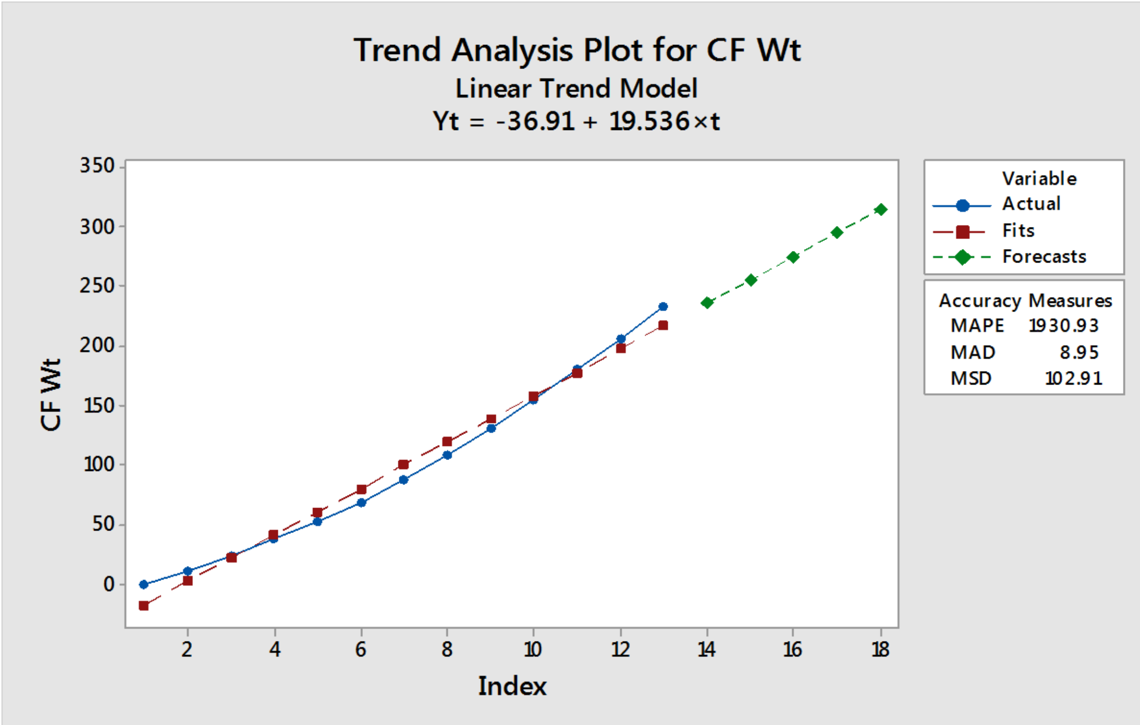

Figure 2: Time series/trend analysis of weight of post larvae fed with commercial feed (CF).

The time series plot for the weight of the post larvae fed on commercial feed is depicted in Figure 2 below. The further five weeks projection or forecast shows a little departure from linearity. However, the linear trend is a fair estimate of the model which gave a forecast of 236.59g after the 13th week and 256.13g, 275.7g, 295.20g and 314.74g after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation below:

$$W_t = -36.91 + 19.536 * t \qquad (16)$$

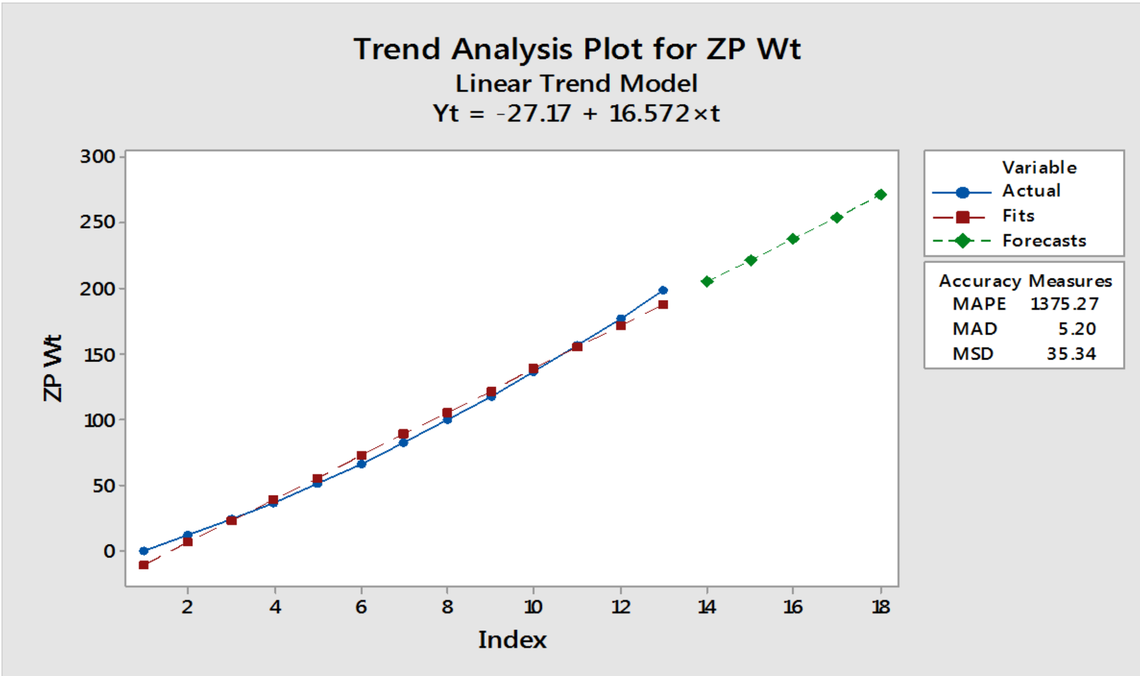

Figure 3: Time series/trend analysis of weight of post larvae fed with mixed zooplankton diet (ZP)

The time series plot for the weight of the post larvae fed on mixed zooplankton diet is given in Figure 3. The five weeks projection or forecast shows a little departure from linearity. However, the linear trend is a fair estimate of the model which gave a forecast of 204.84g after the 13th week and 221.41g, 237.98g, 254.54g and 271.12g after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation:

$$W_t = -27.17 + 16.572 * t \qquad (17)$$

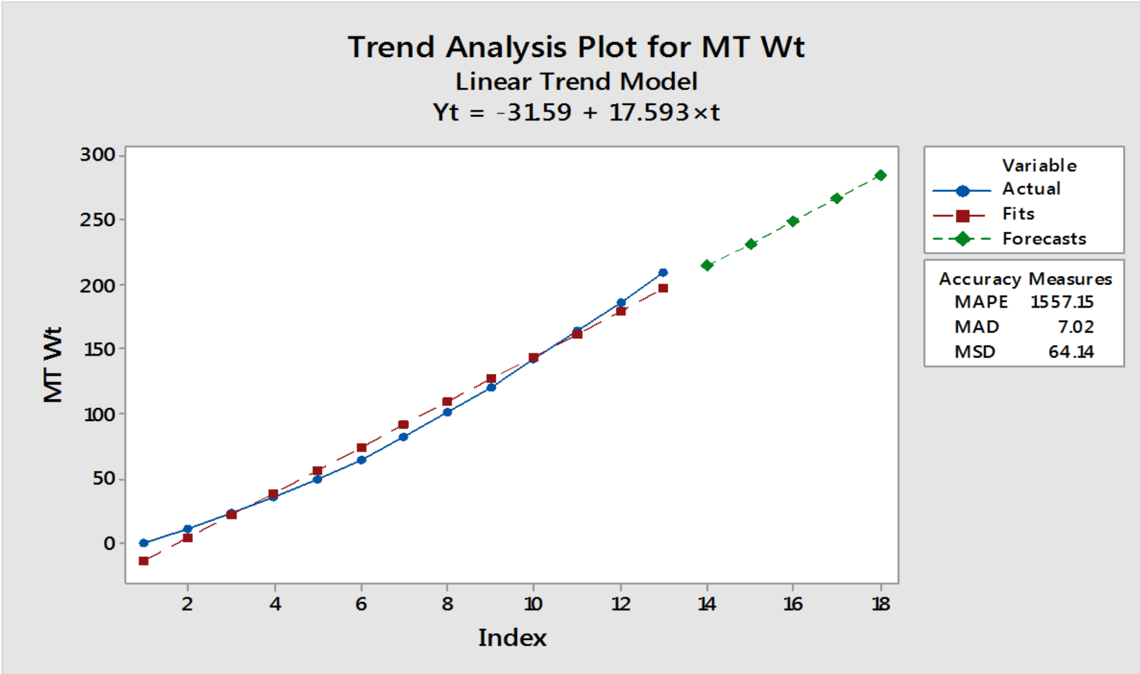

Figure 4: Time series/trend analysis of weight of post larvae fed with maggots (MT).

The time series plot for the weight of the post larvae fed on maggots is given in Figure 4 The five weeks projection or forecast shows linearity. The linear trend is a good estimate of the model which gave a forecast of 213.71g after the 13th week and 232.30g, 249.90g, 267.49g and 285.08g after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation:

$$W_t = -31.59 + 17.593 * t \qquad (18)$$

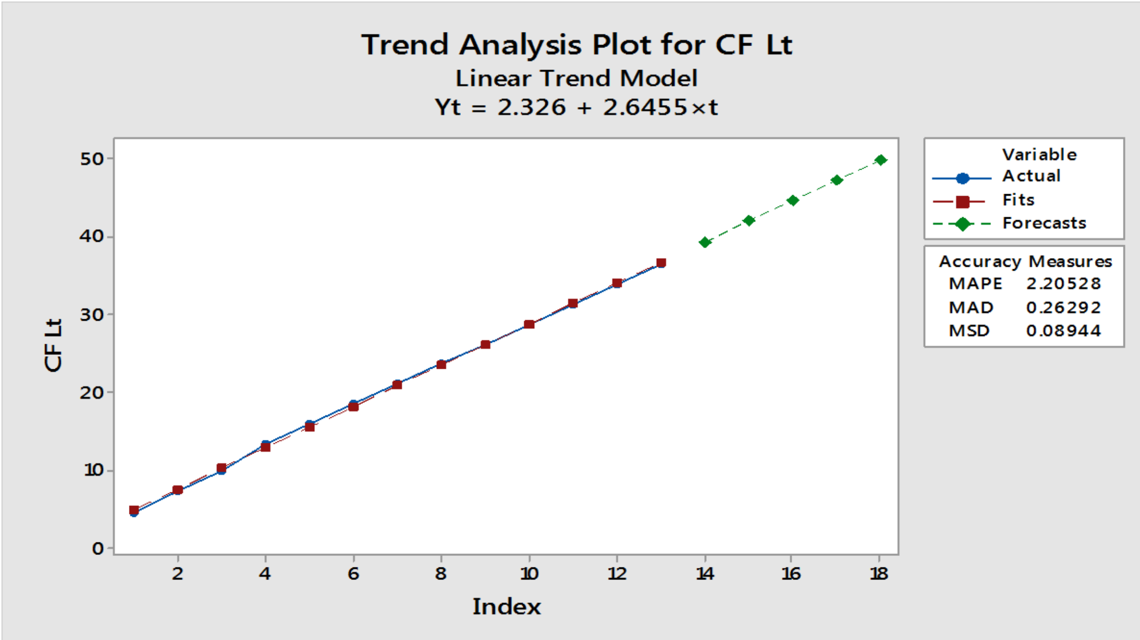

Figure 5: Time series/trend analysis of length of post larvae fed with commercial feed (CF).

The time series plot for the length of the post larvae fed with commercial feed is given in Figure 5. The five weeks projection or forecast shows very linear relationship with the model. The linear trend is a very good estimate of the model which gave a forecast of 39.36cm after the 13th week and 42.01cm, 44.30cm, 47.30cm and 49.95cm after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation:

$$L_t = 2.326 + 2.6455 * t \qquad (19)$$

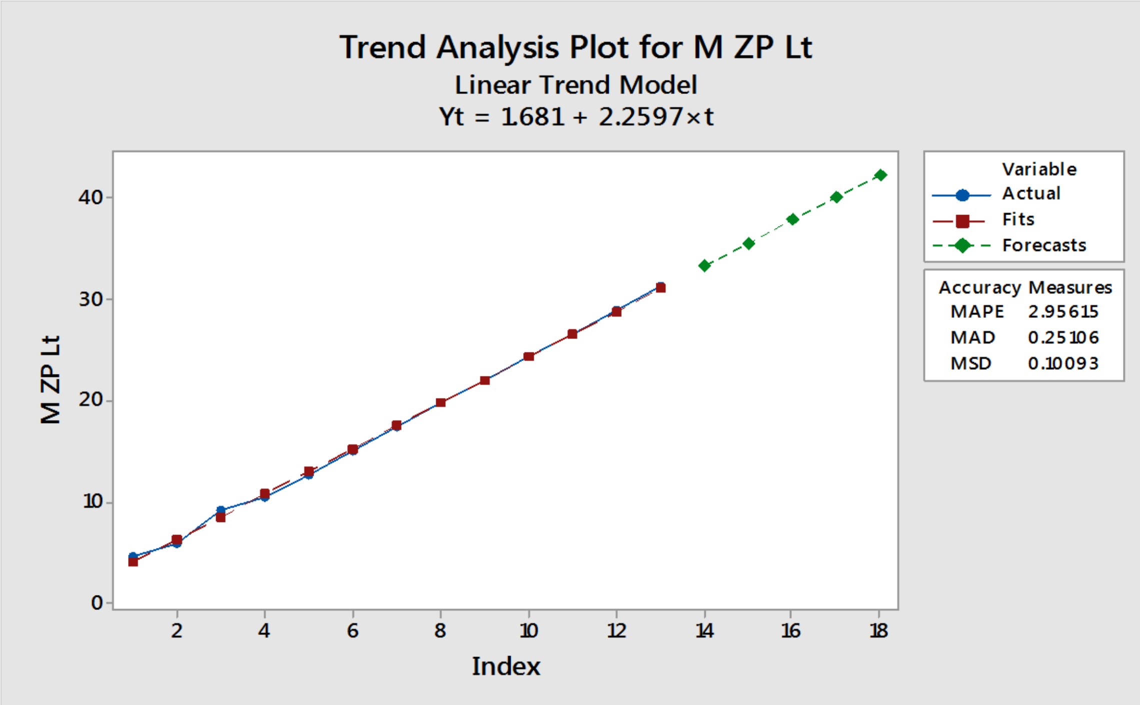

Figure 6: Time series/trend analysis of length of post larvae fed with mixed zooplankton diet (ZP).

Figure 6 is the time series plot for the length of the post larvae fed with mixed zooplankton diet. The projection or forecast for a five week period shows a near linear relationship with the model. Perhaps, it was nonlinear between 0 and the 4th week. The linear trend is a good estimate of the model which gave a forecast of 33.16cm after the 13th week and 35.58cm, 37.84cm, 40.10cm and 42.35cm after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation:

$$L_t = 1.681 + 2.2597 * t \qquad (20)$$

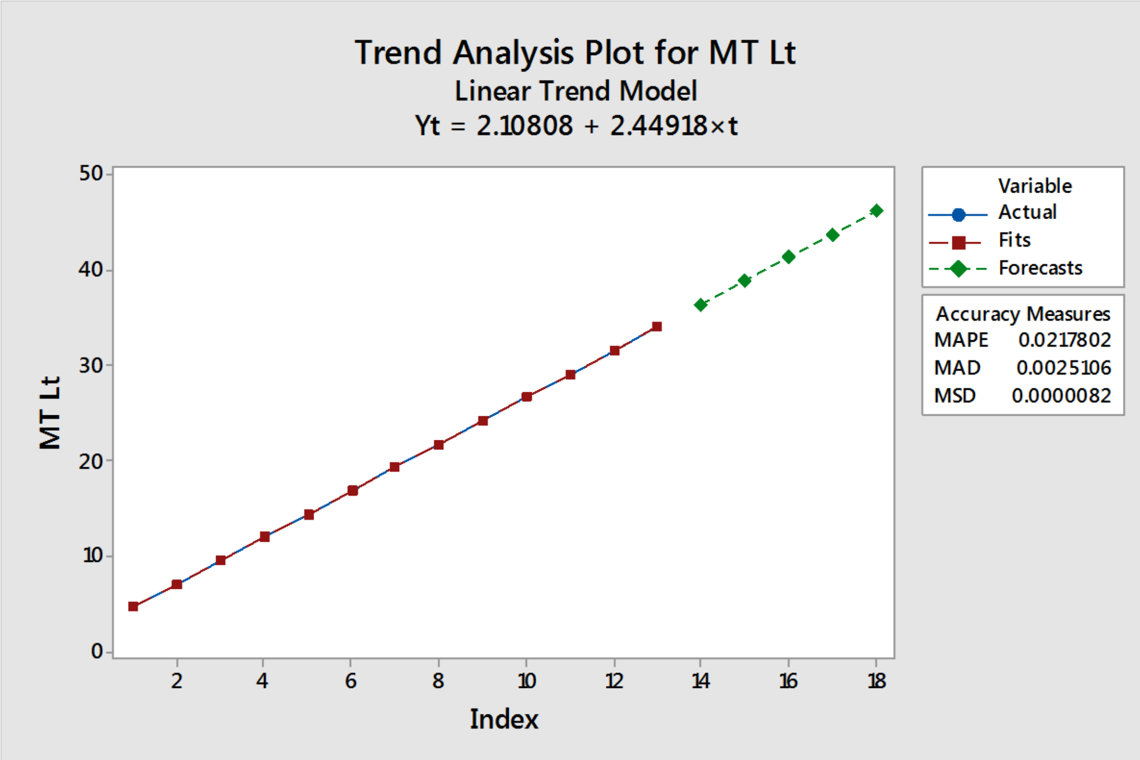

Figure 7 : Time series/trend analysis of length of post larvae fed with maggots (MT).

The time series plot for the length of the post larvae fed with maggot feed is given in Figure 7. The five weeks projection or forecast shows very linear relationship with the model. The trend is a very good estimate of the predictive model which gave a forecast of 36.40cm after the 13th week and 38.85cm, 41.30cm, 43.74cm and 46.19cm after the 14th, 15th, 16th and 17th week of projected culture period. The relationship was established using the time series equation:

$$L_t = 2.10808 + 2.44918 * t \qquad (21)$$

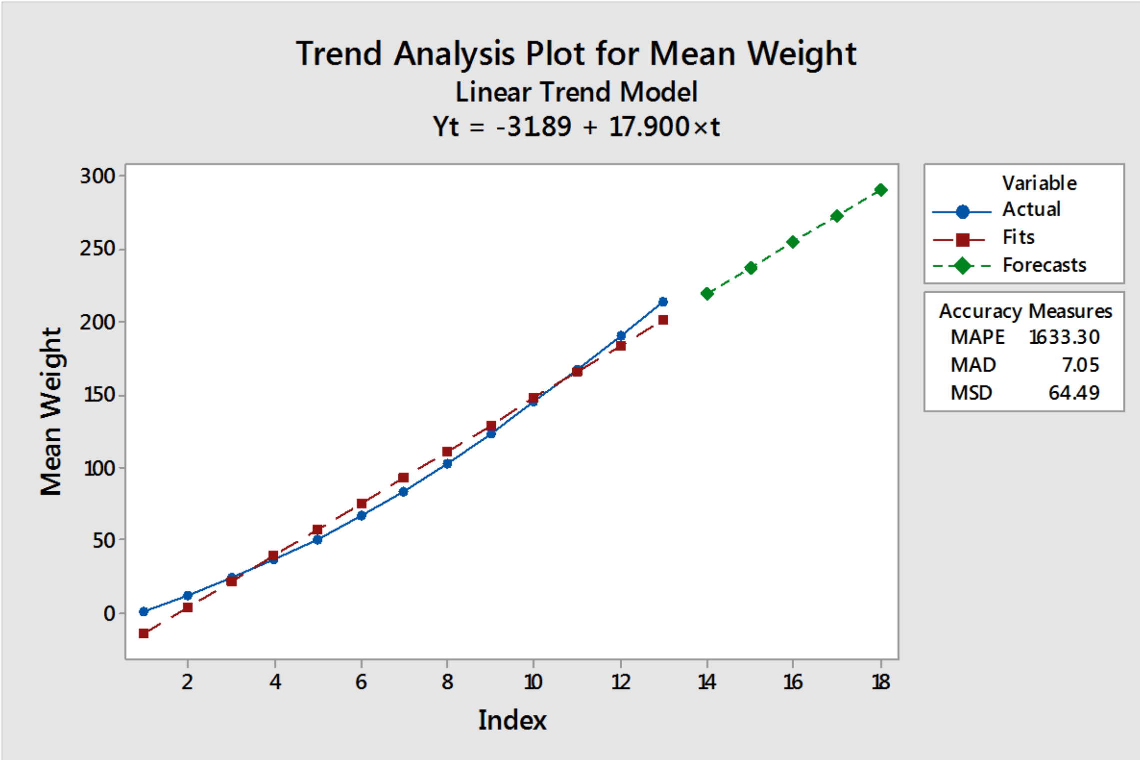

Figure 8 : Time Series/Trend Analysis of mean weight of post larvae catfish fed the three fed treatments.

The time series plot for mean weight of post larvae cat fish fed on the three feed treatments is shown in figure 8. The trend equation was obtained as

$$y_t = -31.89 + 17.90 * t \qquad (22)$$

with error measurements; $MAPE = 1633.30$, $MAD = 7.05$ and $MSD = 64.49$ and forecasts given as 218.713g, 236. 613g, 254.513g, 272.414g and 290.314g for the 13th week, 14th week, 15th week, 16th week, and 17th week respectively.

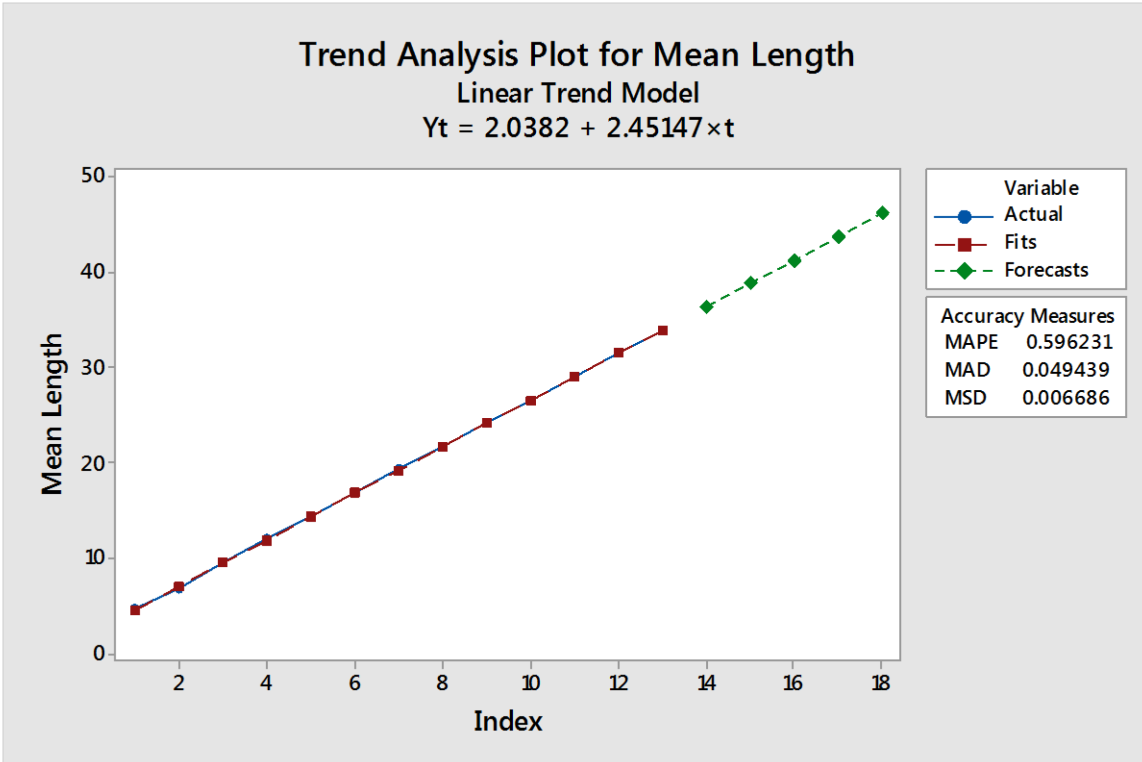

Figure 9: Time Series/ Trend Analysis of mean length of post larvae cat fish fed on the three treatment diets.

The time series plot of meant length of post larvae catfish fed on the three treatment diets is shown in Figure 9. The trend equation was obtained as

$$y_t = 2.0382 + 2.45147 * t \qquad (23)$$

with error measurements; $MAPE = 0.596231$, $MAD = 0.049439$ and $MSD = 0.006686$ and forecasts given as 36.3587cm, 38.8102cm, 41.2616cm, 43.7131cm and 46.1646 for the 13^{th,} 14th, 15th, 16th and 17th week respectively.

REGRESSION ANALYSIS OF MEAN LENGTH AND MEAN WEIGHT

The scatter plot of the relationship between Mean Length (the dependent variable) and mean weight (the independent variable) is shown in Figure 9.

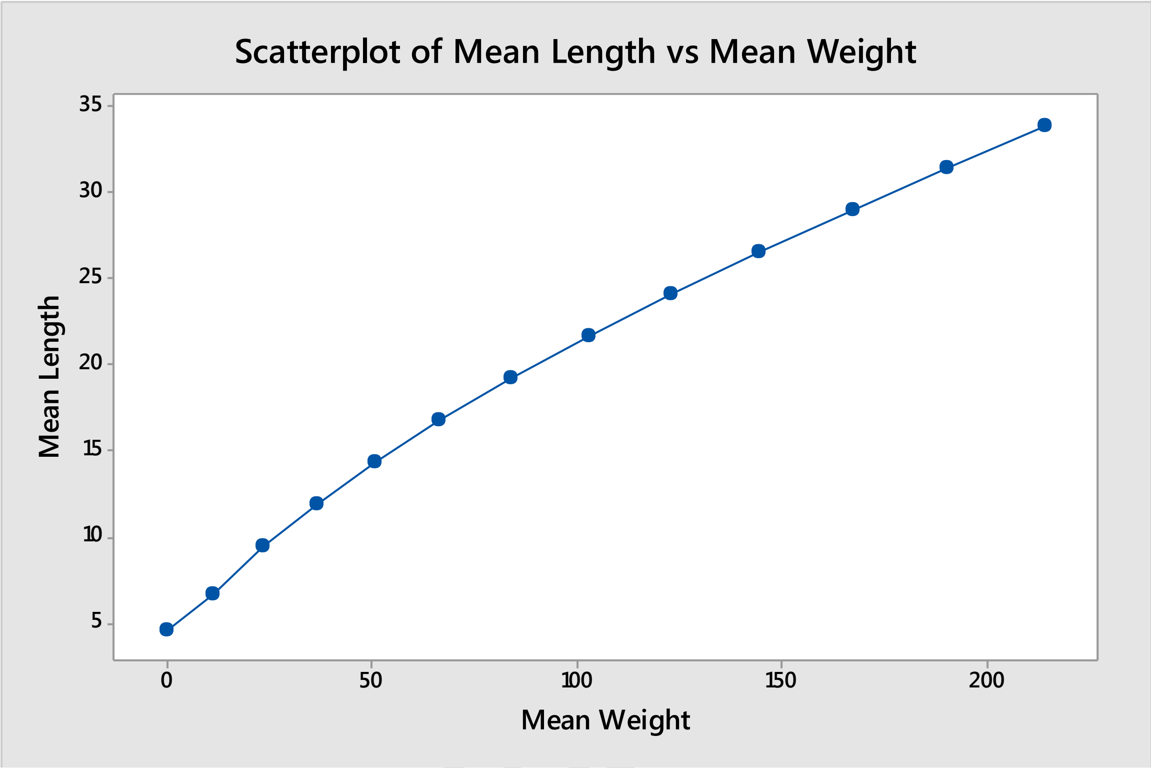

Figure 10: A scatter of the relationship between mean length of post larvae catfish and mean weight.

The scatter plot is suggestive of a linear relationship hence, a linear regression model is adopted for the prediction of the relationship between the two variables.

The predictive model was estimated as

$$Mean\ Length = 6.591 + 0.13497 * Mean\ Weight \tag{24}$$

Table 4: ANOVA TABLE FOR REGRESSION OF MEAN LENGTH ON MEAN WEIGHT

Sum of Squares	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	P-Value
Regression	1	1077.63	1077.63	730.82	0.000
Error	11	16.22	1.47		
Total	12	1093.85			

Now, the null hypothesis, $a = b = 0$, is rejected since the p −value 0.000 is less than the 0.05 at the 5% level of significance and accept the alternative, $H_a: a \neq b \neq 0$.

4.0 SUMMARY AND CONCLUSION

The study has successfully evaluated the growth parameters (weight and length) of post larvae catfish fed on Commercial feed, Zooplankton and Maggots. The experiment was carried out at the hatchery unit, Animal and Environmental Biology (AEB) Animal house, Delta State University

(DELSU). Statistical analysis of data obtained for the study revealed that: the growth index for the length and weight for post larvae fed on mixed zooplankton was consistently lower than the other treatments; the linear trend for weight of post larvae fed on commercial feed is a fair estimate of the model which gave a forecast of 236.59g after the 13th week and 256.13g, 275.7g, 295.20g and 314.74g after the 14th, 15th, 16th and 17th week of projected culture period; the linear trend is a fair estimate of the model for weight of post larvae fed on zooplankton which gave a forecast of 204.84g after the 13th week and 221.41g, 237.98g, 254.54g and 271.12g after the 14th, 15th, 16th and 17th week of projected culture period; the linear trend is a good estimate of the model for weight of post larvae fed on maggot which gave a forecast of 213.71g after the 13th week and 232.30g, 249.90g, 267.49g and 285.08g after the 14th, 15th, 16th and 17th week of projected culture period; the linear trend for length of post larvae fed on commercial fed is a very good estimate of the model which gave a forecast of 39.36cm after the 13th week and 42.01cm, 44.30cm, 47.30cm and 49.95cm after the 14th, 15th, 16th and 17th week of projected culture period; the linear trend is a good estimate of the model for length of post larvae fed on zooplankton which gave a forecast of 33.16cm after the 13th week and 35.58cm, 37.84cm, 40.10cm and 42.35cm after the 14th, 15th, 16th and 17th week of projected culture period; the trend for the length of post larvae catfish fed on maggot is a very good estimate of its predictive model which gave a forecast of 36.40cm after the 13th week and 38.85cm, 41.30cm, 43.74cm and 46.19cm after the 14th, 15th, 16th and 17th week of projected culture period; the trend of mean weight of post larvae catfish fed on the three feed types is a good estimate of the predictive model that gave forecasts of 218.713g, 236. 613g, 254.513g, 272.414g and 290.314g for the 13th week, 14th week, 15th week, 16th week, and 17th week respectively; the trend of mean length of post larvae catfish fed on the three treatment diets as forecasted with the predictive model are 36.3587cm, 38.8102cm, 41.2616cm, 43.7131cm and 46.1646 for the 13th, 14th, 15th, 16th and 17th week respectively and; the linear regression model was found to be significant for the relationship between mean length and mean weight thus, the length of post larvae catfish in the studied population can be predicted from their weight using the regression model. This certainly adds value to the work because it is easier to measure the weight of post larvae catfish, without causing injury, than their length.

References

Brzuska, E. (2001). Artificial spawning of European catfish Silurus glanis L.: differences between propagation results after stimulation of ovulation with carp pituitary and Ovopel. *Aquaculture Research, 32*(1), 11-19.

Conceição, L. E., Yúfera, M., Makridis, P., Morais, S., & Dinis, M. T. (2010). Live feeds for early stages of fish rearing. *Journal Aquaculture Research, 41*(5), 613–640.

Dennis, E. U., & Uchenna, O. J. (2016). Use of probiotics as first feed of larval African catfish Clarias gariepinus (Burchell 1822). *Annual Research & Review in Biology*, 1-9.

Drapper, N. R., & Smith, H. (1998). *Dummy Variable. Applied Regression Analysis.* New York: Wiley.

Eyo, V. O., & Ekanem, A. P. (2011). Effect of feeding frequency on the growth, food utilization and survival of African catfish (Clarias gariepinus) using locally formulated diet. *African Journal of Environmental Pollution and Health, 9*(2), 11-17.

Freund, F., Hörstgen-Schwark, G., & Holtz, W. (1995). Seasonality of the reproductive cycle of female Heterobranchus longifilis in tropical pond culture. *Journal Aquatic Living Resources, 8*(4), 297–302.

Giri, S., Sahoo, S., Sahu, A., & Meher, P. (2003). Effect of dietary protein level on growth, survival, feed utilization and body composition of hybrid Clarias catfish (Clarias batrachus X Clarias gariepinus). *Journal of Animal Feed Science and Technology, 104*, 169–178.

Haylor, G., & Muir, J. (1998). *A Fish Hatchery Manual for Africa.* . . Stirling, Scotland: Pisces Press LTD.

Ileleji, K. E., Garcia, A. A., Kingsley, A. R., & Clementson, C. L. (2010). Comparison of standard moisture loss-on-drying methods for the determination of moisture content of corn distillers dried grains with solubles. *Journal of AOAC International, 93*(3), 825 - 832.

Kandathil Radhakrishnan, D., AkbarAli, I., Schmidt, B. V., John, E. M., Sivanpillai, S., & Thazhakot Vasunambesan, S. (2020). Improvement of nutritional quality of live feed for aquaculture: An overview. *Aquaculture Research, 51*(1), 1-17.

Khanom, M., Rahman, S. M., Ali, M. Y., Parvez, M. S., Antu, A. H., & Ahsan, M. N. (2022). Effect of formulated feed as a subsitute for live feed on growth performances, biochemical composition and digestive enzyme activities of asian stinging catfish, Heteropneustes fossilis (Bloch, 1794) larvae. *Adv. Anim. Vet. Sci, 10*(6), 1264-1271.

Maina, A. (2020). Growth Performance and Carcass Characteristics of the African catfish (Clarias gariepinus) Reared on Diets Containing Black Soldier Fly (Hermetia illucens) Larvae Meal. *Doctoral dissertation, Kenyatta University*. Kenya.

Munguti, J. M., Kim, J.-D., & Ogello, E. O. (2014). An Overview of Kenyan Aquaculture: Current Status, Challenges, and Opportunities for Future Development. *Fisheries and Aquatic Sciences, 17*(1), 1–11.

Nagoli, J., & Balasubramaniam, A. (2008). Natural spawning of the African catfish (Clarias gariepinus). *Aqua*. Retrieved from https://www.aquapublishers.com

Neter, J., Wasserman, W., & Kutner, M. H. (1995). *Applied Linear Regression Models* (3rd ed.). Boston: Irwin.

Okunsebor, S., & P.C., O. (2012). Mass production of Moina micrura through manipulation of concentration, combinations of manure and period of growth in laboratory. *Euro. J. Scie. Res., 83*, 576-589.

Olurin, K. B., & Oluwo, A. B. (2010). Growth and Survival of African Catfish (Clarias gariepinus) Larvae Fed Decapsulated Artemia , Live Daphnia , or Commercial Starter Diet. *African Journal of Food Science and Technology, 62*(1), 50–55.

Omodu, A. O., Solomon, R. J., & Wilfred-Ekprikpo, P. C. (2017). Length weight relationship of Clarias gariepinus (catfish) fed with local feeds. *New York Science Journal, 10*(5), 46-59.

Ovie, S. I., & Ovie, S. O. (2004). Effect of aeration on brood production and size of Moina micrura (Kurz, 1874) (Crustacea; Anomopoda). *Journal of Aquatic Sciences, 19*(2), 107-112.

Remilekun, A. O., Akinola, O. G., & Olubusola, O. O. (2022). Comparative growth performance and survival of hatchery-reared African catfish fry (Clarias gariepinus Burchell 1822) fed on live and artificial diets. *International Journal of Fisheries and Aquatic Studies, 10*(2), 106 - 112. doi:https://doi.org/10.22271/fish.2022v10.i2b.2647

Sorgeloos, P., Lavens, P., Leger, P., & Tackaert, W. (1986). Manual for the culture and use of brine shrimp Artemia in aquaculture. Belgium: Ghent State University.

VedExcel. (2021, May 31). *How to Calculate MAPE in Python*. Retrieved December 20, 2022, from vedexcel: www.vedexcel.com