



Growth Performance, Length – Weight Relationship and Condition Factor of *Clarias gariepinus* Fed *Anisophyllea laurina* Seed Meal Substitute

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ABSTRACT: Length-weight relationships are of significance as an important tool for the assessment of the growth pattern of fish species and the condition in which they grow. This study evaluates the biological parameters (a , b , and r^2) as well as length-weight relationship and condition factor of 150 specimens of *Clarias gariepinus* fed dietary inclusion of *Anisophyllea laurina* seed meal. The values of the regression coefficient 'b' obtained for the length-weight relationship for the five treatments were 3.3, 3.03, 3.0, 2.9 and 2.7 with corresponding coefficient of determination (R^2) values of 0.8313, 0.9517, 0.9629, 0.9223, and 0.8726. T4 and T5 exhibited a negative allometric growth pattern. In addition, T1, T2 and T3 demonstrated isometric growth and displayed the ideal shape of fish. The regression equation for the LWR was ($W=32.72 \pm 0.32$), revealing a significant correlation between the variables. The coefficient of determination shows a significant relationship ($r^2 = 0.95$) between length and weight of T2 and T3 (25% and 50% ASM inclusions) and other treatments. The species are found to be in a good condition as shown by the condition factor which was $k > 1$. In conclusion, the results revealed that *Anisophyllea laurina* seed meal could serve as substitute source of vital nutrient and antioxidant ingredients with health benefits at 25% and 50% levels.

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The Length-weight relationship and condition factor are useful biological tools that has been applied to examine the effect of environmental changes on the well-being of fish. These tools were applied to study the growth pattern and condition factor of African catfish (*Clarias gariepinus*) raised in indoor tanks over a period of 14 weeks at the Department of Aquaculture and Fisheries Management, Njala University, Sierra Leone. The African catfish is widely distributed in tropical Africa, Asia and North America. It is often refer to as the farmers fish because of its adaptability to varying environment conditions and because of its possession of certain attributes that makes it culturable (Dan-Kishiya, 2013). *Clarias gariepinus* feed on almost anything (Gupta and Banerjee, 2015; Serajuddin *et al.*, 2013) and convert it effectively for growth. *Clarias* is an esteemed fish (Martin-Smith, 1996), and interest is growing for its culture globally. Aquaculture is believed to be the way to upsurge fish production needed to meet the demand of a growing human population. Intensively farmed fish will however not succeed without proper feeding and best management practices. Fish growth performance is a product of many factors of which feed is fundamental.

Numerous studies on the food composition of *C. gariepinus* using different plant materials as substitute for fishmeal has been carried out. The usage of plant obtained materials as fish feed components is restricted by the existence of a wide variety of anti-nutritional factors (ANFs). It has also been quantified that, disproportionate ingesting of plant protein materials by fish could result to measured growth pattern and deprived performance, which may upshot in mortalities if condition continues (Olapade and Kargbo, 2015). *Anisophyllea laurina* is vastly exploited in West Africa, particularly Sierra Leone and Guinea but data on its exploitation as a protein material for fish feed preparation is scanty. *A. laurina* R. Br. Ex Sabine (Anisophylleaceae) is a tropical plant that is commonly found in wet lowland mainly forests and has been found very useful by local communities. This beneficial plant due to its diverse uses has been the cause of skirmishes among local landowners, forest supervisors and communities in many African countries. *A. laurina* comprise greater quantities of crude fat, crude fibre, proteins, total energy, vitamins, carbohydrates, anti-nutrient factors and antioxidant activity, which if well utilized can resolve many

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nutritional associated disorders and also be beneficial in the food industry for the production of a sequence of value-added feedstuffs. The objective of this study is to examine the potentiality of *Anisophyllea laurina* seed meal as a perfect substitute to fishmeal in fish diets for sustainable aquaculture production.

MATERIAL AND METHODS

The study was carried out in the Department of Aquaculture and Fisheries Management, School of Natural Resources Management, Njala University, Njala Campus, Kori Chiefdom, Moyamba District, Southern Sierra Leone.

Collection and processing of Anisophyllea laurina seed meal: *A. laurina* fruits were obtained towards the fall of the dry season (April and May) within Njala University Campus. Samples were first sun-dried and the seeds were thereafter removed by breaking the nut using stones and hammers, and the seeds were gathered and sun-dried for one week. The dried seeds were roasted using hot sand in order to destroy any anti-nutritional factor in the seed and to make it easier to reduce the seeds into meal. The roasted *A. laurina* was further dried and thereafter finely ground before adding to other feed ingredients at the desired inclusion rate. The formulated diet has a crude protein level of 40% for *Clarias gariepinus* as suggested by Akinwale and Faturoti (2007). Feed ingredients were weighed into proportion using Pearson's square approach to estimate the ratio of inclusion of each constituent in the final mix. The carefully mixed ingredients was pelleted and sundried for three days before storing it in airtight transparent polythene bags.

Experimental fish and feeding method: *C. gariepinus* juveniles 32.72 ± 0.32 (150 specimens) used in the study were acclimated in an open tanks for 3 days before distributing them into the rearing tank (59 – litre capacity rearing troughs). Five treatments (T1, T2, T3, T4, and T5) and fifteen replicates were allotted to the completely randomized design (CRD) experiment (10 fish per replicate). Water quality variables determined for this experiment were temperature, dissolved oxygen, pH, and $\text{NO}_3\text{-N}$. Constant water supply (2.5L/min) was maintained during the study to ensure constant oxygen supply to the system. Fish Feeding commenced three days after distribution of fish into the experimental trough at 5% body weight. The prepared diets were fed at 0%, 25%, 50%, 75% and 100% *A. laurina* inclusion and were fed twice-daily between the hours of 8:00 and 9:30 in the morning, and 16:00 to 17:00 in the evening. Experimental diets were crushed to allow for easy picking by the fish. Uneaten feed was siphoned out of trough daily before feeding and total cleaning of fish

troughs and replenishment with clean fresh water was completed every three days until 98 days when the experiment was over. Fish weighing and length measurement was carried out weekly.

Length-weight estimation: The total length, standard length, and fork length were evaluated through an improvised measuring board calibrated in cm^3 . The average weight of the fish was obtained using the Soehnle Electronic Kitchen Balance Model Art-Nr. 65055 and mortality in each tank were recorded and estimated at the end of the study. The length-weight relationship was determined with the equation prescribed by LeCren (1951).

$$W = aL^b$$

$$\ln W = \ln a + b \ln L$$

The "a" and "b" values were obtained from a linear regression of the length and weight of the specimens measured. Condition factor was determined from the relation below:

$$K = 100w/L^3$$

The parameters ('a' and 'b') were evaluated from the log-transformed values of length and weight, i.e. $\log W = \log a + b \log L$, where W = weight (g) of the fish, L = standard length (using the linear regression model of Microsoft Office Excel in PC windows 10). The parameters a (intercept) and b (slope) were anticipated by linear regression based on logarithms; $\log (W) = \log (a) + b \log (L)$. The significance of regression was evaluated by analysis of variance (ANOVA) using the DPS software package (Version 15.10), significant mean differences were separated at 0.05-probability level according to Tang and Zhang, (2013).

The statistical significance level of the coefficient of determination (R^2) was calculated, and the b-parameter for each treatment was tested by Fisher's LSD (Least Significant Difference) test to confirm if it was significantly varied from the isometric growth pattern ($b = 3$). The growth is isometric if $b = 3$ and the growth is allometric if $b \neq 3$ (negative allometric if $b < 3$ and positive allometric if $b > 3$). All the statistical analyses were observed at significance level of 5% ($p < 0.05$). Weekly data were collected on fish growth performance and nutrient consumed by ascertaining mean weight gain (MWG), feed intake (FI), specific growth rate (SGR), percentage survival rate (%SR), protein efficiency ratio (PER), feed conversion ratio (FCR) and protein intake (PI). Mean weight gain (MWG) of individual fish in each treatment was estimated by subtracting the initial mean weight from the final mean weight at harvest.

$$MWG = W2 - W1$$

Where: W2: final mean weight of fish at 98 days; W1: initial mean weight of fish at stocking

The specific growth rate was collected as prescribed Brown, (1975).

$$SGR = \frac{(\log W2 - \log W1) \times 100}{\text{Cultured period}}$$

Survival rate articulated in percentage was calculated from the relationship:

$$SGR = \frac{\text{Initial number of fishes} - \text{mortality} \times 100}{\text{Initial number of fishes stocked}}$$

Feed intake was estimated by the addition of daily mean feed intake of fish in each treatment throughout the experimental duration. Feed conversion ratio was estimated with the equation below:

$$FCR = \frac{\text{Total feed fed}}{\text{Total wet weight gained}}$$

Protein efficiency ratio was estimated with the equation:

$$PER = \frac{\text{Wet weight gained (g)}}{\text{Amount of protein fed (g)}}$$

Protein intake was determined from the proportion of protein in total feed fed by the fish. PI = Total feed fed x Percentage protein fed (40%).

RESULTS AND DISCUSSION

Feed utilization of experimental fish: The proximate composition of processed *A. laurina* feed meal (ASM) is presented in Figure 1 while formulated diets and proximate composition of experimental diets; growth and nutrient utilization of *C. gariepinus* are presented in Tables 1 and 2. This present study differ from the work of Paiboon and Kriangsak, (2015) in terms of crude protein content. While Paiboon and Kriangsak, (2015) used commercial feed (39% CP) in their study; the fishes in this present study were fed formulated treatment diets (40% CP) with varying inclusion of fishmeal and *A. laurina* meal. The growth and nutrient parameters obtained in this study revealed that *C. gariepinus* responded well to the feeding trials. MWG of fish however decreased as level of ASM inclusion increases in the diets. The disparity in growth and nutrient utilization may be due to the differences in the protein content of the diet. Protein efficiency ratio (PER) was highest in fish fed the control diet 0% ASM

and least in treatment diet 5 but were not significantly different from 25%, 50%, 75% and 100% ASM inclusion. Webster *et al*, (1992) found that PER for blue catfish *Ictalurus furcatus* fed diets in which 30% of fish meal protein was replaced by defatted soybean meal or by full-fat soybean meal were non-significantly ($P > 0.05$) different from those fed the control diet. In a previous work, Carter and Hauler (2000) substituted 25% and 33% of fishmeal with soybean meal in the diets of Atlantic salmon, *Salmo salar*. They found that the augmented inclusion of soybean meal or field peas from 25% to 33% had no significant consequence on PER but there were significant decreases when narrow-leafed lupin was added at 33%.

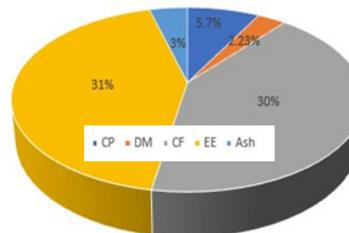


Fig 1: Proximate composition (%) of processed ASM: (CP – crude protein, DM – dry matter, CF – crude fiber, EE – ether extract)

The results in this study compared favourably with what Paiboon and Kriangsak (2015) obtained in their study with the exception of SGR that did not follow a consistent pattern. The results of the nutrient utilization and growth responses in this study agreed with those of Olapade and Lombi, (2015). An important aspect of the study that set it apart from the work of Olapade and Lombi, (2015) is that the study determined the growth patterns of the fish and the conditions of their growth as a measure to ascertain whether the growth is proportional or disproportional. Feed conversion ratio (FCR) recorded in the study were in the order (T1: 6.90 ASM) > (T2: 8.70 ASM) > (T3: 9.01 ASM) > (T4: 10.05 ASM) > (T5: 10.45 ASM) (**Table 2**). There was insignificant differences between these values indicating the possibility of partial replacement of FMP by ASMP in *C. gariepinus* diets at 25% and 50% inclusion level without any adverse effect on the feed conversion ratio and these findings are in conformity with those reported by Webster *et al* (1992) for the blue catfish *Ictalurus furcatus*. The growth retardation observed in T4 and T5 was believed to be caused by low protein content in the feed, amino acid disproportion, low palatability and possible presence of endogenous anti-nutrient factors (such as protease inhibitors etc). The observed trend in reduced growth was similar to what Olapade and Lombi (2015), Olapade and Kargbo (2015) reported in their study. \

Table1: Diet formulation and proximate composition of ASM based diets in fractional substitutions of Fish Meal (0 ~ 100%)

Gross composition of ingredient (g/100g/DM)	Final values at different ASM inclusion rates (%)				
	Diet 1 0%	Diet 2 25%	Diet 3 50%	Diet 4 75%	Diet 5 100%
Fish meal	24.4	18.3	12.2	6.10	0
Anisophyllea laurina	0	6.10	12.2	18.3	24.4
Yellow maize	26.8	26.8	26.8	26.8	26.8
Soybean meal	45.8	45.8	45.8	45.8	45.8
Vitamin Premix	0.5	0.5	0.5	0.5	0.5
Vegetable oil	2.0	2.0	2.0	2.0	2.0
Salt	0.5	0.5	0.5	0.5	0.5
Chemical composition (%) on a dry matter basis					
Crude protein	16.4	15.8	18.6	19.7	16.2
Crude fiber	2.0	2.0	2.0	2.0	1.0
Ether Extract	26.0	24.0	24.0	22.0	23.0
Ash	2.0	2.0	3.0	2.0	2.0
Dry Matter	2.13	2.13	2.10	2.19	2.17

Vitamin A (12,000,000 IU), Vitamin D₃ (4,000,000 IU), Riboflavin (8 g), d-Pantothenic acid (24 g), Choline (1,400 g), Niacin (100 g), Vitamin E (100 g), Vitamin K (4 g), Vitamin C (500 g), Folic acid (1 g), Pyridoxine (5 g), Thiamine (5 g), BHT (5 g).

Table 2: Growth and nutrient utilization of *Clarias gariepinus* fed varying inclusions rates of ASM based Diet

Parameters	Treatment ASM inclusion rates (%)				
	T1 0	T2 25	T3 50	T4 75	T5 100
Culture period (days)	98	98	98	98	98
The initial number of fish	30	30	30	30	30
The final number of fish	29	28	28	27	29
Initial mean weight (g)	38.5±0.42	37.4±0.59	36.3±0.20	36.2±0.24	35.5±0.16
Final mean weight (g)	66.2±1.36	57.2±3.68	54.9±3.32	51.3±2.24	49.7±0.91
MWG (g)	27.7	19.8	18.6	15.1	14.2
FI (g)	191.08	172	167.6	151.8	148.4
SGR	0.24	0.19	0.18	0.15	0.15
FCR	6.90	8.70	9.01	10.05	10.45
PER	0.36	0.29	0.28	0.25	0.24
PI	76.43	68.8	67.04	60.72	59.36
Survival Rate (%)	97	93	93	90	97

Length-weight relationship and condition factor of experimental fish: The values of the regression coefficient 'b' obtained for the length-weight relationship for the experimental fish for the various treatments were 3.37, 3.07, 3.03, 2.94 and 2.74 with corresponding coefficient of determination (R^2) values of 0.8313, 0.9517, 0.9629, 0.9223, and 0.8726 for T1, T2, T3, T4, and T5 respectively (Figure 2 – 6). While T1, T2 and T3 demonstrated isometric growth (b-values not significantly different from 3, Fisher's LSD test $p > 0.05$), T4 and T5 exhibited negative allometric growth pattern respectively (i.e. $b < 3$, Fisher's LSD test $p < 0.05$). The coefficient of determination shows a significant relationship ($r^2 = 0.95$) between length and weight of T2 and T3 (25% and 50% ASM inclusion) and other treatments. The b-values obtained in this study is in agreement with the results of Madhusoodanan *et al.*, (2016) for *Clarias gariepinus* (especially with respect to T1, T2 and T3) in Mattupetty reservoir, Kerala, India. The results obtained for males, females and sexes combined of *C. gariepinus* in Mattupetty reservoir was 2.9614, 2.9056 and 2.9589 respectively; a growth pattern that denote isometric growth of fish ($b=3$). The results of this study did not synchronize with the findings of Olapade and Tarawallie, (2014) who reported positive

allometric growth pattern for *Pseudotolithus senegalensis* in Tombo, western rural district of Sierra Leone; and that of Paiboon and Kriangsak, (2015) who reported b-values (regression co-efficient) of 2.94, 3.12, 2.67 and 2.03 for *P. gigas*, RCBC, BC and F1 hybrid type respectively. The disparity in findings of this study and those of other researchers could be explained from the understanding that fish in a natural environment where there are abundance of food materials and minimal anthropogenic disturbances tends to grow isometrically as was the case in Mattupetty India. The results of Paiboon and Kriangsak (2015) had proven the possibility of isometric fish growth in controlled experiment, where treatment diets and water quality are well managed. The knowledge derived from these studies is a clear indication that feeding and environmental conditions are vitally important, as they appear to be the major determinants of how fish grow especially with respect to length and weight gained.

The mean condition factor (k) of 0.95 obtained in this study differed from the findings of Basudha, (2016) who reported k values of 1.839 and 1.0 for *Clarias filamentosus* in Lake Oguta. Nwadiaro and Okorie, (1985) reported k values ranging from 0.917 to 0.985

for the same fish in Nkoro River and these were not different from what was obtained in this study.

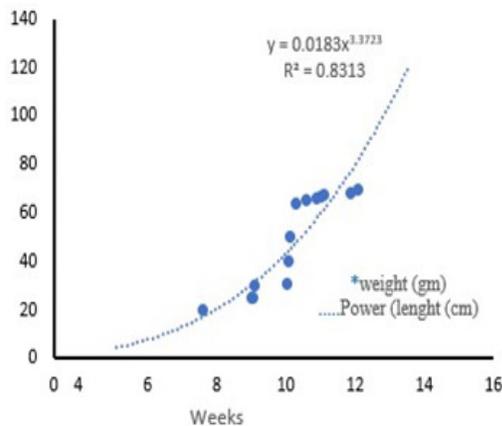


Fig. 2: Length – Weight Relationship of *Clarias gariepinus* (Treatment 1)

Higher K value ($K > 1$) is an indication that the environmental conditions where the fish grows is conducive (Madhusoodanan *et al.*, 2016). The values obtained from this study revealed that *C. gariepinus* was in perfect condition. LeCren (1951) described that ecological factors, food supply, and parasitism have a great impact on the welfare of the fish. The condition factor replicates the health state of the fish (Kumolu-Johnson and Ndimele, 2010). According to Edah *et al.*, (2010) condition factor can be utilized as an index to ascertain the state of the aquatic environment. Gomiero and de Souza Braga (2005) reported that certain factor, including data pulling, arrangement into classes, sex, and phases of development often affects the welfare of fish.

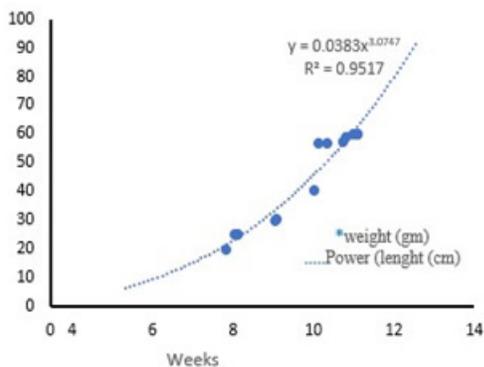


Fig 3: Length – Weight Relationship of *Clarias gariepinus* (Treatment 2)

Madhusoodanan *et al.* (2016) reported a higher k-value of 1.07, 1.14 and 1.15 of sexes combined for *C. gariepinus* during pre-monsoon, monsoon and post-monsoon. Olapade and Tarawallie (2014) reported a mean k-value of 0.98 for *P. senegalensis* in Tombo water, Sierra Leone; this result was similar to what was

obtained in this study. Paiboon and Kriangsak (2015) on the other hand reported k-values that ranged from 0.85 – 1.01, 0.78 – 0.90, 0.82 – 1.16 and 0.78 – 1.58 for *P. gigas*, RCBC, BC and the F1 hybrid respectively. These results did not differ significantly from what was obtained in this study.

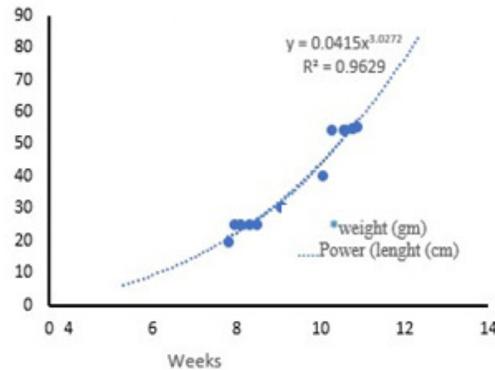


Fig. 4: Length – Weight Relationship of *Clarias gariepinus* (Treatment 3)

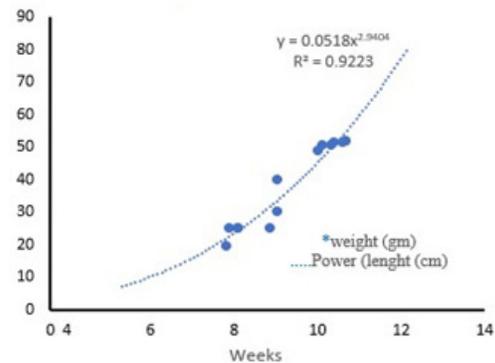


Fig. 5: Length – Weight Relationship of *Clarias gariepinus* (Treatment 4)

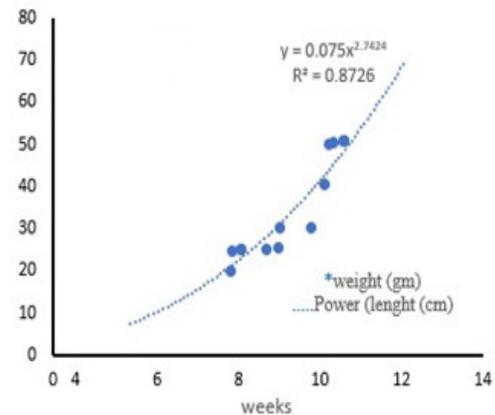


Fig. 6: Length – Weight Relationship of *Clarias gariepinus* (Treatment 5)

Water quality parameters of the culture environment: Figures 7 shows the physico-chemical parameters observed in the experiment, however, these parameters are within the recommended values for freshwater fish species (Omitoyin, 2007). These

favourable physico-chemical variables no doubt determined the high survival rates observed at all stages of ASM inclusion. The implication of water quality effect on the fish was evident in the result of the condition factor obtained in this study.

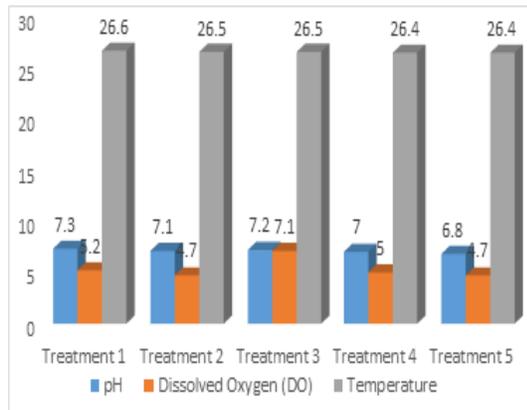


Fig 7. Water quality parameters of the culture medium

Conclusion: Based on the k value obtained in this study, it is evident that the species under investigation was in perfect state in all the treatments. In addition, since the length and weight gain of fish is what will construe into income for the fish farmer at the end of the production period, the study has shown that partial replacement of fishmeal with ASM is promising at the 25% and 50% inclusion level without a reduction in fish growth and development. The replacement besides attenuating feed cost will also not negatively affect water quality of rearing medium.

REFERENCES

- Akinwale, A; Faturoti, E (2007). Biological performance of African Catfish (*Clarias gariepinus*) cultured in recirculating system in Ibadan. *Aquacultural Engineer*. 36(1): 18-23
- Basudha, C (2016). Length-weight relationship and condition factor of *Barilius ngawa* from headwater of Thoubal River, Manipur, India. *Inter. J. Fisheries Aquatic Stud*. 4(6): 254-256
- Brown, S (1975). Experimental studies on growth (M. E. Brown Ed.). *The physiology of fisheries* vol. 1 Academic Press, London 360-400
- Carter, C; Hauler, R (2000). Fishmeal replacement by plant meals in extruded feeds for Atlantic salmon, *Salmo salar* L. *Aquaculture* 185(3-4): 299-311
- Dan-Kishiya, A (2013). Length-weight relationship and condition factor of five fish species from a tropical water supply reservoir in Abuja, Nigeria. *Am. J. Res. Comm*. 1(9): 175-187
- Edah, B; Akande, A; Ayo-Olalus, C; Olusola, A (2010). Computed the wet weight-dry weight relationship of *Oreochromis niloticus* (Tilapia). *Inter. J. Food Safe* 12: 109-116
- Gomiero, LM and de Souza Braga, FM (2005). The condition factor of fishes from two river basins in São Paulo state, Southeast of Brazil. *Acta Scientiarum: Biol. Sci*: 73- 78
- Gupta, S; Banerjee, S (2015). Length-weight relationship of *Amblypharyngodon mola* (Ham- Buch., 1822), a freshwater cyprinid fish from West Bengal, India. *Zoology and Ecology*, 25(1): 54-58
- Kumolu-Johnson, C; Ndimele, P (2010). Length-weight relationships and condition factors of twenty-one fish species in Ologe Lagoon, Lagos, Nigeria. *Asian J. Agric. Sci*. 2(4): 174-179
- LeCren, CP (1951). The length weight relationship and seasonal cycle in gonad weights and condition of the perch (*Perea fluviatilis*). *J. Animal Ecol*. 16: 189-204.
- Madhusoodanan, PP; Prasannan, K; Smrithy, R (2016). Length-weight relationship and condition factors of the African catfish *Clarias gariepinus* (Burchell 1882) in Mattupetty reservoir, Southern Western Ghats, Kerala, India. *J. Aquatic Biology & Fisheries*, 4. 81 – 88
- Martin-Smith, K (1996). Length/weight relationships of fishes in a diverse tropical freshwater community, Sabah, Malaysia. *Journal of Fish Biology* 49(4): 731-734
- Nwadiaro, C; Okorie, P (1985). Biometric characteristics: length weight relationships and condition factors in *Chrychthys filamentosus*, Pisces, Bagridae from Oguta Lake Nigeria. *Biol. Afr* 2: 48-56
- Olapade, OJ; Kargbo, M (2015). Effect of *Terminalia catappa* on growth and hematology of *Clarias gariepinus* juveniles–*Journal of Aquaculture Feed Science. Tech* 7: 1-5
- Olapade, OJ; Tarawallie, S (2014). The Length-Weight Relationship, Condition Factor and Reproductive Biology of *Pseudotolithus* (P)

- senegalensis (Valenciennes, 1833) (Croakers), in Tombo Western Rural District of Sierra Leone. *Ajfan Journal Online*. 14 6: 2176 – 2189
- Omitoyin, BO (2007). Introduction to fish farming in Nigeria. Ibadan University Press. p. 87
- Paiboon, P; Kriangsak, M (2015). Growth performance, length-weight relationship and condition factor of backcross and reciprocal hybrid catfish reared in net cages. *International Journal of Zoological Research* 11 (2): 57 – 64.
- Serajuddin, M; Prasad, L; Pathak, BC (2013). Comparative study of length-weight relationship of freshwater murrel, *Channa punctatus* (Bloch 1793) from lotic and lentic environments. *World Journal of Fish and Marine Sciences*, 5(2): 233-238
- Tang, QY; Zhang, CX (2013). Data Processing System (DPS) software with experimental design, statistical analysis and data mining developed for use in entomological research. *Insect Science* 20(2): 254-260
- Webster, CD; Tidwell, JH; Yancey, DH (1992). Effect of protein level and feeding frequency on growth and body composition of cage-reared channel catfish. *The Progressive Fish-Culturist* 54(2): 92-96