RELATIONSHIP BETWEEN BASIC MORPHOMETRIC MEASUREMENT, GROWTH PATTERN AND PROXIMATE COMPOSITION OF SILVER CATFISH (*BAGRUS FILAMENTOSUS)* FROM AGAIE- LAPAI DAM

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Abstract
Relationship between basic morphometric measurement, growth pattern and cross carcass variation in the body parts of Bagrus filamentosus from Agaie-Lapai Dam, were examined and evaluated using linear regression and correlation through length-weight relationship (LWR) and proximate composition analysis. A total of 153 Bagrus filamentosus specimen were collected from the dam using gill net for a period of seven months. Sampling of the specimen was done fortnightly. The results of the biometrics of Bagrus filamentosus specimens examined provides the following information; the total length of this specimen ranges from 24.1-36.7(cm) with mean standard deviation of 29.4±3.41and a corresponding bodyweight ranging from 47.5-147.7(g) with a mean standard deviation of 103.2±14.88, while the standard length ranges from 12.4-26.5cm and a mean standard deviation of 20.2±2.88.The result of the morphometric relationships shows that there was a strong relationship between the standard length and the body weight, snout length and standard length, head length and the standard length, snout length and the body weight, head length and the body weight (P<0.05). Proximate analysis showed that the lipid and moisture were inversely proportional in the body of the fish while other nutrients in the body of the fish did not fluctuate significantly over time and nutrients were not evenly distributed among the body parts. Growth pattern analysis depicts that the growth was negatively allometric with b value of 2.17; hence it could be concluded from this study that the growth pattern of Bagrus filamentous from Agaie-lapai dam is negative allometric growth.

Keywords: K value; Length –weight relationship, Snout length, head length, Silver catfish

Introduction
Developing countries, Nigeria inclusive are characterized by low protein food intake and poor nutritional status especially in the area of protein and energy. In Nigeria, starchy foods from root crops and cereals form majority of staple foods depending on the area of the country involved. In recent years, research into increase production of fish as a cheap and available source of animal protein has been on with the assistance of government in various areas. Research findings have also rated fish nutrients quality very high thus making it ideal source of vital nutrients both for nourishment and medicinal purposes. The increase in population in the world is at an alarming rate, Nigeria been the giant of Africa has a population estimated to be at 250 million people. There is a need to feed the ever-increasing population with adequate food, and also pay attention to fish resources which provide first class protein to all. However, the demand for fish in Nigeria is estimated at 1.4 million metric tonnes, on the other hand domestic fish production from all sectors (industrial, artisanal and culture) is at the lower level of 0.4million metric tonnes annually. Industrial fisheries yield is the least;

while fish culture is still growing then the highest contributor is artisanal fishery falling in the range of 60% - 80% (Abohweyere *et al.*, 2011).

The dwindling capture fisheries production in the last decades is already having a negative impact on total fish supplies, protein intake, livelihoods and national revenue generation. This can largely be attributed to the unrestricted use of bio- resources and the consequent decline in the stocks, population growth, rise in the international demand for fish, improvements in the internal market infrastructure, modern technologies, environmental conditions, high price for certain species and poor fisheries management (Soumendra *et al.*, 2009).Therefore, for fish supply to meet up with fish demand there is need to explore and gather data of fishes in the wild and their aquacultural potentials especially there growth pattern and their well-being in their natural environment. Efficient fishery management and sustainability requires adequate data on population parameters such as length-weight, condition factor, age and growth, mortality and recruitment of the exploited stock and basically be used to predict the potential yield and determination of size at capture for obtaining optimum yield (Ekelemu *et al.*, 2006; Offem *et al.,*2008). The length-weight relationship is relevant in the determination of weight when only length is available to estimate the standing biomass, comparison between fish population of different regions and future fish generations (Ude *et al.*, 2011). Furthermore, in fisheries science the relationship between the length and weight of a fish is used by researchers and managers for two main purposes (Le Cren, 1951). First; this relationship is used to predict the weight from length of a fish. This is particularly useful for computing the biomass of fish from the length-frequency of that sample. Second, the parameters estimate of the relationship for a population of fish can be compared to average parameters for the region, parameters estimated from previous years, or parameter estimates among groups for fish to identify the relative condition or robustness of the population. By convention, this second purpose is usually generically referred to as describing the condition of the species (Blackwell *et al.*, 2000; Abdullahi *et al.,* 2001).

In fisheries science, morphological characteristics are of paramount importance in identifying fish species and their habitat as well as their ecological niche (Bagenal & Tesch, 1978; Akombo *et al.,* 2011). The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007).

Fisheries managers often need to know if fish are growing poorly or even losing weight. Lack of food, poor water quality or disease can cause stress that results in poor growth. While growth may be difficult to measure, condition or plumpness of the fish is easy to measure and indicates if the fish are under stress.

Analysis of basic nutrient; water, protein, fat and ash contents of fish is known as proximate body composition (Muhammad *et al.*, 2001). However, before any species is subjected to commercial exploitation, it is expedient that its biology is well understood, and its biochemical nature is inquisitively understood. The importance of any species lies primarily in its nutritional status. Proteins, lipids, moisture and minerals were the major content which had been considered in evaluating the nutritional value of the specie studied. Fish like other animals has different chemical compositions which have diverse uses and significance. As a highly cherished food constituent of our diet, fish proximate composition includes amino acids, essential fatty acids and minerals and vitamins which are principal and key to healthy living (Azim *et al.*, 2012). Fish is not only eaten as food, but the chemical composition of fish is important to nutritionist for their high protein content and low-fat in freshwater fishes (Foran *et al.*, 2005). The chemical composition of the fish is a concern of the consumer, who only cares in the edible parts of the fish, while the manufacturer on the other hand is interested in the raw materials found in the fish and the processors of fish oils, is concerned with liver contents (Rasheed, 2011). Season, sizes, sex, geographical conditions and species are responsible for the differences in the nutritional component of freshwater fish. Fish body proximate conditions vary also as a result of food composition, genetic traits and environment. The scientist utilizes all of these in the making of high protein foods with the finest quality, colour, flavor, texture, odour and safety that comes with maximum nutritive value (Mohamed *et al*., 2010). Fish proximate composition evaluation is not only important to the scientist, but to the cook, nutritionist, and the processor and for preservation.

Analyzing the body component of large numbers of fish found in water bodies brings to mind the need to find a simpler shortcut to it. Also, protein and fat contents are relatively constant except in terms of food deprivation periods or during reproduction times (Mohamed *et al.,* 2010). Indices of condition that are conveniently and easily measured are continuously used in the determination of body composition of fish because they prove to be good indicators. This is unlike body composition which is time consuming (Salam *et al*., 1991). Given that there are considerable evidences in the use of fish and fish products for solving health problems (Mumba, 2005; Onasanya, 2002; Hetzel & Pandav, 1996), the need therefore arises to research into the nutritional composition of freshwater fishes in respect to seasonal variations and various parts of the fish body. This is because chemical composition of fish varies greatly from one species and one individual to another depending on age, sex, environment and season. The variation in chemical composition of fish may closely be related to its feed intake, migratory swimming and sexual changes in connection with spawning (Silva & Chamul, 2000).

Asides from being a source of protein for livestock and other animal producing sector, fish plays an important role medically as it replenishes the human body with vitamins A and D; calcium, phosphorus and lysine; sulphur and amino acids (Ohen and Abang, 2007).The knowledge of fish composition is essential for its maximum utilization. The assessment of the proximate composition of the fish is not only important to know its nutritive value, but also for its better processing and preservation (Mridha, 2005). The major cardinal interest of the Fish processors on the proximate composition of fish is to know the nature of the raw material before processing them and to determine the best post-harvest technology to apply in preserving them such as chilling, freezing, smoking or canning (FAO, 2004). While the consumer is interested mainly in the edible part of the fish, that is the flesh or muscle, the fish meal manufacturer is concerned with the composition of the whole fish and the processor of fish oils wants to know what quantity of oil can be generated by different part of the body. Hence, to know the composition of nutrients deposited at different parts of the body of fish, it is very essential and important to different users.

Agaie- Lapai Dam is a man-made dam richly blessed with a lot of commercially economic fish species, there is a dearth of information on the length-weight relationships of freshwater fish resources especially man-made dams of Nigerian waters (Fafioye & Oluajo, 2005). The Bagrid fishes are commonly known as naked catfishes. The family Bagridae is represented by thirty (30) genera and two hundred and ten (210) species. Bagrids have four pair's well-developed barbels; these four pairs of barbels are covered by a layer of taste bud-enriched epithelium, (Zhang *et al*., 2006). Bagrid catfish are important economically and ecologically. They play silent roles in determining the dynamics and structure of the aquatic ecosystem and their value as food by man has been reported by (Hem, 1986).Ikongbeh *et al.,* 2012.) *Bagrus filamentosus (B. filamentosus)* is common throughout the year and it inhabits lakes, swamps and rivers, (Olaosebikan & Raji, 2002). It is widespread in both shallow and deep water (Witte *et al.,* 1995); and is probably associated with rocky bottoms/coarse substrates (Lock, 1982). They are among the fishes of high commercial importance in Nigeria especially at the riverine coast of river Niger and Kaduna.

Although few reports on *Bagrus filamentous* exist there is lack of information about basic morphometric measurement and proximate composition of different body parts of *Bagrus filamentous* found in Man-made dams in the north central zone of Nigeria*.* It is in this view that this research was carried out with the main objective to investigate the relationship between basic morphometric measurements, growth pattern and monthly proximate composition of *Bagrus filamentous* from Agaie- Lapai Dam in Niger state of Nigeria.

Materials and Methods

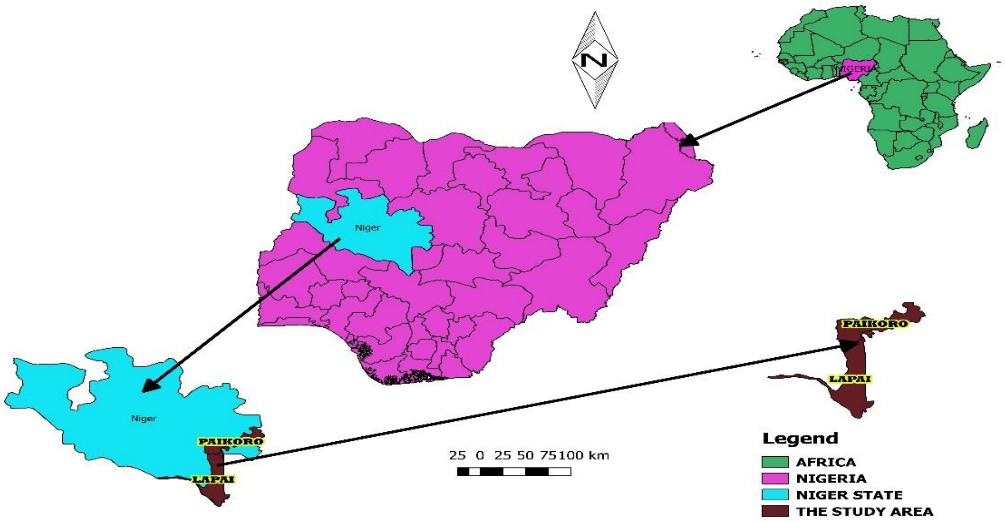

Plate1: Maps of Nigeria and Niger State inset Agaie- Lapai Dam

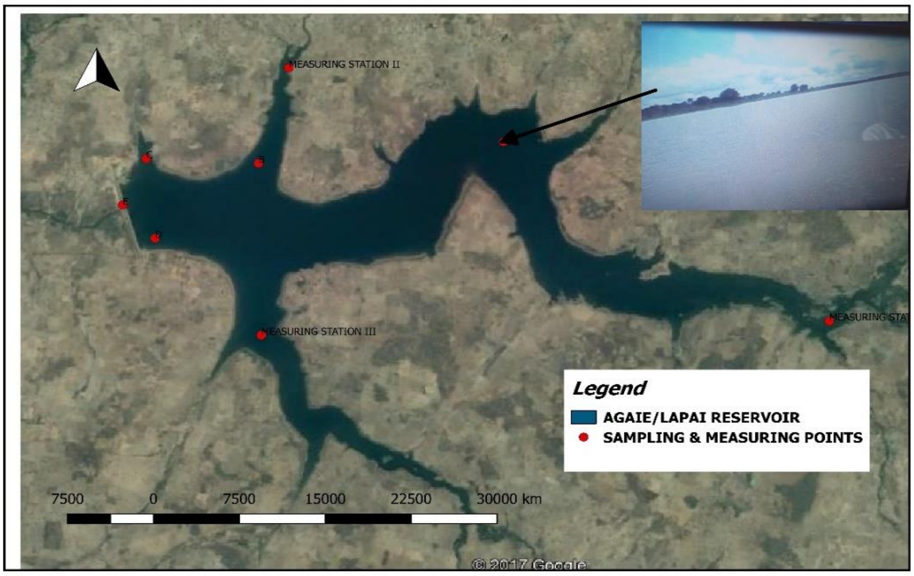

Plate2: Sampling site within the dam

Sampling Area

Agaie – Lapai Dam is located at the boundary between Lapai and Agaie Local Government Areas of Niger state, hence the name Agaie-Lapai Dam. It is a man-made earth fill dam across river Jatau at Bakajeba with a reservoir capacity of $147x10^6$ cubic meters. The dam is of rolled heterogeneous embankment type with a crest length of 1193.87m, maximum height of about 16m and about 38 mm^3 capacities. It also has part of its components about 750 m Spill channel with 3m free board. Accessibility is through a 2.5km-untarred road, which Tees off on the right of Paiko-Lapai tarred road. The dam is about 23km away from Paiko town; it lies to the North-East of Lapai town and East of Bakajeba town. The dam is geographically located at latitude 9^o14^1North of the Equator and longitude 6^o30^1East of Greenwich. The major source of the dam is River Jatau, which is a tributary of River Kaduna. The main purpose of establishing the dam was to be able to get water for Abuja metropolis and also to supply water for irrigation to Agaie, Lapai and its environment. The dam site has a typical tropical climate characteristic seasonal change: rainy and dry seasons. The rainy season is usually from April to October having its peak within the month of August and September while the dry season covers the remaining months of November to March. Maximum and minimum mean temperature between 28.33^oC – 38.89^oC and 19.44^oC – 26.67^oC respectively. Before the construction of the dam, the major occupation of the people was farming and fishing around the dam site.

Fish Sampling and Measurement

Specimens of *Bagrus filamentosus* were collected from the fishermen at the eight-sampling site twice a month for six months from April 2014 to October 2014. Gill nets of mesh sizes 50-55mm were used. A total of 153 fish were collected at the upper and the lower site of the dam. Specimens collected were kept chilled in an ice chest to avoid postmortem damage. When the fishes were collected, they were washed, kept in the ice chest and quickly taken to the Department of Water Resources, Aquaculture and Fisheries Technology laboratory School of Agriculture and Agricultural Technology Federal University of Technology Minna Niger State Nigeria.

At the laboratory, the total length (TL) was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Standard length (SL) was measured from the tip of the snout to the caudal peduncle, other basic morphometric features; head length, snout length and eyes diameters were measured with the aid of a measuring board and a mathematical set divider. The lengths were taken with measuring board to the nearest 0.1 cm. Body weight of individual fish was measured to the nearest 0.1 g with a digital electronic weighing balance (CITIZEN MP-300) model after removing the water and other particles from the surface of the body.

Growth Pattern and Condition Factor

Linear regression was employed to determine the type of relationship between any given pairs of variables and their linear equation. Correlation analysis was used to ascertain the significance of this relationship a derivative of length weight study is the ponderal index denoted as:

Where W = weight (g) L= standard length (cm)

The length-weight relationship (LWR) was expressed by the equation:

$$\text{Log weight} = \text{Log } a + b \text{ Log length}$$

Where a and b are regression constants.

The condition factor was calculated using the formula:

$K = [100\, W] / L^3$

Where K = condition factor, L = standard length (cm) and W = weight (g).

Proximate Composition Analyses
After preparation of edible parts of fish as described, proximate composition analyses were performed according to AOAC procedures (AOAC, 2000). Moisture content was determined by drying samples at 105±2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content (AOAC, 2000).

Statistical Analyses
Data collected were analyzed using one – way analysis of variance (ANOVA) using Statistical 6.0 (Stat-Soft, Inc., USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

Results
The result of the biometrics of *Bagrus filamentosus* specimens examined provided information on total length of the specimens which ranged from 24.1-36.7cm with a corresponding body weight ranging from 47.5g-147.7g and standard length ranging from 12.4 – 26.5cm. The result of the morphometric measurement of *Bagrus filamentosus s*specimens examined also provide the following information; the snout length ranged from 0.8-2.8cm with a mean standard deviation of 1.9±0.4, while the head length ranges between 4.0-7.1cm with a mean deviation of 5.8±0.7.

Relationship between the Morphometric Measurements

Standard Length - head Length Relationship
The head length was regressed against the Standard length as shown in figure. 1 it was observed that there was a strong positive relationship between the head length and the standard length, correlation co-efficient r was 0.8 and was significant ($p<0.05$). This indicates that a proportional increase in the standard length can be associated with an increase in the head length.

Body Weight- head Length Relationship
The head length was regressed against the body weight as shown in figure. 2 it was observed that there was a strong positive relationship between the head length and the body weight. Correlation co-efficient r was 0.7 and was significant ($p<0.05$). This indicates that a proportional increase in the body weight can be associated with an increase in the head length.

Standard Length- Snout Length Relationship
Snout length was regressed against the standard length as shown figure. 3 it was observed that there was a strong significant relationship between the snout length and the standard length as correlation co-efficient r was 0. 8 ($p<0.05$). This means that a proportional increase in the standard length was associated with increase in head length.

Body Weight- Snout Length Relationship
The snout length was regressed against the body weight as shown in figure. 4 it was observed that there was a strong positive relationship between the snouts length and the weight as correlation co-efficient r was 0.7 and was significant ($p<0.05$) This means that an increase in weight was associated with an increase in snout length.

Standard Length – Body Weight Relationship, Condition Factor and Growth Pattern

Figure 5 showed the regression of standard length against the body weight. It was observed that there was a strong positive relationship between the standard length and the body weight, as correlation coefficient r was 0.8 and was significant (*P*<0.05). This means that an increase in standard length was associated with an increase in body weight. It was also observed that the growth pattern indices of *Bagrus filamentosus* from Agaie - Lapai dam was negatively allometric with b value of 2.2. The condition factor *Bagrus filamentosus* from Agaie - Lapai dam is also shown in table 1 and it ranges from 0.6 – 2.6 with a mean value of 1.3±0.4.

Proximate Composition and Carcass Variation of the Body Parts

Whole body composition: The result of the monthly proximate composition of whole *Bagrus filamentosus* specimens from Agaie- Lapai dam is shown in Table 2. There was a significant monthly variation in the lipid and moisture values of the specimens. Lipid from the samples collected ranged from 5.2±0.3 to 8.3±1.3% and was significantly highest in July and lowest in April (P<0.05), while the moisture content of the samples ranged between 70.4±3.2 and 73.6±2.1 and was significantly highest in April and lowest in July (*P*<0.05); the crude protein did not vary considerably over time, values ranged between 18.1±1.3 and 18.2±1.5 hence, there was no significant difference in the crude protein between April to October in all the samples analysed (P>0.05).The Ash content ranged between 3.0±0.3 and 3.1±0.1. There was no significant difference (p>0.05) in the ash content of the samples throughout the period of the study (P>0.05).

The body parts composition: The results of the sampled fish body parts composition analysis is shown in table 3. The results revealed that the skin had the highest values in both moisture and crude protein and was significantly higher than other body parts examined (*P*<0.05) (72.0±1.6 and 19.5±0.7), while the head region had the lowest moisture content and crude protein (42.0±0.2 and 16.2±0.9) and was significantly (*P*<0.05) lower than other body parts measured. The fillet region had the highest lipid content (8.2±0.8) and was significantly different than other body parts analyzed. The head region had the highest significant value in the ash content (8.6±0.0) while the fillet had the lowest significant ash content (2.0±0.1) although it was not significantly different than the skin.

Table 1: Summary of biometric measurement sand K value of *B. filamentosus* sample from Agaie-Lapai dam, Niger State

Measurement	Range (cm)	Mean value
Total length (cm)	24.1 - 36.7	29.4±3.4
Standard length (cm)	12.4 - 26.5	20.2±2.9
Body weight (g)	47.5 - 147.7	103.2±14.9
Eye diameter (cm)	0.5 - 0.9	0.7±0.2
Head length (cm)	4.0 - 7.1	5.8±0.7
Snout length (cm)	0.8 - 2.8	1.9±0.4
K value	0.6 - 2.6	1.3±0.4

Table 2: Summary of the whole body of proximate composition of *B. filamentosus* Sample from Agaie-Lapai dam, Niger State

Months	Moisture	Lipid	Protein	Ash
April	73.6±2.1^{a}	5.2±0.3^{d}	18.1±1.3^{a}	3.1±0.1^{a}
May	72.2±2.4^{b}	6.6±0.4^{c}	18.1±1.3^{a}	3.1±0.1^{a}
Jun	71.0±1.3^{c}	7.7±1.2^{b}	18.2±1.5^{a}	3.1±0.6^{a}
Jul	70.4±3.2^{d}	8.3±1.3^{a}	18.2±1.5^{a}	3.0±0.3^{a}
Aug	71.6±2.5^{bc}	7.3±1.0^{b}	18.2±2.1^{a}	3.1±0.6^{a}
Sept	72.1±1.1^{b}	6.4±0.3^{c}	18.2±0.5^{a}	3.1±0.2^{a}
Oct	73.1±2.2^{a}	5.6±0.2^{d}	18.1±1.0^{a}	3.1±0.1^{a}

*1 Values in the same column with different superscript letters are significantly different ($p<0.05$) from each other (n=3).

Table 3: Summary of Proximate composition of various body parts of *B. filamentosus* sample from Agaie-Lapai dam, Niger State

Body component	Crude protein	Lipid	Ash	Moisture
Fillet	18.2±0.9^{a}	8.1±0.3^{a}	2.0±0.1^{b}	70.2±0.6^{a}
Skin	19.5±0.7^{a}	5.1±0.5^{b}	3.2±0.0^{b}	72.0±1.6^{b}
Head	16.2±0.9^{b}	4.1±0.4^{c}	8.6±0.0^{a}	42.0±0.2^{c}

*1 Values in the same row with different superscript letters are significantly different ($p<0.05$) from each other (n=3).

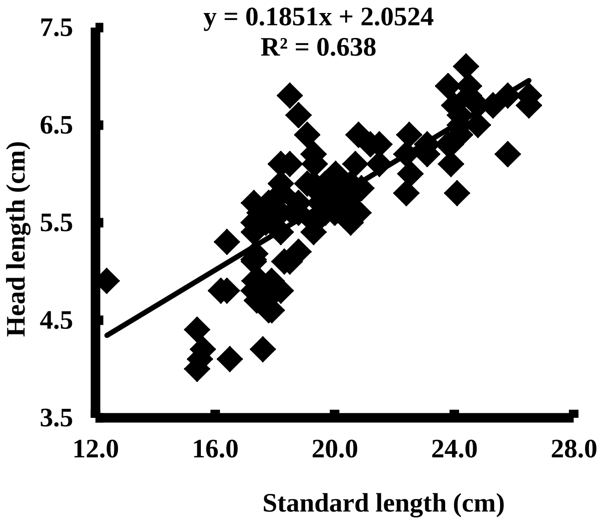

Figure 1: Standard length-head length relationship

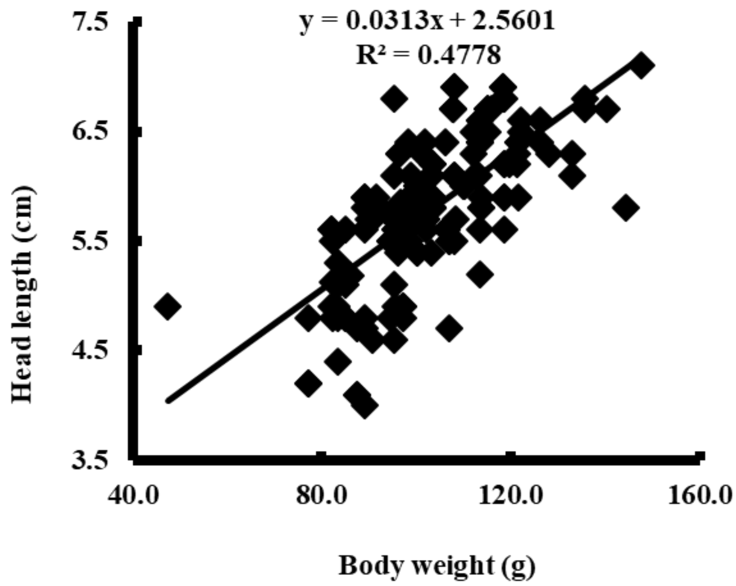

Figure 2: Body weight-head length relationship

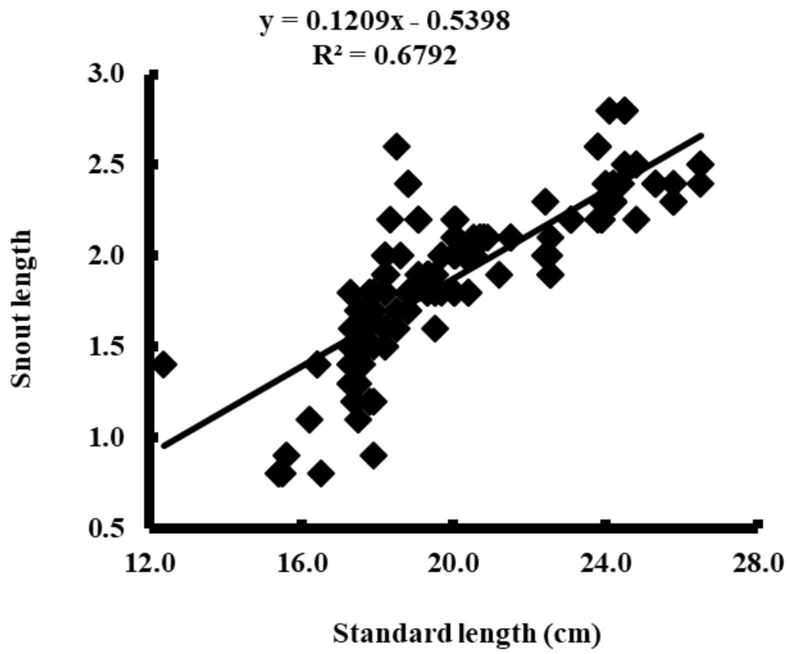

Figure 3: Standard length -snout length relationship

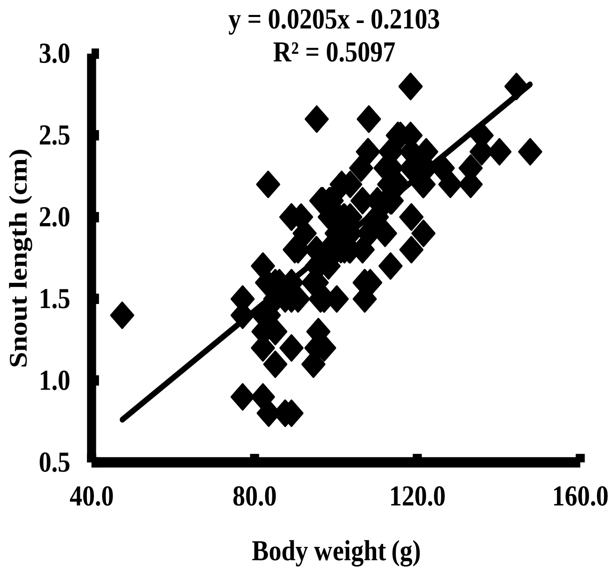

Figure 4: Body weight-snout length relationship

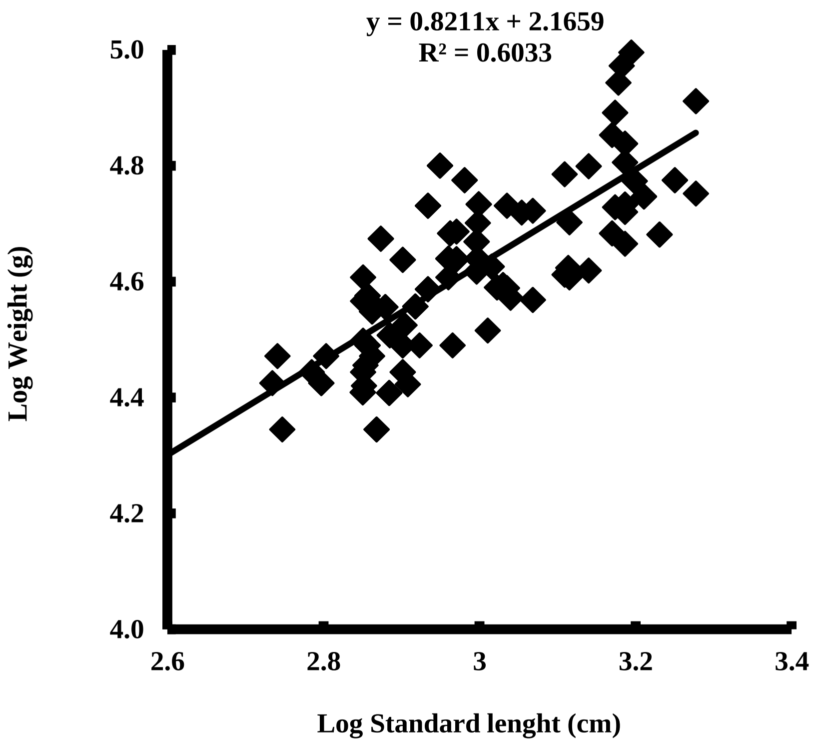

Figure 5: Standard length – Body weight relationship

Discussion

Result of the basic morphometric measurement of the 153 *Bagrus filamentosus* specimens from Agaie-Lapai dam examined, showed that the fish have the ability to grow averagely big. Biometric analysis of the body parts shows a positive correlation between the snout length and the standard length. Hence it was indicated that an increase in the length of the fish also leads to a proportionate increase in the snout length. The head length also showed a strong positive correlation when regressed against the standard length; hence an increase in the length was associated with an increase with head length. From the above analysis, it could be said that any increase in size could be associated to all parts of the fish body; a strong positive linear relationship between the head length and the body weight. This implies that for any increase in weight, there is also a proportional increase in the head length which is in agreement with the theory of proportionality of growth of organism (Mosby, 2009; Bake & Sadiku, 2012; Bake *et al.,* 2015).

Froese (2006) reported that length-weight relationship of fishes can be used to estimate biomass when the length–frequency distribution is known and that several intrinsic factors such as gonadal development, age, sex, and genetic makeup) and extrinsic factors such as food availability, season, and habitat characteristics) are known to affect the b value of fishes. In the present study b value for the fish species were found to be consistent with the expected range of 2.17. Length-weight relationship data also gives useful information concerning the growth pattern as well as the well-being of the fish. Zafar *et al.,* (2003) reported that fish weight is considered to be a function of length. Growth was described as the change in the absolute weight (energy content) or length of fish over time (Wooten, 1998), while Sadiku, (1994); Bake and Sadiku, (2012) and Bake *et al.* (2015) summarized growth as a function of size. Wooten reported that fish grow in length as well as in bulk. From the result of this study it was observed that *Bagrus filamentosus* from Agaie – Lapai dam was negatively allometric with "b" value of 2.17; this showed a deviation from the cube law and agrees with findings of Fagbenro *et al.,* (1991) who stated that obedience to the cube law (isometric growth, b = 3) is rare in a majority of fishes especially freshwater fishes. This implies that the length growth rate is faster than the body weight growth rate.

This result is similar to the findings of Ikongbeh, *et al.,* (2012) on other species (*B. Bayad*) of the same family with *Bagrus filamentosus* from Benue River. Regression coefficients obtained from length-weight relationships (L-W) which are indicative indices of the growth pattern i.e. isometric or allometric growths differ not only between species but sometimes also between population of same species. The developmental phase of fish involves several stages, each of which has its own length-weight relationships.

Samat *et al.,* (2008) and Abowei (2009) reported that the suitability of an aquatic habitat for fish growth is determined by the value of the condition factor. This study showed that the condition factor of *Bagrus filamentosus* from Agaie - Lapai dam ranges from 0.6 – 2.6 with a mean value of 1.3±0.4, hence in this study the condition factor of *Bagrus filamentosus* from Agaie – Lapai dam indicated that the fishes were in a good condition and wellbeing.

The proximate composition of the fish shows that the fish has high amount of moisture and protein. Lipid and ash are in fair amounts. The skin has the highest protein value; this could be due to the presence of collagen, myosin and keratin on the skin. There was even distribution of lipid in all the regions of the fish. There was no significant relationship in ash content between the caudal and skin regions. There was no significant relationship between the skin and fillet; however, there was a significant relationship between the head and caudal regions. Moisture content was very high; this is good indicator of its relative contents of energy, protein and lipids. The lower the percentage of water, the greater the lipids and protein contents and the higher the energy density of the fish. Mean monthly indices of condition, (Table 2) shows that there was an improvement in fish condition between April and September (wet season). This observation agrees with the findings of Welcomme (1979) and Fagbenro *et al*., (1991) for many freshwater fishes in Africa. Lagler *et al*., (1977) attributed such differences in seasonal values of condition to availability and abundance of food supply, timing and duration of breeding cycle; physiological stress caused by changes in water quality properties within the habitat; sexual differences age; changes in seasons; and gonad maturity stages in fish.

The seasonal variations in fish condition observed in this study may be attributed to the availability of natural food in the habitat consequent upon flooding during the rainy season which resulted in the inundation of previously dry ground thereby altering a number of water quality properties which ensured growth and production of natural food indicating that seasonal variations did not affect the general condition of the fish. Seasonal variation in condition factor of fish has been reported for Leuciscus lepidus and Brycinus nurse (Karabatak, 1997); (Saliu, 2001). These differences not withstanding (Oni *et al.,* 1983) noted that condition factor is not constant for a species or population over a time interval and might be influenced by both biotic and abiotic factors such as feeding regime and state of gonadal development (Saliu, 2001). Gomiero and Braga, (2005) reported that better conditions during the wet season were due to the availability of food and enhancement during their gonad development. Samat *et al.,* (2008) also reported that fish condition can be influenced by certain extrinsic factors such as changes in temperature and photoperiod.

Every consumer wants to obtain a good quality nutrient especially protein from fish. Fish like any other animals show preferential bioaccumulation of nutrients in the various organs of the body. From this study, it has been observed that protein is more concentrated in the head than other parts of the body under investigation, followed by bones then fins and lastly flesh. The result of this study is at variance with that of Abolude and Abdullahi, (2005) where protein was more concentrated in the flesh of *Bargus filamentosus* and *Hydrocynus brevis*.

These values indicate that they are a rich source of protein to consumers. This finding is similar to that reported by (Eyo, 2001). The values were higher than those reported in mackerel and oyster (Eyo, 2001). The protein content in fish range with species due to certain factors such as the season of the year, effect of spawing and migration, and food availability (Abdullahi, 2001). The fat concentration in this report is higher than the value (5.21%) of *Gymnarchus niloticus* (Adeyeye & Adamu, 2005). This shows that the fish species mighty be very good sources of fish oil. This is required for food therapy in humans (Oyebanmiji *et al.*, 2008). In conclusion the study of the biometric shows that there is a proportionate growth reflecting a good physiological growth of the fish and the growth pattern of *Bagrus filamentosus* from Agaie-Lapai dam is negatively allometric.

References

Abdullahi, S. A. (2001). Investigation of nutritional status of *Chrysichthys nigrodigitatus*, *Barus filamentous* and *Auchenoglanis occidentals*: Family Barigdae. *Journal of Arid Zone Fisheries,* 139-50.

Abdullahi, M. (2005). Diversity and abundance of fish species in River Benue- Boronji area. B. Tech. *Thesis*, Dept. of Biological Sciences. F.U.T. Yola, Pp. 15-16.

Abolude, D. S., & Abdullahi, S. A. (2005). Proximate and mineral content in component parts of *Clarias gariepinus* and *Synodontis schall* from Zaria Nigeria. *Nigerian Food Journal* 23,1-7.

Abohweyere, P. O., Anyanwu, A. O., Jim-Saiki, L.O., Abiola, T. K., Ogunbadejo, K. H., Alhaji T. A., Williams, A. B., Esewane, G. N., Adeogun, O. A., Gbolagun, A., & Aroriode, R. O. (2011). Fishers and fisheries: Issues of sustainable resource exploitation: A case study of Bonny Area in Nigeria. *Nigerian Journal of Fisheries,* 8.1.

Abowei J. F. N., & Hart, A. I. (2009). Some morphometric parameters of ten finfish species from the Lower Nun River, Delta, Nigeria. *Research Journal of Biological Sciences* 4(3),282–288.

Adeyeye, E. I., & Adamu, A. S. (2005). Chemical composition and food properties of *Gymnarchus niloticus* (Trunk fish). *Biosci. Biotech. Res. Asia*, 3(2), 265-272.

Akombo, P. M., Atile, J. I., Adikwu, I. A., & Araoye, P. A. (2011). Water requirements of floodplain rivers and fisheries: existing decision support tools and pathways for development. *International Journal of Fisheries and Aquaculture,* 3(15), 263-270.

Azim, M. A., Islam, M. R., Hossain, M. B., & Minar, M. H. (2012). Seasonal variations in the proximate composition of gangetic sillago, *Sillaginopsis panijus* (Perciformes: Sillaginidae). *Middle East J. Sci. Res.*, 11, 559-562.

Bake, G. G., & Sadiku, S. O. E. (2012). Basic morphometric measurements and growth pattern, of *Heterotis niloticus* from River Kaduna flood plains, Nigeria. *Journal of Science, Technology, Mathematics and Education* (JOSTMED), 9(2).

Bagenal, T. B., (1978). *Methods for assessment of fish production in freshwaters,* 3rd Edn. Oxford, UK: Blackwell Scientific Publication. P. 365.

Blackwell, B. G., Brown, M. L., & Willis, W. D. (2000). Relative weight (Wr) status and current use in fisheries assessment and management. *Rev Fish Sci,* 8, 1-44.

Ekelemu, K. J., & Samuel, A. A. Z. (2006). Growth patterns and condition factors of four dominant fish species in Lake Ona, Southern Nigeria. *J. Fish. Int.,* 1, 157-162.

Eyo, A. A. (2001). Fish processing technology in the tropics. National Institute for Freshwater Fisheries Research. Ilorin: University of Ilorin Press. Pp66-70.

Fafioye, O. O., & Oluajo, O. A. (2005). Length-weight relationships of five fish species in Epe lagoon. *Nigeria African journal of Biotechnology,* 4(7), 749-751.

Fagbenro, O. A., Olaniran, T. S., & Esan, A. O. (1991). Some aspects of the biology of the catfish, *Heterobranchus bidorsalis* Geoffrey Saint-Hillarie, 1809 (Clariidae) in River Ogbese, Nigeria. *Journal of African Zoology,* 105, 363 - 372.

Froese, R., (2006). Cube law, condition factor and weight-length relationships: History, meta-analysis and recommendations. *J. Appl. Ichthyol.*, 22, 241– 253.

Foran, J. A., Good, D. H., Carpenter, D. O., Hamilton, M. C., Knuth, B. A., & Schwager, S. J. (2005). Quantitative analysis of the benefits and risks of consuming farmed and wild salmon. *Journal of Nutrition,* 135, 2639–2643
.

FAO (2004). State of world fisheries and aquaculture. Rome, Italy.

Gomiero, L. M., & Braga, F. M. S. (2005). The condition factor of fishes from two river basins in São Paulo state, Southeast of Brazil state, Acta Scientiarum. *Biological Sciences Maringá,* 27(1), 73-78.

Hem, S. (1986). Premiers resultats sur la reproduction controlee de Silver Catfish on milieu d'elevage. In E. A. Huisman (ed.) Aquaculture research in the Africa region. Wageningen, The Netherlands. Pp. 189-205.

Hetzel, B.S., & Pandav, C. S. (1996). *S.O.S. for a billion: The conquest of iodine deficiency disorders. 2nd Ed.* Dehli: Oxford University Press publ. Pp. 1-466.

Ikongbeh, O. A., Ogbe, F.G., Solomon, S. G.(2012). Length-weight relationship and condition factor of Bagrusdocmac from Lake Akata, Benue state, Nigeria. *Journal of Animal and Plant Sciences,* 15, 2267-2274.

Karabatak, M. (1997). The time of spawning and seasonal variations in length-weight relationship and condition of chub, *Leuciscus lepidus* (Heckel, 1834) in Lake Beysehir (Turkey), *Acta Hydrobiol.,* 39, 39-46.

King, M. (2007). *Fisheries biology, assessment and management, 2nd edition.* Oxford: Blackwell Scientific Publications. P. 189-192.

Le Cren, E. D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (Perca fluviatilis). *J. Anim. Ecol*., 20, 201-219.

Lagler, K. F., Bardach, J. E., & Miller, R. R. (1977). *Ichthyology: The study of fishes.* New York, USA: John Wiley and Sons Incorporated. P. 544.

Mohamed, H.A.E., Al-Maqbaly, R., & Mansour, H. M. (2010). Proximate composition, amino acid and mineral contents of five commercial Nile fishes in Sudan. *Afr. J. Food Sci*., 4, 650-654.

Mridha, M. A., Lipi, S.Y., Narejo, N.T., Uddin, M.S., Kabir, M. S., & Karim, M. (2005). Determination of biochemical composition of *Cirrhinus reba* (Hamilton, 1822) from Jessore, Bangladesh. *Journal of Science & Technology University Peshawar*, 29(1), 1-5.

Offem, B. O., Yemi, A., & Isaac, T. O. (2008). Diet, size and reproductive biology of the silver catfish, Chrysichthys nigrodigitatus (Siluformes: Bagridae) in the Cross River, Nigeria Revista de biología tropical, 56(4), 1785-1799.

Ohen, S. B., & Abang, S. O. (2007). Economics of catfish farming in Rivers State, Nigeria. *Academic Journal of Plant Sciences*, 2(1), 56-59.

Olaosebikan, B. D., & Raji, A. (2002). *Field guide to Nigerian freshwater fishes second edition.* New Bussa: Federal College of Freshwater Fisheries Technology. P.106.

Oni, S. K., Oluyemi, J. Y., & Adegboye, J. D. (1983). The comparative physiology of three ecologically distinct freshwater fishes, Alestes nurse (Ruppel), *Synodontis schall*, (Bloch and Schneider) and Tilapia zilli (Gervais). *Journal of Fish Biology,* 22,105-109.

Oyebamiji, F. O., Asiru, R. A., & Oladunjoye, R. Y. (2008). Length-weight relationship, abundance and sex ratio of the Giant River Prawn Macrobrachium vollenhovenii (Herklots, 1857) From River Osun, Southwestern Nigeria. *J Aquac Res Development,* 9(10).

Rasheed, R. O. (2011). Seasonal variation in fat percentage and water content of muscle tissues of some fishes endemic to Derbendikham reservoir. *J. Bab. Univ. Pure. Appl. Sci.,* 19, 435–443.

Saliu, J. K. (2001). Observation on the condition factor of Brycinus nurse (Pisces: *Cypriniformes, Characidae)* from Asa reservoir, Ilorin, Nigeria. *Trop. Freshwater Biol*., 10, 9-17.

Samat, A., Shukor, M. N., Mazlan, A. G., Arshad, A., & Fatimah, M. Y. (2008). Length-weight relationship and condition factor of *Pterygoplichthys pardalis* (Pisces: Loricariidae) in Malaysia Peninsula. *Research Journal of Fisheries and Hydrobiology*, 3(2), 48-53.

Soumendra, N. S., Vijayanand, P., & Rajagopal, S. (2009). Length-weight relationship and relative condition factor in Thenus Orientalis (Lund, 1793) along East Coast of India. *Current Research Journal of Biological Sciences*, 1(2), 11-14.

Ude, E. F., Ugwu, L. L. C., Mgbenka, B. O., & Nwani, C. D. (2011). Evaluation of length-weight relationship of fish species of Ebonyi River, Nigeria. *Nigerian Journal of Fisheries*, 8(1),136-144.

Welcomme, R. L. (1979). *Fisheries ecology of floodplain rivers.* London: Longman. P.317.

Wootton, R. J. (1998). Ecology of teleost fishes. 2nd Edition. Dordrecht Kulwer. 392 p.

Zafar, M., Mussaddeq, Y., Akhter, S., & Sultan, A. (2003). Weight-length and condition factor relationship of Thaila, *Catla catla* from Rawal Dam Islamabad, Pakistan. *Pakistan Journal of Biological Sciences,* 6(17), 1532 – 1534.