NUTRIENT COMPOSITION OF FRESHWATER FISH FAMILIES IN NORTHERN NIGERIA

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DEDICATION

This Doctoral thesis is affectionately dedicated to the almighty ALLAH and my Late Father, MALLAM ABDULLAHI for my up bringing.

DECLARATION

I hereby declare that this thesis is wholly that of the author and has not been presented in any form for another qualification at any other university or institution. Information derived from the published and unpublished works or other authors has been duely acknowledged in this work.



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CERTIFICATION

This thesis entitled, Nutrient Composition of Freshwater Fish Families of Northern Nigeria, by **SHUAIBU AKPAI ABDULLAHI** meets the regulations governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

The proximate, amino acid, nutritional values and mineral contents of fourteen fresh water fish families viz: Cichlidae, Bagridae, Mochokidae Cyprinidae, Clariidae, Characidae, Mormyridae, Schilbeidae, Citharinidae, Centropomidae, Distichodontidae, Gymnarchidae, Osteoglossidae and Malapteruridae comprising of fourty species collected from Tiga dam, Zaria dam, Shiroro dam and Niger-Benue Confluence were determined using standard procedures of AOAC (1975 and 1980), Winberg (1971), TSM, FA) (1973) Atomic Absorption spectrophotometer (AAS), Flame photometer and Spectronic 20. The carbohydrate, lipid and protein were generally in the ratio of 1:2:4. The range of the nutrients contained were moisture 70.20-79.60g/100g wet weight, Ash 2.40 - 39.70, Organic matter 60.00 - 98.00, Carbohydrate 4.60 - 28.30, Lipids 15.80 - 56 40, protein 28.10 - 58.30g/100g dry matter while the calory was 235.62 - 728.90 k cal./l00g organic matter. These range of values were found to be within the range recommended for human of all ages. Seventeen amino acids were also observed with significant difference (P<0.05) between the most prominent was glutamic acid and the least prominent was mainly methionine. However, the essential amino acids contained in all families had values indicating that fish proteins are of good quality, this was confirmed by the high values of Essential to non essential ratio, Essential to total nitrogen, Essential to protein ratio, Essential amino acid index and protein scores. The results also indicated that calcium dominated the mineral pool and the least was copper. The fresh water fishes were good sources of dietary minerals. There was no significant difference (P>0.05) in all nutrients contained in fishes collected from the four locations, however some nutrients were significantly higher (P<0 05) during the wet seasons.

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CHAPTER ONE

INTRODUCTION

Fish contributes about half of the animal protein intake in Africa, and in-land fisheries provide about 40% of this (West, 1982).

Since the era of oil boom in Nigeria (early 1970's) there has been a gradual increase in private consumption expenditure (PCE) resulting in higher demand for animal protein by a wider spectrum of the Nigerian populace, thus increasing the demand for fish and fisheries products (Dada and Gnanados, 1983).

The Sahelian drought of the mid-seventies (Sagua, 1979), coupled with the intermittent out break of rinder pest (Hall, 1977) resulted in escalated cost of beef cut and made fish to become the best alternative source of animal protein especially for the less privileged Nigerians.

Studies on domestic fish production in Nigeria, indicated that as much as seventy percent of fish catch and supply comes from artisanal fisheries in marine, coastal and inland fresh waters (West, 1982, and Anon, 1986). However, the estimated yield of the freshwater bodies are less than their potential production capacities, especially from capture fisheries (Bazigos, 1972; Ekwemalor, 1975; West, 1982; Ita, 1982 and Balogun, 1986) and therefore not meeting the requirements of the teaming Nigerian population.

Aquaculture compared to capture fisheries is relatively a new industry in Africa (West, 1982). Fish culture gradually gained prominence in Nigeria because of the growing deficiency in capture fisheries (Bayagbona, 1983). It is however characterised by small scale subsistence farming of *Tilapia spp, Clarias spp, Carp, Heterotis spp and Chrysicthys spp* most recently

(Onyia, 1992). Yet Nigeria has excellent fish culture potential because of its abundant water resources. Intensification of fish culture has been identified by various workers as the only short-term and of course long-term solution to the inadequate fish supply to the Nation (Sagua, 1976; Ita, 1980 and Eyo, 1983) following the complete ban on fish importation. The anticipated progress in aquaculture has been less remarkable because of lack of suitable feeds for the different fish families.

Artificial diets have been developed based on nutritional requirements of fish and the availability of nutrients from which feeding ingredients is obtained (Hardy, 1989 and Well, 1992). Artificial diets based on this approach have been developed for marine fishes such as *Salmon gairdneri, S. solar, S coptholmus maximus, Carassius auratus, and Cyprinus carpio* (Runsey and Ketola 1975, Arai, 1981, Wilson and Poe, 1985 and Cowey and Tacon, 1992). The mineral composition of fish was also known to correlate to the mineral requirements of *Cyprinus carpio and Salmons spp* (Steffens, 1989).

The nutritional requirement of a significant part of the world population especially the developing countries including Nigeria are yet to be satisfied. In most cases the nutritional insufficiency is attributed to unavailability of protein, amino acids and minerals (Seelstra et al, 1974). An under untilized resources of excellent animal protein, fish oils, vitamins and minerals are present in the world's water bodies, but the main problem is to get these resources to the consumers (Seelstra et al, 1974). The use of fish oil in the diet is reported to reduce the risk of coronary heart diseases, arthrities, atheroscelerosis, asthma, auto-immune diseases, cancer and multiple scelerosis (Ackman, 1992).

It was in recognition of the unique roles played by the fisheries resources in the national

economy and the nutritional well-being of its citizens that the Federal Government of Nigeria in conjunction with donor agencies such as JICA (Japan International Coopoeration Agency) FAO/UNDP, DRC, and CIDA presented some well thought out plans to achieve self sufficiency in fish production and mapped out strategies as follows:-

i) Increased exploration of Nigeria fishing resources to meet the ever increasing demand for fish and encourage the development of fisheries based industries.

ii) Establishment of National Accelerated Fish Production Project (NAFPP).

iii) Development of Inshore Fishing Project (IFP).

iv) Establishment of Artisanal and Inshore Fisheries Development Project (AIFDP)

v) Funding of all state fisheries developments and research institutes in the area of fish seed production through Directorate of Food Roads and Rural Infrastructure (DFRRI) in 1987 (Anon, 1980). The increased fish seed production was remarkabled for *Tilapia spp* and *Clarias spp* (Eyo, 1990).

Previous studies on the fresh water fish families were mainly on their biology and ecology in some selected water bodies, such as, in lake Kainji were biological studies of Citharinidae (Bakare, 1968); Bagridae (Ajayi, 1972); Mochokidae (Lewis, 1974); Chichlidae (Akintunde, 1976); Clupeidae (Otobo, 1977); Schilbeidae (Olatunde, 1978) and Centropomidae (Balogun, 1988), have been carried out. Similar studies carried out elsewhere were on Kaingimi dam on all families (Abdullahi, 1987), Bagridae in Tiga dam (Abdullahi, 1988) and in Zaria dam were Cichlidae (Elakhame, 1983); Cyprinidae (Faruku, 1984); Malapteruridae (Ogb , 1985); Characidae (Odigie, 1983) and Characidae (Ogeh, 1983).

Reports on the nutritional contents and biochemical composition of fresh water fishes

are scanty. The upgrading and expansion of our present knowledge of chemical composition and nutritive value of the fresh water fish families will lead to more judicious use, most especially in infant diets. Perhaps also the comprehensive knowledge of the fish families nutrient composition will step up the use of hitherto some neglected families and species.

AIMS AND OBJECTIVES

The general aim of this study was to upgrade and expand our present knowledge of the chemical composition and nutritive value of the fresh water fish families in Northern Nigeria. The specific objectives were as follows:

i) To determine the proximate components such as the ash, organic matter, carbohydrate, lipids, proteins and calory of the species in each family.

ii) To determine the qualities and quantities of the amino acids in each species.

iii) To determine the nutritive values of the respective species using chemical indices.

iv) To determine the quantities of some mineral elements in the species.

v) To establish the effect of the selected locations and the two seasons on the nutrient components of the species in each family.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 Nutrient composition of Marine Fish Species

Quite a number of workers have made valuable contributions in the use of statistics to estimate the nutritive value of fish species. Huxley (1932) made a pioneering application of a simple exponential equation $Y=a^{xb}$ to determine the protein, carbohydrate, fats and mineral elements of fish,

where a = intercept constant

b = slope constant

x = independent variables

y = dependent variables (protein, carbohydrate, lipids and mineral contents).

Another equation Log Y = Log a + b log x

where a, b, x and y are of similar functions as Huxley (1932) equation was employed by Isles and Wood (1964) to determine the proximate composition of *Clupea harengus*. Isles and Wood (1964) observed that the equation was a more accurate method of evaluation of nutrient content than a purely chemical method. Later other workers employed the equation to determine nutrient composition of some marine species. Bret et al (1969) as well as Illiot (1976) all employed this equation to determine the nutritive value of *Lepomis macrochirus* and *Salmo trutta* respectively. These two equations were derived from a simple relationship exisinting between the values of carbohydrates, proteins, fats and ash (dependent variables) and those of standard length and fresh body weights (independent variables). The lipid content of

fishes was also estimated from the relationship between the percentage dry mass and the percentage fats or from the inverse relationship between the percentage water and percentage fats (Neiland, 1970). Caulton and Bursell (1977) however employed the relationship existing between the amount of fats protein and water to estimate the fat content of young *Tilapia vendalii*. The workers noted that when components are expressed as percentage of dry matter to which all of them contribute in fishes, correlation must be carried out by calculating the regression equation relating the size to its major nutrient constituents and comparing 0the measured amounts of each component with the predicted values from the equation. Both workers also found that a lorgarithmic transformation of the data provided the best expression of the relationship between the body mass and the protein, fats and ash contents.

Seasonal changes in nutrient composition of marine fishes

Studies on the effect of season on the nutrient composition of fish have been conducted mainly on marine fishes and in specific components. Quayam (1984) observed that high levels of free amino acids in *Ophiocephalus punctatus* were influenced by seasonal feeding rhythms and the break down of protein for the development of gonads. Oser (1965) also observed that arginine, lysine, aspartic acid and cysteine amino acids in marine fishes generally increase with the size and flooding season, due to higher consumption of more nutritional diets during these periods or richer sources of food. Zinc however was lost from the body of fishes in winter and gained from the environment during spring especially in *Salmo gairdneri* (Berman and Vitin, 1968). The workers also observed increase in the iron content of the body of *Salmo gaidneri* during spring use to higher metabolic activities. Similar increases were reported for sodium, potassium, chlorides, calcium and magnesium during spring in *Salmo gaidneri*.

Voltanem (1973) worked on *Coregonus nasans* and reported a gradual rise in the Copper content of the liver from January to maximum in March and April while Magnesium rose to the peak in May. He suggested that these changes were due to enzymatic composition of the fish during the period.

Shulman (1984) observed large variation in the fats and protein levels during the annual cycles especially in the tropical oceanic fishes. The levels of carbohydrates were significantly influenced by the seasonal glycogen level in the blood, liver and muscles which were mansimal from January to July.

In the analysis of edible portion of commercial fishes caught in Netherlands, seasonal variation in protein, fat and moisture contents were insignificant in cod fish (*Gadus morrhau)* while the protein and fat contents in *Pleuronectes platessa* and *Merlanguis merlangus* varied significantly during spring season (Luter et al, 1984).

(Craig , 1977) reported that both protein and lipids are utilized for gonadal development most especially at the start of the rains in *Percia fluviatilis*. Damson and Grimm (1980) also noted some depletion in the protein and lipid reserves of *Pleuronectes platessa* during egg production in winter, and that the reproductive activities and season affect the protein and fat content of this fish.

In Malaysia, Abdullahi and Hails (1983) analysed the nutritive value of *Trichogaster pectoralis* separately during and after breeding and observed that changes in caronhydrate was insignificant but fat and protein levels were high in the muscles and intestine during the breeding activities.

Effects of location on nutrient composition of marine fishes

The effect of location on the nutrient composition is a reflection of its being marine or fresh water, as well as being temperate or tropical. These two factors significantly affect the diets of fish (Akulin, 1979). Different locations with no marked differences in the climate and limnological parameters have little effect on the diet and therefore the nutrient composition of the fish (Akulin, 1979). Chebotarova and Krebs (1979) worked on the variation in lipid content of the liver and muscles of *Onchorhychus nerka* with respect to habita .t, and reported marked variation in these organs. The fish contained more fatty acids when in fresh water than in the sea, especially linoleic acid. This they observed might be due to differences in the dietary items consumed (Chebotarova and Krebs, 1979). The flounder fish (*Pseudo plenronectes americanus)* doubled its fat content when in the Northern latitudes compared to those in the Southern latitudes (Numes et al, 1992), however the Atlantic herring (*Clupea harengus)* had modest changes in the fat content in the same locations.

Nutritional Value of Marine Species

Studies on the nutrional value of fish have been conducted mainly on marine fish species such as *Ictalurus punctatus, Salmo gairdneri, Sardinop melanosticta, Sardinella longiceps* (Mustafa and Miediros, 1985; Erickson, 1992; Caulton and Bursell, 1977; Quaglia and Organ, 1990 and Sara et al, *1992).*

Mustafa and Miediros (1985) carried out the chemical analysis of *Ictalurus punctatus* which they found to contain 77.8% moisture, 15.4% protein, 4.5% fat and 1.2% ash in the raw fish while the baked fish was found to contain 71.4% moisture, 20.5% protein, 6.3% fat and

1.4% ash. Baking was found to conserve the nutrient content of *Ictalurus punctatus.*

In another studies on three sizes of *Salmo gaidneri,* the proximate components were found to be 14.2% protein, 3.5% fat and 75.5% moisture for the 3.62g fish, 18.2% protein, 2.8% fat and 77.2% moisture for the 201.3g fish and 20.2% protein, 2.8% fat and 78.2% moisture for 1223.0g fish indicating a general increase in the protein and moisture content with body weight.

Oyvind *et al* (1994) worked on the proximate composition of fillets from bony fishes. The results indicated that the highest dry matter was contained in eel (541g/kg) and the least dry matter was contained in Plaice (177g/kg). The highest protein was contained in blue fin (240g/kg) while the least was recorded in plaice (134g/kg). The fat content was very high in eel (325g/kg) and least in blue ling (110g/kg). The glycogen level was generally low in all bony fishes analysed. The eel was found to be a good of source of lipid calory and minerals while the blue ling was found to be the best source of protein.

In the determination of amino acids, Baboo *et al* (1976) observed that acid hydrolysis caused partial destruction of cysteine and tyrosine and the complete destruction of tryptophan, while in the complete liberation of valine and isoleucine and the removal of serine and threonine, the presence of carbohydate and acid hydrolysate moderate the respective amino acids.

In later studies on amino acid content of fishes, Bhiyan *et al* (1986) indicated that smoking and sun drying had selective effect on the fish amino acids such as lysine and tryptophan.

Oyvind *et al* (1994) carried out amino acid analysis of fillets of bony fishes such as Tuna, Catfish, Char, Cod, Eel, Halibut, Haddock, Herring, ling and Mackerel. A profile of

seventeen amino acids was obtained, the highest amino acid contained in all the species was glutamic acid, followed by leucine, lysine and aspartic acid respectively while the least amino acid contained in all species was tryptophan.

Orlova *et al* (1993) worked on the nutritive value of *Electrona caresbergi* fish in Moscow, found the predominant amino acids to be glutamic acid, methionine threonine, isoleucine and phenylalanine as the total pool of essential amino acid was 323.5mg/g protein content.

Various workers have made frantic efforts at proper evaluation of the protein value of fish using chemical scores. Sinkka *et al* (1979) carried out analysis of three fish families, namely family Arridae, Trichuiridae and the milkfish family. The workers observed that the three families contained the same profile of amino acids but significantly different quantities were found. It was also observed that the level of essential amino acids contained in the three families approahced closely to that in egg protein. Sikka *et al* (1979) also indicated that the E:N (ratio of Essential to non-essential amino acid), E:P (ratio of Essential amino acid to protein), E:T (ratio of Essential Amino acids to total amino acid) and the EAAI (Essential Amino Acid Index) were highest in Arridae family followed by family Trichuiridae and the least were recorded in the milkfish. The EAAI for Ribbon fish approached closely the EAAI for egg protein taken as 10. These chemical indices indicated high nutritive values for the three fish families.

In an attempt to find suitable source of dietary minerals, some investigations were carried out on the mineral composition of sea fish species. Falandysz (1985), worked on 35 flat fishes from Southern Baltic and the mean values of the mineral compositions were obtained

as 0.012mg/kg Cadmium, 0.16mg/kg Lead, 0.15mg/kg Manganese, 0.14mg/kg Copper, 5.0mg/kg Zinc and 2.2mg/kg Iron.

In the analysis of the mineral contents of *Godus morrhua, Pleuronectes plastessa* and*Merlanguius merlangus,* Luten *et al* (1984) reported 80mg/100g, 120mg/100g, 326mg/100g and 360mg/100g of Potassium, 23mg/100g, 39mg/100g and 25mg/100g of Calcium and 24mg/100g, 30mg/100g and 30mg/100g of Magnesium respectively.

Eighty-eight samples of tuna fish from Tenerife Canary Island, Spain were also analysed for mineral contents, and the mean values obtained were 2.16mg/g of Lead, 0.05mg/g of Zinc, 10.85mg/g of Cadmium, 1.49mg/g of Copper and 4.13mg/g of Iron in the dry samples (Hardisson *et al*, 1986).

Fourteen species of mackerel *Scomber scombus* were analysed for their Iron contents. They were observed to contain between 0.2mg/100g to 1.0mg/100g of Iron in the edible portion The percentages of the Iron content were found to vary with the seasons (Leu *et al*, 1981). Terry *et al* (1984) observed 0.2mg/100g to 0.9mg/100g of Iron in the North East pacific species of mackerel while Jhaveri *et al* (1984) only observed 0.2mg/100g to 0.5mg/100g of Iron in the same fish species from southern New England.

Processing and freezing was reported to reduce the quantity of Iron in the Cod, *Gadus morrhua* and Mackerel, *Scomber scombus* tissues (Gomez and Regenstein, 1993). The workers also reported that the dietary Iron derived from fish was more easily assimilated than that from plant materials.

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Nutrient composition of fresh water fish species

Literature on the biochemical composition and nutritional value of fresh water fish famlies have been limited to a few families like Cichlidae, Claridae and Schilbeidae and in such cases restricted to some selected nutrients.

Afolabi *et al* (1984) studied the proximate composition and amino acids of *Oreochromis niloticus, S. galilaeus, Tilapia zilli* and *Hemichromis fasciatus.* The highest moisture (71.11g/100g) and crude fibre, protein (78.89g/100g and total lipid (19.88g/100g) was reported in *S. galilaeus.* Total ash (12.32g/100g) was four times in *H. fasciatus* than in the other species. The workers similarly reported seventeen amino acids in the four species. The highest amino acid in all four species was glutamic acid, followed by lysine and aspartic acid. However, the least amino acid reported in the four species was cystine. In a later study, Boman (1992) reported the proximate composition of *T. zilli* as organic matter (74.05%), protein (63.29%) crude fibre (0.52%) and carbohydrate (15.17%).

Also, Al-Ogaily *et al* (1996) reported the body compsotion of *Oreochromis niloticus* as moisture (71.70%), crude protein (14.83%), crude lipid (7.11%) crude ash (4.77%) and energy (6.30kj/g). Otitologbon *et al* (1997), however reported the proximate composition of *O. niloticus* as moisture (772.1g kg^{-1}), of fresh weight, crude lipid (98.1g kg^{-1}), crude protein (658.3g kg^{-1}) and ash (104.4g kg^{-1}) while the mineral contents were Calcium (8.83mg g^{-1}), Phosphorus (5.08 mg g^{-1}), Potassium 2.69mg g^{-1}), Magnesium (0.36mg g^{-1}), Sodium (0.72mg g^{-1}), Zinc (0.07mg g^{-1}), Iron (0.03mg g^{-1}), Copper (0.003mg g^{-1}) In another development, Adeyeye *et al* (1996) further reported the mineral composition of *O. niloticus.* The quantities of the minerals contained were Zinc (3.92%), Lead (0.79%), Manganese (2.56%), Iron

(37.0%), Sodium (630.59mg), Potassium (491.17mg) while Copper and Cobalt were in trace quantities of the total ash of edible portion.

Sadiku and Oladimeji (1989) carried out analysis of amino acid composition of *S. galilaeus* in Zaria. The prominent amino acid was glutamic acid while the least in concentration was methionine. Higher concentrations of all amino acids were reported in the fish during the dry season.

The only available report on the biochemical composition of the family Cyprinidae was carried out in Zaria.

Wuddivira (1992) reported that *Labeo coubie* contained mean dry matter (23.04%), moisture (76.96%), organic matter 95.55%), crude protein (75.13%), crude lipid (10.61%), Carbohydrate (11.45%), crude fibre (1.36%) and ash (1.45%) of the edible portion. In the same report the contents of minerals were Calcium (1.21%), Potassium (1.23%), Magnesium (0.10%), Sodium (0.10%), Copper (0.015%), Manganese (0.0015%), Zinc (0.0021%) and Iron (0.016%) of the flesh. The tissues of *L. coubic* contain higher quantities of dietary nutrients.

Adeyeye *et al* (1996) also analysed some minerals in *Cyprinus carpio* in a polyculture fresh water pond. They reported Zinc (1.33ppm), Manganese (0.65ppm), Iron (5.42ppm), Sodium (480ppm) and Potassium (168.63ppm) in the sex organs, gills liver, intestine eyes, head, scales combined together. *C. carpio* was confirmed to be a good source of dietary minerals.

Olatunde (1980) worked on the biochemical composition of *Eutropius niloticus, Schilbe mystus* and *Physaila pellucida* (family schilbeidae). *E. niloticus* was reported to contain the highest moisture (74.0g/100g), while the highest ash (11.7g/100g) and carbohydrate

(15.3g/100g) were contained in *S. mystus*. The highest protein (54.2g/100g) was reported in *E. niloticus*, the highest lipid (34.3g/100g) was observed in *P. pellucida*. The mineral contents of the family were generally high with *S. mystus* containing the highest Calcium (3800mg/100g) and Magnesium (139mg/100g); while *E. niloticus* contained the highest Potassium (607mg/100g) and Sodium (312.5mg/100g). *P. pellucida* contained the highest Copper (2.7mg/100g), Iron (6.8mg/100g) and Zinc (16.5mg/100g). He also reported that there was no significant difference in the calories of the three species. Similarly, Wuddivira (1992) studied the biochemical composition of *S. mystus* in Zaria and reported crude protein (57.53%), crude lipid (31.19%), carbohydrate (4.66%), crude fibre (1.59%) and ash (5.03%).

In the family Characidae, Faturoti and Aransiola (1985) reported that the moisture, fat and volatile nitrogen contents of sun dried *Alestes macrolepidotus* to be higher than contained in the smoked one. Gwaza (1992) worked on the nutritive value of *Alestes nurse* of between lengths 12.14cm and 20.67cm. The nutrients contained were dry matter (23.66%), moisture (79.9%), fat (31.52%), protein (52.2%), and carbohydrate (3.72%). The mineral pool also showed the composition as Manganese (0.00068%), Sodium (0.124%), Copper (0.0026%), Zinc (0.02%), Iron (0.014%), Magnesium (0.124%), Calcium (1.70%) and Potassium (1.70%).

Sadiku and Oladimeji (1989) reported that *Synodontis schall* (family mochokidae) contained seventeen amino acids with glutamic acid as the dominant amino acid and the least being methionine. Oni (1979) studied the chemical composition of *S. schall* and reported high carbohydrate content but low protein and calory were contained. In a later study, Boman (1992) on *S. budgetti*, observed dry matter (67.52%), crude protein (45.90%), crude fat

(28.80%), carbohydrate (10.12%), and crude fibre (1.07%). The mineral pool was also reported as Calcium (1.8%), Potassium (1.9%), Magnesium (0.1%), Sodium (0.12%), Copper (0.002%), Zinc (0.003%), Iron (0.02%) and Manganese (o.001%).

In the biochemical analysis of oven dried *Clarias gariepinus* family claridae, Afolabi *et al* (1984) reported the nutrient contents as moisture (72.90%), crude protein (74.45%), total lipid (21.90%), total ash (3.36%) and crude fibre (0.67%). Seventeen amino acids were also reported in *C. lazera* with glutamic acid (16.98g/16gN) as the predominant amino acid, followed by lysine (13.57g/16gN) and aspartic acid (12.59g/16gN) in that order. The least amino acid reported in *C. lazera* was cysteine (0.29g/16gN).

C. gariepinus was also studied for the proximate composition. Gwaza (1992) reported the nutrients as dry matter (18.6%), moisture (75.4%), fat (12.75%), carbohydrate (10.80%), protein (63.0%) while the minerals were Potassium (1.02%), Calcium (1.12%), Manganese (0.0003%), Copper (0.002%), Magnesium (0.14%), Sodium (0.15%), Zinc (0.014%) and Iron (0.012% of the flesh. Otitologbon *et al* (1997) also reported the proximate and mineral composition of *C. gariepinus* as moisture content (744.1g kg^{-1}), crude lipid (141.0g kg^{-1}), crude protein (685.7g kg^{-1}), and ash (64.6g kg^{-1}), while the mineral contents were Calcium (8.32g kg^{-1}), Phosphorus (5.16g kg^{-1}), Potassium (3.71g kg^{-1}), Magnesium (0.35g kg^{-1}), Sodium (0.81g kg^{-1}), Zinc (0.08g kg^{-1}) and Copper (0.0005g kg^{-1}).

Deelstra *et al* (1974) in their study of the nutritive value of fishes of Lake Tanganyika, reported *Lates stappersii* family Centropomidae as containing moisture (78.8%), protein (77.0%), lipid (4.70%) and ash (11.6%). Seventeen amino acids were also reported in *L. stappersii*. They were isoleucine (263mg/gN), leucine (535mg?gN), lysine (613mg/gN), methionine (215mg/gN), cysteine (76mg/gN), phenylalanine (253mg/gN), Tyrosine

(220mg/gN), Threonine (306mg/gN), Tryptophan (30mg/gN), valine (300mg/gN), Arginine (377mg/gN), Histidine (370mg/gN), Alanine (443mg/gN), Aspartic acid (654mg/gN), Glutamic acid (870mg/gN), Glycine (340mg/gN), Proline (281mg/gN) and Serine (300mg/gN). Sadiku and Oladimeji (1989) also reported seventeen amino acids in *L. niloticus*, however observed glutamic acid as the predominant amino acid and the least as methionine, but the essential amino acids were within those recommended for humans. Otitologbon *et al* (1997) similarly carried out the proximate and mineral analysis of *Mormyrus rume* and observed the nutrient contents as moisture content (752.5g kg^{-1}), crude lipid (157.7g kg^{-1}), crude protein (722.2g kg^{-1}), and ash (63.5g kg^{-1}), the mineral contents were calcium (3.59mgg^{-1}), phosphorus (6.59mgg^{-1}), potassium (3.22mgg^{-1}), magnesium (0.18mgg^{-1}), sodium (0.34mgg^{-1}), zinc (0.06mgg^{-1}) iron (0.01mgg^{-1}) and copper (0.002mgg^{-1}).

Faturoti and Aransiola (1985) studied the nutrient content of three dried samples of *Heterotis niloticus* family osteoglossidae. The three samples were found to contain 16.6%, 22.6% and 76.2% moisture and 2.28%, 2.28% and 0.82% fat respectively. The workers concluded that methods of processing affects the nutrient concentration of fish samples. In a later study, Knauer *et al* (1995) reported the amino acid and mineral content of *H. midae* in South Africa. The amino acids were reported as percentages of the protein. Seventeen amino acids were reported as Alanine (1.33%), Arginine (1.81%), Aspartic acid (2.41%), Cysteine (0.56%), Glutamic acid (3.38%), Glycine (1.91%), Histidine (0.42%), Isoleucine (0.93%), Leucine (1.59%), Lysine (1.42%), Methionine (0.48%, phenylalanine (0.89%), proline (1.20%), serine (1.17%), Threonine (1.15%), Tryptophan (0.19%) and valine (1.06%). The mineral contents were reported as calcium (243,300mgg^{-1}), cadmium (0.7 mgg^{-1}), cobalt (8.0

mg/g), Copper (16.6mgg), Iron (182.8mgg), Potassium (100.5mgg) Magnesium (953.3mgg^{-1}) Manganese (2.7mgg^{-1}), Nickel (12.6mgg^{-1}), and Zinc (37.5mgg^{-1}).

Furthermore, Eyo (1992) carried out assessment of nutritional value of two species of the family Clupeidae *Pellonula afzeliusi* and reported that they contain dry matter (90.22%), crude protein (71.33%), fat (7.97%), crude fibre (1.08%) and total ash (20.22%) while *Serrathrissa leonensis* contained dry matter (90.23%), crude protein (68.47), fat (8.02%), crude fibre (0.39%), total ash (17.81)%. The worker concluded that *P. afzeliusi* ws a better source of dietary protein and minerals than *S. leonensis*.

Mineral content of the two species indicated that *P. afzeliusi* contained Sodium (0.83%), Calcium (3.56%), Potassium (0.90%), Phosphorus (2.24%), Magnesium (0.10%), Iron (1.60%), and Manganese (0.40ppm) while *S. leonensis* contained Sodium (0.66%), Calcium (2.27%), Potassium (0.76%), Phosphorus (1.62%), Magnesium (0.03%, Iron (1.40ppm) and Manganese (0.20ppm). Seventeen amino acids were also reported in the two species each containing high quantities of essential amino acids.

Human Nutritional Requirements

Research into the nutritional requirements of man have been conducted mainly in the advanced societies by a few workers, the Food and Agricultural Organisation and the World Health Organisations.

In a twenty-year survey, it had been reported that males in particular and indeed patients frequently eating fish had reduced cardiovascular mortalities and also the introduction of fatty fish in the diets of cardiac patients, improved their survival after 100 days and also reduced the

risk of stroke (Keli et al, 1994). Kuem and Joe (1993) also reported that consumption of fishes reduce the risk of coronary diseases in human.

Tontisirin et al (1993) worked on amino acid requirements of human of all ages. They reported a minimum tryptophan requirement of 2mg/kg body weight for the aged, 3mg/kg body weight for adult and 4mg/kg body weight for children. However the threonine daily requirements were 7.6mg/kg for the aged and 6.8mg/kg/day for adults. Kennedy et al (1989) however, recommended a daily minimum of all amino acids (essential amino acids) of 2mg/kg body weight. The authors also reported that deficiency of methionine, phenylalanine and tryptophan reduced growth while that of arginine and histidine retarded spermatogenesis. Low level of threonine was reported to resulting in liver fat accumulation while deficiency of valine led to negative nitrogen balance. Low isoleucine led to low haemoglobin level while that of lysine led to nausea, anaemia and dizziness.

The Food and Agricultural Organisation (FAO)/World Health Organisation (WHO) (1973) recommended 3.5-3.7g/16gN for infants and 1.8g/16gN isoleucine for adults, leucine 5.6-8.0g/16gN and 2.5g/16gN, lysine 5.2-7.5g/16gN and 2.2g/16gN, methionine 2.9-3.4g/gN and 2.4g/16gN, phenylalanine 3.4-6.4g/gN and 2.5g/16gN, Threonine 4.4-4.5g/16gN and 1.3g/16gN, raline 4.1-4.7g/16gN and 1.8g/16gN and Histidine 1.4g/16gN respectively for infants and adults. The Food and Nutrition Board, National Academy of Sciences, National Research Council, USA also specified minimum daily requirements of tryptophan, phenylalanine, lysine, threonine, methionine, leucine and isoleucine as 2.5-3.6g/16gN.

Maren and Marlene (1994) jointly in their findings gave US/RDA (Recommended Dietary Allowance) of Iron (5g), Magnesium (2g), Potassium (219g), Copper (0.2mg), and all

amino acids combined 8g in the daily diet as the most convenient healthy level and best body defence system. However, Kruppet et al (1970) reported the specific values required in the human blood as amino acids (3-5.5mg/100ml, Calcium 5-11mg/100ml, Copper 100ppm - 200ppm/100ml, glucose 80-120mg/100ml, Iron 50-175mg/100ml, Magnesium 1-3mg/100ml and Potassium 14-20mg/100ml.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 COLLECTION SITES

Fish samples were collected from four locations in the savannah region of Northern Nigeria (fig.3.1). The sites were Benue-Niger confluence at Lokoja, Kogi State, Shiroro dam in Niger State, Zaria dam in Kaduna State and Tiga dam in Kano State. The locations lie between latitude 6°.30¹N and 8°.45¹ and between longitude 8°.50¹ and 12°.30¹

3.2 SAMPLE COLLECTION

At the collection sites fish samples were identified using keys by Holden and Reed (1978) and Le wis (1974). Specimens were obtained either directly from the fishermen or the fish retailers twice each month, between January 1990 and September 1993. The samples were each time transported in ice-chest to the laboratory where they were kept in the freezer until required for analysis.

3.3 METHODS OF ANALYSIS

3.3.1 FRESH WEIGHTS

Each fish sample was weighed to the nearest 0.1g, using an electronic mettler balance, while for weights above 1kg, salter scale balance was used. The mean weights were then obtained from the duplicates.

The fresh weights were obtained after the fishes were gutted. Scaled fishes were also descaled before weights were obtained.

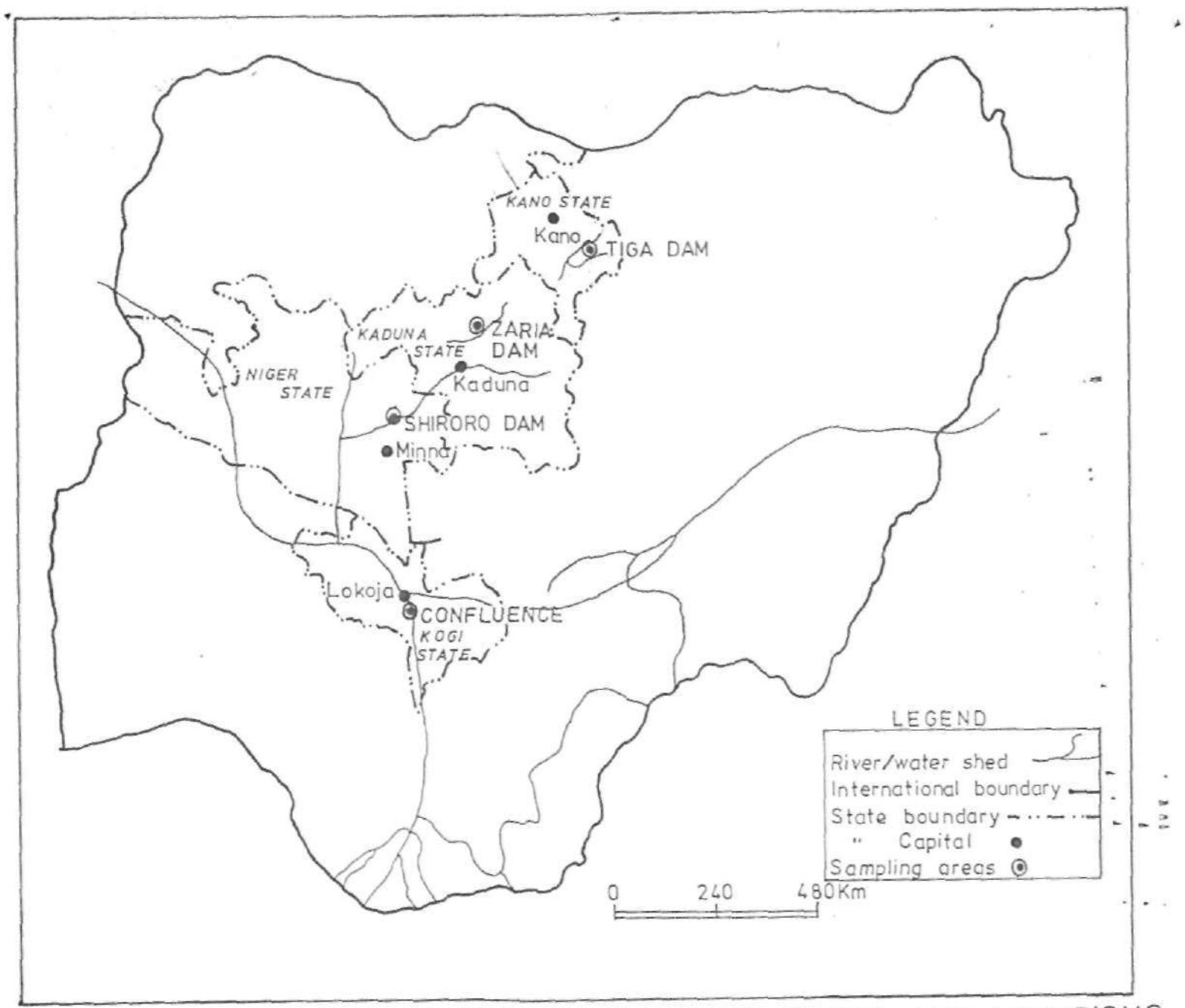


FIG:- 3·1 MAP OF NIGERIA SHOWING SAMPLING STATES AND LOCATIONS

3.4 PROXIMATE ANALYSIS

The chemical composition of the fish samples were determined using methods of the Association of Official Analytical Chemicals AOAC (1975, 1980), in the research laboratory of National Animal Production Research Institute, Shika, Zaria. The analysed chemical components were the moisture content, ash, lipids, crude protein, crude fibre, as well as specific minerals. These were determined in duplicates.

3.4.1 DETERMINATION OF MOISTURE CONTENT AND DRY MATTER

The weighed samples were labelled and placed in pre-weighed crucibles. The samples in the crucibles were then dried in Gallenkamp hot box humidity - oven model OV-620 at 105°C for forty-eight hours. The weights were taken at intervals of six hours after the first twenty-four hours. The samples were dried and cooled in an air-tight desiccator and later weighed directly on electric mettler balance. The samples were dried until constant weights were obtained. The moisture contents were thus obtained from the weight loss of the fresh sample:

(i) Weight of crucible with fresh sample weight of crucible with dry sample.

= moisture content.

(ii) Dry matter weight = constant weight after drying.

(iii) $$\% \text{ Dry matter} = \frac{\text{Dried sample wt}}{\text{Fresh sample wt.}} \times 100$$

(iv) $$\% \text{ moisture content} = \frac{\text{wt of water in sample}}{\text{Fresh sample wt}} \times 100$$

3.4.2 ASH DETERMINATION

Each dried fish sample was ground into a homogenous powder with the laboratory electric grinder and transfered into labelled sample bottles for further chemical analysis. Two grames was removed from each of the homogenous sample powder, labelled and placed in a pre-weighed procelain crucible. The crucibles and their contents were ignitted in an ashing muffle furnance maintained at 600°C for twenty-four hours. The white ash obtained was then cooled in the oven to 100°C and later transfered to a desiccator and cooled further for another twelve hours. The crucibles and their contents were then weighed. The heating, cooling and weighing were repeated at four hours intervals until no further change in colour and weight occured. The percentage ash content was estimated as:

$$\% \text{ ash} = \frac{\text{weight of ash}}{\text{weight of sample powder}} \times 100$$

3.4.3 TOTAL ORGANIC MATTER

The total organic matter (T.O.M) component of the fish samples were determined by the procedures of Linghstein and Oginsky (1965). The total organic matter comprises the crude protein, lipid and carbohydrate was obtained as shown below:

$$\text{Total organic matter} = \text{Dry matter} - \text{Ash}$$

$$\% \text{ T.O.M.} = \frac{\text{wt of dry matter - Ash}}{\text{wt of dry matter3.4.4}} \times 100$$

DETERMINATION OF LIPID CONTENT

Soxhlet Continuous Extraction Method.

The lipid content was determined using the soxhlet continuous extraction method (AOAC, 1975) in NAPRI research laboratory.

From each dry sample, 5gm weight was put into a pre-weighed extraction thimble. The thimble was plugged with fat free cotton wool and the contents were placed in the central syphon portion or extractor of the soxhlet apparatus. A 250cm^3 ground - glass - joint flask was weighed and 40cm^3 of analytical grade diethyl-ether plus 40cm^3 analytical grade (60 - 80° C) petroleum ether were poured into the flask.

The flask was then connected to the soxhlet syphon and condenser with the flask sitting in the heating mantle. The mantle was then connected to the electric supply and heating was slowly increased until the solvent boiled. The vapour of the boiling solvent which condensed in the soxhlet syphon where the sample was placed and the lipid was dissolved.

At a certain level, the solvent with the dissolved lipid ran back into the 250cm^3 ground-glass-joint flask. The heating and hence the extraction was continued for 8 hours. At the end of eight hours, the thimble was removed and placed in an oven at 105°C for three hours. The glass flask was cooled in the desiccator and weighed. The flask and content were placed in the oven for another 30 minutes and reweighed. This was repeated until a constant weight was obtained. The increase in weight of the flask was taken as the weight of lipid or crude fat extracted.

$$\% \text{ lipid or crude fat} = \frac{\text{weight loss of sample}}{\text{weight of sample}} \times 100$$

The defatted material was then preserved for protein analysis.

DETERMINATION OF CRUDE FIBRE

The crude fibre content of fish samples were determined according to AOAC (1980), at the research laboratory, National Animal Production Research Institute (NAPRI), Shika.

Two grames of sample powder were transferred to a soxhlet apparatus and extracted with petroleum ether and diethyl ether as in soxhlet continuous extraction procedure. The extracted sample was dried and transferred into dried 100cm^3 conical flask. 200cm^3 boiled 0.255N sulphuric acid was added. The content of the flask was boiled gently for exactly half an hour with the flask rotated to mix the contents and remove particles from the sides.

A Buchner funnel fitted with a perforated plate covered with filter paper was prepared. Boiling water was poured into the funnel and allowed to remain until the funnel was hot. The water was then drained by suction. At the end of the half an hour boiling period, the acid mixture was allowed to stand for 1 minute and then poured immediately into a shallow layer of hot water under gentle suction in the prepared funnel. Suction was adjusted so that the bulk of the 200cm^3 0.255N sulphuric acid was completed within 10 minutes.

The insoluble matter was washed with boiling water until the washings were free from acid, then the insoluble matter was washed back into the original flask by means of a wash bottle. containing 200cm^3 0.313N sodium hydroxide solution measured at ordinary temperature and brought to boiling point. The boiling was continued for half an hour after which the mixture was allowed to stand for one minute and then filtered immediately through a Whatman No.1 filter paper. All the insoluble materials were transferred to the filter paper and washed

first with boiling water then with 1% hydrochloric acid and finally with boiling water until free from the acid. The washing was continued twice with alcohol and three times with ether. The insoluble matter was then transferred to a dry, weighed ashless filter paper and dried at 100°C to a constant weight. The paper and the contents were incinerated to ash at a dull red heat.

The weight of the ash was subtracted from the increase of weight of the paper due to the insoluble matter. The difference was reported as the fibre content.

$$\% \text{ crude fibre} = \frac{Y - X}{Z} \times 100$$

where X = weight of the ashless filter paper.

Y = weight of the ash after incinerating.

Z = weight of the powdered sample.

3.4.6 DETERMINATION OF CRUDE PROTEIN

The kjeldahl method used in this analysis involved heating the sample with concentrated sulphuric acid. This converts the protein nitrogen into ammonium sulphate (digestion). The second stage was the estimation of the ammonia produced by neutralising the digest then distillation and finally titration with an acid (Microkjeldahl method, AOAC, 1980).

Digestion:

2.0g Each sample powder measuring 2.0g was accurately weighed on a filter paper. The filter paper and samples were transferred into small kjeldahl flasks containing 0.8g of catalyst mixture and anti-bumping granules. (1g $CuSO_4$, 8g K_2SO_4, 1g Solenium dioxide

mixture). To another flask 0.165g of glycine was added as standard. 20cm^3 of concentrated sulphuric acid was added to each of the flasks. The flasks were warmed gently at first to minimise frothing then the heat was increased until the solution was cleared. Digestion was carried out for six hours. Boiling was continued for a further 30 minutes, after which the solutions were allowed to cool (Colour changed from apple-green to colourless solution).

The content of the flask were transferred into 100ml volumetric flasks and the volume made up to 100ml mark with distilled water.

Distillation:

The contents of the flasks were transferred into the distillation apparatus. The apparatus was steamed for 10 minutes before use into the digest, 10ml of 40% sodium hydroxide were added to make the digest alkaline. The ammonia librated was condensed in the condensed of the apparatus and collected in a receiving flask was set up containing approximately 25cm^3 of boric acid and 4 drops of screened methyl red. The tip of the condenser was set to deep into the beaker containing the boric acid to avoid escape of ammonia. Distillation was done to the 25ml mark. Care was taken to ensure that ammonia did not escape into the atmosphere. The ammonia was boiled over into the receiving flask.

Titration: The ammonia mixture was titrated with 0.02m Hcl to end point, and the titra values for blank and sample obtained.

The percentage crude protein was calculated as percentage nitrogen (%N) x 6.25. The (%N) was calculated as follows:

NH_3 x H_2S04 - NH_4SO_3

(1mole) (1mole) (1 mole)

1ml of 0.02m H_2SO4 = 1ml 0.02m Nitrogen (N)

= 0.0002gN.

$$\% \text{ crude protein} = \frac{M \times 0.014 \times D \times T \times 6.25 \times 100}{W \times L}$$

where:

M = molarity of acid

0.014 = Nitrogen content per $100cm^3$

D = Dilution factor

6.25 = Protein conversion factor

W = weight of sample powder

L = volume of Liquor distillate

DETERMINATION OF CARBOHYDRATE

The method of AOAC (1975) was adopted and calculated by difference.

% carbohydrate of the dry matter = 100 - (% crude protein + % crude fibre + % lipid + % ash).

3.4.8 CALORIC VALUE

The caloric values of the lipid, crude protein and carbohydrate were calculated using standard conversion factors (Winberg, 1971) as follows:

(i) Lipid caloric value = amount of lipid g/100g x 9.5kcal/g.

(ii) Protein caloric value = amount of protein g/100g x 5.5kcal/g.

(iii) Carbohydrate caloric value = carbohydrate values x 4.1 kcal/g.

(iv) Total calory = Lipid x protein x carbohydrate values (kcal/g)

3.4.9 DETERMINATION OF AMINO ACIDS

The determinations were carried out at the post graduate research laboratory of the University of Jos.

The samples were first weighed, defatted, hydrolysed and then evaporated in a rotary evaporator before being loaded into the amino acid analyser (TSM).

(i) DETERMINATION OF DRY WEIGHT

Three filter papers (No 1-type) were accurately weighed on a chemical balance. 1.5g of sample was added to the weighed filter paper. The sample was dried in the rotary evaporator. The weight of the dried sample and the filter paper were noted. The difference between the weight of the filter paper with sample and that of the filter paper only gave the weight of the dry sample which was used for the analysis.

(ii) DEFFATING OF THE SAMPLES

The weighed triplicate samples were carefully transferred into different lipid extraction thimbles. Each thimble was plugged with cotton wool (to prevent particles of the samples from floating) and placed in 100cm^3 soxhlet extractor. Both were connected

to a round bottom flask which was 3/4 filled with petroleum spirit (60 - 80°C). The assembly was connected to Davids double surface condener and heated with an electrothermal heater at 70°C. Extraction was allowed to continue for a minimum period of 6 hours after which the defatted sample materials were evaoporated to dryness at 50°C under oxygen-free nitrogen. The samples were divided into two parts, one for the determination of crude protein (as earlier) and the other for hydrolysis.

(iii) HYDROLYSIS OF SAMPLES

The deffatted samples were accurately weighed and 0.5g of each sample was transferred into an ampaule 7cm^3 of 6NHcl was added to the ampoule and nitrogen gas (oxygen free) was passed through the solution to expel the air for 20 minutes. (This prevented the possible oxidation of some amino acids during hydrolysis). The ampoule was sealed and incubated at 100 - 110°C for 22 hours. At the end of the incubation, the ampoule was broken at the neck and the content was filterred using a whatman filter paper No.1.

(iv) EVALOPRATION OF THE SAMPLE FILTRATES

The filtrate was transferred into a 250cm^3 round bottomed flask of the rotary evaporator where it was evaporated to dryness at 40°C under suction. The residue was subsequently washed twice with 10cm^3 of de-ionized water and evaporated to dryness each time. The residue was picked up in 3cm^3 of o.01N Acl and preserved in a refrigerator at -6 ± 4°C for loading into an amino acid analyser when required.

(v) **LOADING OF SAMPLE INTO TECHNICON-SEQUENTIAL MULTISAMPLE AMINO ACID ANALYSER (TSM)**

1cm^3 of the hydrolysed samples and standard mixture were loaded with equal volume of internal standard solution (Norleucine) using a micropipette. The cartridges were then placed on a sample tray of the TSM sampler. Two chromatographic columns were packed with 75% resin slurry and mounted directly below TSM sampler. The front column was used for separation of the basic amino acids and the rear column for the separation of the acidic and neutral amino acids. Buffer solutions were connected to the systems via a peristatic valve.

(vi) **PREPARATION OF BUFFERS**

a) Buffer No.1 (PH3.25, 0.25N Na^+/0.1m citrate/6% methyl cellosolve). 400cm^3 of stock solution was measured and poured into a 4 litre beaker equipped with stirrer. About 3 litres of distilled water was added and agitated. 240cm^3 methyl cellosolve and 1.0cm^3 thiodiglycol were added after which 6N hydrochloric acid was used to titrate the solution to pH.3.25. It was then transferred to a volumetric flask and made up to a total volume of 4 litres.

b) Buffer No.3 (pH.5.25. 0.37N Na^+/0.1m citrate). This buffer was also prepared in the same way as the second buffer except that 40.0g Sodium Chloride was added. When the analyser was started, the buffers were delivered to the columns through the sampler from two high pressure pumps and selected by the buffer - changing valve (the valve sequences, the buffers required in the stepwise elution of the amino acids and

sequences, the flow of the effluent from either column into analytical system or to the waste). The buffers washed the column, removing some of the amino acids bound to the resin by electrostatic forces. As the amino acids were eluted from the column, they were collected individually partitioned by the bubble system into the analytical system. Here they were mixed with hydrin solution supplied through the proportioning pump. The reaction mixture now formed, passed through a capillary tube immersed in a 100°C water bath where amino acids reacted with ninhydrin to produce a coloured product.

The developed effluent (reaction steam) was led through the colorimeter where the absorbance was monitored continuously as it passed over a sensitive photo-electric unit. The signals from the colorimeter were finally fed into an automatic pen-recorder which then plotted the intensity on a moving linear chart paper, the speed of which was carefully preset. The type of amino acid was established on the basis of its position on the chromatogram and it was quantitatively estimated on the basis of the area under each curve.

(vii) METHOD OF CALCULATING AMINO ACID VALUE FROM THE CHROMATOGRAM PEAKS

The net height of individual peaks were readily measured. The half-height of the peak on the chart was located and width of the peak at the half-height was accurately measured and recorded. The approximation of the area of each peak was obtained by multiplying the net height with the width at half-height.

The norleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula:

$$NE = \frac{Area\ of\ norieucinepeak}{Area\ of\ each\ amino\ acid}$$

From the norleucine equivalent above, a constant S was calculated for each amino acid in the standard mixture.

S standard - NE standard x mol.weight x Nnn AA standard.

(viii) <u>CHEMICAL SCORE (C.S) OR PROTEIN SCORE (P.S)</u>

The chemical score was calculated according to Block and Mitchell (1946) as follows:

The content of each essential amino acid of protein was expressed as percentage of a standard, the lowest percentage being taken as the chemical score.

The standard or reference protein was as recommended by (WHO/FAO, 1973).

$$C.S = \frac{1000\ X\ (g)\ essential\ amino\ acid\ of\ test\ protein\ x100}{(g)\ total\ amino\ acid\ of\ whole\ hen's\ egg.}$$

(ix) <u>ESSENTIAL AMINO ACID INDEX (EAAI)</u>

The essential amino acid index was calculated as the geometric means the ratios of the essential amino acids in a protein to those of standard or reference (usually egg protein) Oser, 1951).

The geometric mean of the ratios as calculated below was taken as the EAAI:

$$EAAI = \frac{1000\ X\ ratio\ of\ (g)\ essential\ amino\ acid}{essentialamino\ acid\ in\ whole\ hen\ egg.}$$

(x) ESSENTIAL TO NON-ESSENTIAL AMINO ACID (E:N)

The essential to non-essential amino acid was the grammes of essential amino acid per grammes of non-essential amino acid in the food protein in terms of nitrogen. The calculation was done according to (Oser, 1951).

$$E.N = \frac{1000\ X\ ratio\ of\ essential\ amino\ acid\ (g)}{ratio\ of\ non\text{-}essential\ amino\ acid\ (g)}$$

(xi) ESSENTIAL AMINO ACID PER (g) TOTAL NITROGEN (E:T)

The essential amino acid per gm protein was calculated according to FAO/WHO (1968) expert group on protein requirement as follows:

$$E.T = \frac{essential\ amino\ acid\ (g)\ x\ 100}{Total\ nitrogen}$$

(xii) ESSENTIAL AMINO ACID TO PROTEIN RATIO

$$E.P = \frac{1000 \times Ratio\ of\ essential\ amino\ acid(g) \times 100}{100g\ protein}$$

3.4.10 DETERMINATION OF MINERAL ELEMENTS

The minerals were analysed using the atomic absorption spectro-photometer (AAS), Perkin-Elmer model 2903, the flame photometer corning-eel model and spectronic 20 (AOAC, 1980). Both the colorimetry and absorption spectrophotometry were based on Beer - Lamberts law,

$$\underline{\text{Log}}\frac{\text{Io}}{\text{It}} = \text{abc}$$

where It = Intensity of transmitted light

Io = Intensity of incident light

a = molar absorptivity

b = concentration

c = thickness of medium.

The AAS was used for the determination of Calcium, Copper, Iron, Magnesium and Zinc. The flame photometer was used for sodium and potassium while spectromic 20 was used for Phosphorus.

(i) **Determination of Calcium, Iron, Magnesium, Copper and Zinc**

250mg of each sample powder was weighed into a porcelain dish. The sample was heated carefully over a bunsen burner with the crucible covered until the smoke had ceased. Then the cover was then removed and the content roasted in a muffle furnance for 8 hours at 500°C. After ashing, the crucible was allowed to cool in a desiccator. The ash was extracted with 20% analytical grade hydrochloric acid. The solution was made up to 50cm^3 with more 20% hydrochloric acid.

(ii) **Dilution of stock solution**

The standard solutions of Sodium, Potassium, Calcium, Magnesium, Iron, Copper and Zinc were used for the analysis. The standard solutions were products of Tokyo photo electric Ltd, Japan.

Each standard solution contained 1000ppm of each element. The stock solutions were diluted to give 2,4,6,8 and 10 ppm of each element except Magnesium. For Magnesium the solutions were further diluted to give 0.2, 0.4, 0.6, 0.8 and 1.0 ppm due to the sensitivity of the magnesium lamp.

Procedure

0.2cm^3 of each stock solution was taken in a graduated pipette and made up to 100cm^3 with distilled water in a volumetric flask. This dilutions gave 2ppm. Other dilutions were made as follows:

o.4cm^3 made up to 100cm^3 gave 4ppm

0.6cm^3 made up to 100cm^3 gave 6ppm

o.8cm^3 made up to 100cm^3 gave 8ppm

1.0cm^3 made up to 100cm^3 gave 10ppm

Magnesium

A further dilution was made as follows: 5.00cm^3 of solution containing 2ppm was made up to 50cm^3 with distilled water to obtain 0.2ppm.

5.00cm^3 of solution containing 4ppm was made up to 50cm^3 with distilled water to

obtain 0.4ppm.

5.00cm^3 of 6ppm made up to 50cm^3 gave 0.6ppm.

5.00cm^3 of 8ppm made up to 50cm^3 gave 0.8ppm.

5.00cm^3 of 10ppm made up to 50cm^3 gave 1.0ppm.

Phosphorus

1 cm^3 stock phosphorus solution contained 0.05mg phosphorus 1,2,3,4 and 5 cm^3 of the stock phosphorus solutions were pipetted into six 50cm^3 volumetric flasks. The flasks were made up to mark with distilled water. The solutions contained 0.5, 100, 150, 200 and 250mg phosphorus respectively.

Phosphorus Stock Solution

0.219g potassium dihydrogen phosphate (KH_2P04) was weighed and dissolved in 700cm^3 distilled water. 25g of ammonium -meta venadate was weighed and dissolved in 500cm^3 hot distilled water (60°C). The entire ammonium molybdate solution was mixed with the ammonium -meta venadate solution, and the resulting solution was added to the potassium dihydrogen phosphate in a two litre volumetric flask.

700cm^3 perchloric acid was added to the two litre volumetric flask content. The solution was allowed to cool down. The complex mixture was made up to two litre with distilled water. This stock solution contained 1000ppm phosphorus ions.

Instrumentation

The atomic absorption spectrophotometer was put on for 30 minutes before the Acetylene gas knob was opened. The gas was ignitted and the standard solutions were introduced at the aspirator. The optical density was read at the wave length of each element. If linear equipment was confirmed to be working properly, the sample was introduced and the concentration was read at the galvanometer against the distilled water. This was used mainly for the determination of Calcium, Copper, Zinc, Iron and Magnesium.

Spectronic 20 was put on for 30 minutes Baton solution was added to the diluted Phosphorus solution. The mixture was left for about 15 minutes for colour development. The colour was then read at 385nm wavelength. The Phosphorus content was calculated as:

$$mg/100g\ phosphorus = \frac{mg\ P\ (\ from\ graph)\ x\ dilution\ factor\ x\ 100}{1000{,}000\ x\ weight\ of\ sample}$$

Sodium and Potassium

Flame photometer was used. The stock solutions were used to set up the sensitivity control of the flame photometer to obtain a scale reading of under 100 divisions. The distilled water was used to obtain zero readings. A calibration curve of concentration against scale reading was prepared. Readings using the sample solutions were taken and concentrations were read off from the calibration curves.

Statistical Analysis

At the end of the experiment all data were subjected to two-way analysis of variance (ANOVA) and the F-value ratio was determined for each sample. The 2-tail test used was given by Pearson Product moment correlation coefficient (r). The maximum error acceptable was at 5 percent ($P<0.05$).

CHAPTER FOUR

4.0 RESULTS

4.1 Samples Collected

The number and relative percentages of fishes collected from all locations are shown in Table 4.1a. The family Bagridae has the highest number of different species collected followed by the family Mochokidae, then Characidae and Cichlidae while the families, Centropomidae, Gymnarchidae, Osteoglossidae and Malapteniridae had one species each in the collectrons. The number of different species collected in each family and their relative percentages are also shown in Table 4.1b The number of specimens collected was largest for the family Cichlidae (1208) or 20% followed by the family Bagridae (1180) or 19.52% while the least number of specimen collected was (18 or 0.30%) for the family Malapteruridae.

Table 4.1a

TOTAL FISH FAMILIES COLLECTED FROM THE FOUR LOCATIONS

FAMILY	SPECIES No.	NUMBER COLLECTED	% OF TOTAL COLLECTED
Cichlidae	4	1208	20.00
Bagridae	8	1180	19.52
Mochokidae	6	745	11.36
Cyprinidae	3	589	9.76
Characidae	4	478	7.92
Mormyridae	3	441	7.32
Claridae	2	415	6.87
Schilbeidae	2	289	4.78
Citharinidae	2	221	3.66
Centropamidae	1	199	3.30
Distichodontidae	2	173	2.86
Gymnarchidae	1	54	0.89
Osteoglosidae	1	28	0.46
Malapteruridae	1	18	0.30
Total Specimens collected	40	6038	100.00

Table 4.1b

TOTAL FISH SPECIES COLLECTED FROM THE FOUR LOCATIONS

FAMILY	SPECIES	NUMBER COLLECTED	% OF TOTAL COLLECTED
Cichlidae	*Oreochromis niloticus*	310	5.13
	Tilapia zilli	351	5.81
	Sarotherodon galilaeus	382	6.33
	Hemichromis fasciatus	165	2.73
Bagridae	*Auchenoglanis occidentalis*	166	2.75
	Chrysichthys nigrodigitatus	216	3.58
	Chrysichthys furcatus	157	2.60
	Chrysichthys auratus	110	1.82
	Bagrus bayad	119	1.97
	Bagrus docmac	183	3.03
	Bagrus filamentosus	177	2.93
	Clarotes laticeps	52	0.84
Mochokidae	*Synodontis schall*	218	3.61
	S. clarias	160	2.65
	S. budgetti	164	2.72
	S. membranaceus	59	0.97
	S. melanopterus	85	1.41
	S. filamentosus	59	0.97
Cyprinidae	*Labeo coubie*	306	5.07
	L. senegalensis	172	2.85
	Barbus occidentalis	111	1.84
Characidae	*Alestes nurse*	167	2.77
	Hydrocynus brevis	93	1.54

FAMILY	SPECIES	NUMBER COLLECTED	% OF TOTAL COLLECTED
	Alestes macrolepidotus	120	1.99
	Hepsetus odoe	98	1.62
Mormyridae	*Mormyrus rume*	229	3.79
	Mormyrops deliciosus	120	1.99
	Hyperopisus bebe	92	1.54
Claridae	*Clarias gariepinrus*	224	3.71
	C. anguillaris	191	3.16
Schilbeidae	*Eutropius niloticus*	153	2.53
	Schilbe mystus	136	2.25
Citharinidae	*Citharinus citharus*	109	1.81
	Citharinus latus	112	1.85
Centropomidae	*Lates niloticus*	199	3.30
Distichodontidae	*Distichodus rostratus*	93	1.54
	Distichodus engycephalus	80	1.32
Gymnarchidae	*Gymnarchus niloticus*	54	0.89
Osteoglossidae	*Heterotis niloticus*	28	0.46
Maclapteruridae	*Malapterurus electricus*	18	0.30
Total **14 families**	**40 species**	**6038**	**100**

KASU

4.2 (a) Proximate component of the family Cichlidae (g/100g)dry matter.

The mean values and standard deviations for the proximate components and caloric values of *Oreochromis niloticus, Tilapia zilli, Sarotherodon galilaeus and Hemichromnis fasciatus* are shown in Table 4.2.

The highest proximate component in all four species was protein (32.0 ± 1.41 to 34.9 ±0.34g/100g) followed by carbohydrate (23.7 ± 1.11 to 7.7 ± 1.00g/100g) and the least was lipid (20.3 ± 1.67 to 24.1 ± 0.33g/100g). The carbohydrate, lipid and protein were in the ratio of 1:1:1.5. There was no significant difference (P>0.05) in the contents of carbohydrate, lipid and protein of the four species.

The ash content was significantly different (P<0.05) in the four species. The highest ash (24.0 ± 0.7g/100g) was recorded in *H. fasciatus*, followed by *T. zilli* (17.4 ± 1.1g/100g) then *S. galilaeus* and the least was contained in *O. niloticus* (14.5 ± 1.3g/100g).

Organic matter content was not significantly different (P>0.05) in the four species, however, the highest was recorded in *O. niloticus* (85.6 ± 1.22g/100g) followed by *S. galilaeus*, then *T. zilli* and the least was in *H. fasciatus* (76.0 ± 2.78g/100g). The carbohydrate was not significantly different (P>0.05) in the species.

The highest carbohydrate was recorded in *T. zilli* (27.7 ± 1.0g/100g) followed by *O. niloticus* and the least was in *H. fasciatus* (23.7 ± 1.33g/100g). Lipid was significantly different (P<0.05) in the four species. The highest lipid (24.1 ± 0.33)g/100g) was recorded in *O. niloticus*, then *H. fasciatus, S. galilaeus* and the least lipid (20.3 ± 1.67g/100g) was in *T. zilli*. The protein content was not significantly different (P>0.05). *O. niloticus, T. zilli* and *S. galilaeus* contained similar quantities (34.3 to 34.9 ± 0.34g/100g) and the least (32.0 ± 1.41g/100g) was recorded in *H. fasciatus*. The calory level were similar in all four species, but

highest (523.26 kcal/100g) in *O. niloticus*, followed by *S. galilaeus* and the least (478.67 kcal/100g) was recorded in *T. zilli*.

(b) **Amino acid composition of the family Cichlidae** (g/100g) protein.

The amino acid composition of *O. niloticus, T. zilli, S. galilaeus and H. fasciatus* in the family Cichlidae are shown in Table 4.3. The profile of the amino acid are the same but there was significant difference ($P<0.05$) in the quantities contained. The highest amino acid contained in all four species was glutamic acid (15.30 - 15.96g/100g), followed by lysine (9.60 - 10.95g/100g), then aspartic acid, leucine, arginine, serine in that order while the least amino acid contained was methionine (2.12 - 2.95g/100g).

O. niloticus contained the highest lysine, histidine, arginine, glutamic acid, proline, cysteine, leucine and phenylalanine (10.95, 3.18, 6.00, 15.96, 3.80, 3.34, 6.88 and 3.15g/100g) respectively, while *T. zilli* contained the highest aspartic acid, alanine, valine, methionine, isoleucine and tyrosine (10.39, 4.65, 4.91, 2.95, 3.02 and 3.90g/100g) respectively. *S. galilaeus* only contained the highest threonine and glycine (4.00 and 4.86g/100g) respectively. *H. fasciatus* contained the highest glutamic acid (16.3g/100g).

(c) **Chemical indices of family Cichlidae**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein score (C.S/P.S) values for the four species of the family cichlidae are presented in Table 4.4. The highest E:N was recorded in *S. galilaeus* (0.90), followed by *T. zilli, O. niloticus* and the least E:N was recorded in *H. fasciatus* (o.87). The highest E:T (49.23) was recorded in *T. zilli*, then *S. galilaeus* and the least was recorded in both *O. niloticus and H. fasciatus* (46.96 and 46.79) respectively. The EAAI was highest in *T. zilli*

(140.27), followed by *S. galilaeus* and the least was recorded in *H. fasciatus* (118.76). The C.S/P.S was highest in *T. zilli* (64.57) followed by *S. galilaeus* (62.91) and the least was recorded in *H. fasciatus* (54.67). The highest E:P was recorded in *H. fasciatus* (1.18) followed by *T. zilli* (0.85) and the least was recorded in *S. galilaeus* (0.79). There was no significant difference (P>0.05) in the E:N, E:T, C.S/P.S values of the four species.

(d) **Mineral contents of the family Cichlidae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *O. niloticus, T. zilli, S. galilaeus* and *H. fasciatus* of the family Cichlidae are presented in Table 4.5. The highest mineral contained in all four species was Calcium (3862.5 - 4525.0 ± 189.3mg/100g) followed by Potassium, then Sodium, Magnesium and the least content was Copper (2.9 ± 0.2 - 3.6 ± 0.2mg/100g). Potassium and Sodium were in the ratio of 2:1 while Calcium and Potassium were in the ratio of 6:1 in all four species.

H. fasciatus contained the highest Calcium content (4525.0 ± 189.3mg/100g), followed by *O. niloticus* (4289.2 ± 110.9mg/100g), then *S. galilaeus* and the least was contained in *T. zilli* (3862.5 ± 204.7mg/100g). The highest Potassium content (706.2 ± 102.3mg/100g) was contained in *T. zilli*, followed by *O. niloticus* (638.4 ± 28.1mg/100g) then *S. galilaeus* and the least was contained in *S. galilaeus* (608.6 ± 57.4mg/100g).

The highest Iron (18.7 ± 2.4mg.100g) was recorded in *S. galilaeus*, then *O. niloticus and H. fasciatus* and the least was contained in *T. zilli* (9.0 ± 1.8mg/100g). Magnesium was highest (37.5 ± 5.6mg/100g in *S. galilaeus*, then *O. niloticus* and *H. fasciatus* while the least magnesium was contained in *T. zilli* (31.0 ± 2.3mg/100g). Three species contained equivalent

quantities of Sodium, these are *O. niloticus, T. zilli* and *H. fasciatus* (300.2 - 300.7 ± 10.3mg/100g) and the least Sodium was recorded in *S. galilaeus* (296.7 ± 11.5mg/100g). Copper was generally low in all four species, however, *H. fasciatus* contained the highest (3.6 ± 0.2mg/100g) then *O. niloticus* and *T. zilli* while the least was contained in *S. galiaeus* (2.9 ± 0.2mg/100g).

The highest Phosphorus was also recorded in *H. fasciatus* (18.2 ± 2.3mg/100g then *T. zilli, O. niloticus* and the least Phosphorus was contained in *S. galilaeus* (15.0 ± 1.8mg/100g). Zinc was also highest in *H. fasciatus* (20.2 ± 2.7mg/100g), then *S. galilaeus, O. niloticus* and the least Zinc was contained in *T. zilli* (14.3 ± 1.1mg/100g). There was significant difference ($P<0.05$) in the contents of Calcium, Potassium and Iron in the four species.

PROXIMATE COMPONENTS (g/100g) AND CALORY (k cal/100g) OF FOUR SPECIES OF THE FAMILY CICHLIDAE

	g/100gWet weight							
Fish Species	moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Oreochromics niloticus	71.48	14.4 ± 1.3	85.3 ± 1.22	25.1 ± 1.80	24.1 ± 0.33	34.8 ± 1.03	523.26	100.0
Tilapia zilli	72.03	17.4 ± 1.1	83.0 ± 1.66	23.7 ± 1.11	20.3 ± 1.67	34.3 ± 1.01	473.67	100.0
Sarotherodon galilaeus	72.03	16.5 ± 1.3	84.5 ± 1.34	26.3 ± 1.00	21.4 ± 1.34	34.9 ± 0.34	503.08	100.0
Hemichromics fasciatus	70.80	24.0 ± 0.7	76.7 ± 2.78	23.7 ± 1.33	22.7 ± 1.03	32.0 ± 1.41	488.82	100.0

Table 4.3

AMINO ACID COMPOSITION OF FOUR SPECIES OF THE FAMILY CICHLIDAE (g/100g PROTEIN)

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Mer	Iso	Leu	Tyr	Phe
Oreochromics niloticus	10.95	3.18	6.00	9.80	3.68	2.27	15.96	3.80	4.40	4.00	3.34	4.35	2.12	2.95	6.88	2.96	3.15
Tilapia zilli	10.92	3.00	5.65	10.39	3.72	5.02	15.85	3.68	4.81	4.65	3.30	4.91	2.95	3.02	6.03	3.90	3.00
Sarotherodon galilaeus	10.85	2.86	5.14	10.10	4.00	5.04	15.90	3.08	4.86	4.05	2.60	4.88	2.46	3.00	6.08	3.04	3.10
Hemichromics fasciatus	9.60	3.12	4.80	10.00	3.84	4.68	16.30	2.10	2.44	3.20	1.60	3.64	2.13	3.00	6.86	2.30	3.00

Table 4.4

The E:N E:T E:P EAAI AND C.S/P.S OF FOUR SPECIES OF THE FAMILY CICHLIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
Oreochromics niloticus	0.88	46.96	133.92	61.56	0.81
Tilapia zilli	0.89	49.23	140.27	64.57	0.85
Sarotherodon galilaeus	0.90	47.53	136.67	62.91	0.79
Hemichromis fasciatus	0.87	46.79	118.76	54.67	1.18

a - Essential to non-essential amino acid ratio

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio

MINERAL CONTENT OF FOUR SPECIES OF THE FAMILY CICHLIDAE (mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
Oreochromis niloticus	3289.2±110.9	638.4 ± 28.1	13.0 ± 3.2	32.7 ± 3.1	300.3 ± 11.7	3.0 ± 0.6	16.7 ± 2.4	16.0 ± 1.3
Tilapia zilli	3862.5±204.7	706.2 ± 102.3	9.0 ± 1.8	31.0 ± 2.3	300.7 ± 10.3	3.0 ± 0.5	17.0 ± 2.1	14.3 ± 1.1
Sarotherodon galilaeus	3956.4±266.5	608.6 ± 57.4	18.7 ± 2.4	37.5 ± 5.6	296.7 ± 11.5	2.9 ± 0.2	15.0 ± 1.8	18.0 ± 1.6
Hemichromis fasciatus	4525.0±189.3	600.7 ± 38.9	13.0 ± 2.3	32.3 ± 5.4	300.2 ± 10.6	3.6 ± 0.2	18.2 ± 2.3	20.2 ± 2.7

4.3 (a) Proximate components of the family Bagridae (g/100g)/drymatter

The mean values and standard deviations for the proximate components and calories of *Auchenoglanis occidentalis, chrysichthys nigrodigitatus, C. furcatus, C. auratus, Bagrus bayad* and *Clarotes laticeps* are shown in Table 4.6. The highest proximate component in the eight species was protein for *A. occidentalis, C. nigrodigitatus, C. auratus* and *C. furcatus* (42.6 ± 2.73, 41.3 ± 2.03, 42.1 ± 0.63 and 40.0 ± 0.04g/100g) respectively. Protein was lowest in *B. bayad, B. docmac, B. filamentosus* and *clarotes laticeps* (27.1 ± 0.01, 27.7 ± 3.14, 28.3 ± 2.17 and 28.0 ± 0.11g/100g) respectively. The next higher proximate component was lipid (29.1 ± 1.06 - 31.6 ± 2.11g/100g) while the least was carbohydrate (8.7 ± 1.12 - 13.2 ± 0.40g/100g).

B. bayad contained the highest ash (25.4 ± 3.7g/100g) followed by *C. laticeps, B. filamentosus, A. occidentalis, C. furcatus, C. nigrodigitatus* in that order and the least was contained in *C. auratus* (14.3 ± 2.1g/100g). However,, the organic matter (92.0 ± 1.2g/100g) was highest in *A. occidentalis,* follwed by *C. nigrodigitatus, C. furcatus, C. auratus, B. docmac* respectively and the least was contained in *C. laticeps* (64.7 ± 2.60g/100g).

Carbohydrate was highest in three species, *B. layad, B. docmac* and *B. filamentosus* (13.2 ± 0.40g/100g), followed by *A. occidentalis, C. auratus, C. furcatus* and *C. filamentosus* respectively while the least was contained in *C. laticeps* (8.7 ± 1.12g/100g). The lipid contents were generally in similar quantities but the highest was obtained in *C. nigrodigitatus, C. furcatus* and *C. auratus* (31.3 ± 1.08, 31.6 ± 2.11 and 31.4 ± 2.12g/100g) respectively. These were closely followed by *A. occidentalis, B. filamentosus* and *C. laticeps* while the least lipid was obtained in *B. docmac* (29.1 ± 1.06g/100g).

The highest protein (42.6 ± 2.73g/100g) was contained in *A. occidentalis,* followed by *C. furcatus* then *C. nigroditatus.* Lower protein contents were obtained in *B. bayad, B. docmac, B. filamentosus* and*C. laticeps* (27.7 ± 0.01, 27.7 ± 3.14, 28.3 ± 2.17 and 28.0 ± 0.11g/100g)

respectively. The calories in all eight species was generally high with the highest obtained in *C. furcatus* (571.11k/cal./100g), followed by *C. nigrodigitatus*, then *A. occidentalis* while lower calories were recorded in *B. bayad, B. docmac, B. filamentosus* and *C. laticeps* (475.62 - 497.62kcal/100g). The values of the proximate components were significantly different ($P<0.05$) in all eight species.

(b) **Amino acid composition of the family Bagridae (g/100g) protein**

The amino acid composition of *A. accidentalis, C. nigrodigitatus, C. furcatus, C. auratus, B. bayad, B. docmac, B. filamentosus* and *Clarotes laticeps* of the family Bagridae are shown in Table 4.7.

The profile of amino acids were the same for all eight species, however there was significant difference ($P<0.05$) in the quantities. The highest amino acid observed in the eight species was glutamic acid (16.02 - 18.58g/100g), followed by lysine (9.98 - 10.94g/100g) and aspartic acid (8.80 - 12.30g/100g) then leucing. Methionine, isoleucine and phenylalanine were found in lowest quantities for all eight species.

A. occidentalis contained low quantities of each amino acid compared to other species in the family. However, *C. nigroditatus* contained the highest glutamic acid (18.58g/100g, cysteine (3.20g/100g) and valine (4.96g/100g). *C. furcatus* contained the highest lysine (10.94g/100g), threonine (3.66g/gN), proline (3.44g/100g), tyrosine (3.89g/100g) and phenylalanine (3.40g/100g). *C. auratus* contained lysine (10.88g/100g), aspartic acid (9.94g/100g), glutamic acid (17.86g/100g) and leucine (6.09g/100g). *B. bayad* contained the highest aspartic acid (12.30g/100g), glycine (4.63g/100g) and leucine (6.68g/100g). *B. docmac* also contained the highest serine (4.04g/100g) and methionine (3.20g/100g). *B. filamentosus* contained the highest histidine (4.31g/100g), glycine (4.64g/100g) and leucine (6.48g/100g). *C. laticeps* generally

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contained the lower quantities of all amino acids among the species in the family Bagridae.

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for the eight species of the family Bagridae are presented in Table 4.8. The E:N ratio was highest in *C. auratus* (1.01), followed by *C. furcatus* (0.97), then *C. nigrodigitatus* (0.92). Other species had values ranging from 0.81 to 0.88. The highest E:T value was recorded in *C. auratus* (50.25), followed by *C. nigrodigitatus* (49.65), *C. furcatus* (49.46). The least E:T value was recorded in *B. bayad* (45.04).

The highest value of EAAI was recorded in *C. furcatus* (142.99) followed by *C. nigrodigitatus* (141.02) and the least was recorded in *A. occidentalis* (124.49). The highest value of C.S/P.S was recorded in *C. auratus* (65.83), followed by *B. bayad* (64.44) and *C. furcatus* (64.92). The least C.S/P.S value was recorded in *A. occidentalis* (57.31). The E:P values were generally above 1.00 in all species except *A. occidentalis* 0.95). The highest value was however recorded in *B. bayad* (1.51) and *B. docmac* (1.51) followed by *B. filamentosus* (1.49).

(d) **Mineral content of the family Bagridae (mg/100g) ash**

The mean values for the mineral contents of *A. occidentalis, C. nigrodigitatus, C. furcatus, C. auratus, B. bayad, B. docmac, B. filamentosus* and *C. laticeps* are presented in Table 4.9. In all the species the highest mineral contents was Calcium, followed by Potassium, Sodium, Magnesium, Iron, Phosphorus, Zinc and the least mineral observed was Copper. *B. filamentosus* contained the highest Calcium (3010.0 ± 278.7mg/100g) followed by *C. auratus* (3004.0 ± 186.1mg/100g) then *C. nigrodigitatus* (2942.0 ± 107.3mg/100g) in that order. The least Calcium

was observed in *C. laticeps* (2572.3 ± 326.4mg/100g). The highest content of Potassium was observed in *C. furcatus* (858.4 ± 114.8mg/100g) followed by *B. filamentosus* (732.0 ± 11.3mg/100g), *C. auratus* (729.3 ± 89.5mg/100g), *B. docmac* (703.1 ± 55.6mg/100g) and *C. nigrodigitatus* (703.1 ± 106.1mg/100g) in that order. The least Potassium was observed in *B. bayad* (500.0 ± 63.1mg/100g). The highest Iron content was observed in *B. filamentosus* (42.3 ± 5.8mg/100g) followed by *C. furcatus* (38.0 ± 6.3mg/100g), *B. docmac* (36.1 ± 8.3mg/100g) and *A. occidentalis* (35.8 ± 6.3mg/100g). The least Iron content was observed in *C. auratus* (28.1 ± 12.0mg/100g). There was no significant difference (P>0.05) in the Magnesium content of all eight species, however the highest content was observed in *B. filamentosus* (240.6 ± 28.7mg/100) followed by *B. docmac* (238.2 ± 23.3mg/100g) and the least value was recorded in *A. occidentalis* (200.4 ± 32.7mg/100g). The highest Sodium was observed in *C. furcatus* (384.0 ± 41.0mg/100g) followed by *C. auratus* (358.3 ± 40.4mg/100g, *C. nigrodigitatus* (318.2 ± 23.3mg/100g) and *A. occidentalis* (308.6 ± 22.7mg/100g) in that order. The least Sodium value was recorded in *C. laticeps* (210.3 ± 19.7mg/100g). Copper was quite low in all species and not significantly different (P>0.05), however, the highest Copper value was recorded in *C. furcatus* (5.0 ± 1.1mg/100g) then *C. nigrodigitatus* (4.3 ± 1.3mg/100g), followed by *A. occidentalis* (4.1 ± 1.1mg/100g) and *B. docmac* (4.0 ± 1.0mg/100g) respectively. The least Copper value was recorded in *C. auratus* (3.0 ± 0.5mg/100g).

The highest Phosphorus value was observed in *C. laticeps* (28.7 ± 6.3mg/100g) followed by *A. occidentalis* (25.3 2.6mg/100g), *C. nigrodigitatus* (25.0 ± 3.0mg/100g) and *B. filamentosus* (25.1 ± 3.4mg/100g) in that order. The least Phosphorus value was observed in *C. auratus* (22.7 ± 4.3mg/100g).

There was no significant difference (P>0.05) in the Zinc content of all eight species. However, the highest Zinc value was observed in *C. furcatus* (21.0 ± 1.2mg/100g), followed by

B. filamentosus (19.0 ± 8.4mg/100g), then *B. docmac* (18.7 ± 2.1mg/100g) and *C. nigrodigitatus* (18.2 ± 1.0mg/100g) in that order. The least zince value was recorded in *C. laticeps* (16.3 ± 1.1mg/100g).

Table 4.6

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (kcal./100g) OF EIGHT MEMBERS OF THE FAMILY BAGRIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Auchenoglanis occidentalis	78.04	18.0 ±1.3	82.0 ± 1.2	10.0 ± 1.01	30.0 ± 3.01	42.0 ± 2.73	561.66	100.00
Chrysichthys nigrodegitatus	77.40	15.0 ± 1.6	85.0 ± 1.00	9.6 ± 1.23	31.3 ± 1.08	43.8 ± 2.03	563.86	100.00
Chrysichthys furcatus	76.04	16.3 ± 1.9	84.5 ± 1.61	10.6 ± 1.24	31.0 ± 2.11	42.1 ± 0.63	571.11	100.00
Chrysichthys auratus	76.88	25.0 ± 2.1	83.6 ± 1.32	9.8 ± 1.01	31.4 ± 2.12	2.4 ± 0.04	555.48	100.00
Bagrus bayad	76.40	24.0 ± 1.8	75.6 ± 2.12	13.2 ± 0.30	24.6 ± 1.09	27.1 ± 0.01	484.37	100.00
Bagrus docmac	78.60	20.4 ± 3.7	97.0 ± 2.2	12.2 ± 0.40	29.1 ± 1.06	37.7 ± 3.14	482.92	100.00
Bagrus filamentosus	74.60	23.3 ± 1.4	76.0 ± 1.80	12.2 ± 0.32	30.3 ± 1.08	38.3 ± 2.17	497.62	100.00
Clarotes laticeps	75.04	23.0 ± 1.3	64.7 ± 2.60	8.7 ±1.12	30.1 ± 1.12	38.0 ± 0.11	475.62	100.00

Table 4.7

AMINO ACID COMPOSITION OF EIGHT MEMBERS OF THE FAMILY BAGRIDAE (*g/100g protein*)

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Gys	Val	Met	Iso	Leu	Tyr	Phe
Auchenoglanis occidentalis	9.98	4.02	4.90	10.02	3.65	4.00	16.02	3.00	4.58	5.06	2.56	3.04	2.10	2.38	5.90	3.65	3.08
C. nigrodigitatus	10.83	3.98	5.00	9.90	3.65	2.75	18.58	3.06	2.88	3.50	3.20	4.96	3.06	3.00	6.06	3.80	2.50
C. furcatus	10.94	3.88	5.80	9.82	3.66	2.63	18.45	3.44	2.87	3.65	3.06	4.80	3.06	2.96	6.02	3.89	3.40
C. auratus	10.88	3.46	4.10	9.94	3.01	2.48	17.80	3.08	2.84	3.75	3.20	4.74	3.08	2.78	6.09	3.88	3.40
Bagrus bayad	10.74	4.02	4.10	12.30	3.05	4.02	17.04	3.07	4.63	4.88	2.66	3.86	1.60	2.30	6.68	3.00	3.10
B. docmac	10.69	4.28	4.00	10.20	3.06	4.04	17.04	3.06	4.64	4.88	2.56	3.88	3.20	1.98	6.50	2.86	3.02
B. filamentosus	10.81	4.31	4.20	10.20	3.03	4.00	17.25	3.08	4.64	4.92	2.98	3.86	3.02	2.04	6.48	2.86	2.90
Clarotes laticeps	10.28	4.06	5.85	8.80	3.06	4.02	17.00	2.86	4.61	5.50	3.00	3.04	3.00	2.40	5.95	2.98	3.30

Table 4.8

The E:N, E:T, E:P Ratios EAAI and C.S/P.S of the family Bagridae

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
Auchenoglanis occidentalis	0.82	45.21	124.49	57.31	0.95
C. nigrodigitatus	0.92	49.65	141.02	64.31	1.08
C. furcatus	0.97	49.46	142.99	64.92	1.08
C. auratus	1.01	50.25	139.33	65.83	1.12
Bargrus bayad	0.81	45.04	128.40	64.44	1.51
B. docmac	0.87	46.64	131.60	59.11	1.51
B. filamentosus	0.88	46.83	132.41	60.58	1.49
Clorates laticeps	0.83	45.55	128.59	59.20	1.46

a - Essential to non-essential amino acid ratio

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

Table 4.9

MINERAL CONTENTS OF FOUR MEMBERS OF THE FAMILY BAGRIDAE (mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
Auchenoglanis occidentalis	2898.2±148.6	635.7±36.4	35.8±6.3	200.4±32.7	308.6±22.7	4.1 ± 1.1	25.3 ± 2.6	17.5 ± 1.3
Chrysichthys nigroigitatus	2942.0±107.3	703.1±106.1	32.2±9.1	210.5±22.4	318.2±23.3	4.3 ± 1.3	25.0 ± 3.0	18.2 ± 1.0
C. furcatus	2964.0±240.3	858.4±114.8	38.0±6.3	210.0±20.2	384.0±41.0	5.0 ± 1.1	24.8 ± 3.8	21.0 ± 1.2
C. auratus	3004.0±186.1	729.3±89.5	28.1±12.0	210.0±20.3	358.3±40.4	3.0 ± 0.5	22.7 ± 4.3	17.0 ± 1.7
Bargus bayad	2906.9±188.3	500.0±63.1	30.8±10.2	216.3±21.4	260.8±30.3	3.5 ± 0.6	24.3 ± 4.1	16.5 ± 1.6
B. docmac	2862.7±169.8	703.1±55.6	36.1±8.3	238.2±23.2	229.4±18.7	4.0 ± 1.0	23.9 ± 5.2	18.7 ± 2.1
B. filamentosus	3010.0±278.7	732.0±11.3	42.3±5.8	240.6±28.7	278.7±21.1	3.2 ± 0.8	25.1 ± 3.4	19.0 ± 8.4
Clarotes laticeps	2572.3±326.4	515.4±18.1	28.6±8.5	230.9±15.3	210.3±19.7	3.6 ± 1.0	28.7 ± 6.3	16.3 ± 1.1

4.7 (a) Proximate Components of the Family Mochokidae (g/100g) dry matter.

The mean values and standard deviaions for the proximate components and calory of *Synodontis schall, S. clarias, S. budgetti, S. membranaceus S. melanopterus* and *S. filamentosus* are shown in Table 4.10. The highest proximate component in the six species was protein (45.7 ± 0.81 g/100g),followed by lipid (29.6 ± 1.70 - 33.4 ± 0.31 g/100g) and the least observed was carbohydrate (9.3 ± 1.12 - 9.6 ± 0.80 g/100g). The carbohydrate, lipid and protein were in the ratio of 1:3:4.

The ash content was significantly different (P<0.05) in the six species, however the highest value was recorded in *S.membranaceus* (22.1 ± 11 g/100g), followed by *S. melanopterus* (197 ± 0.3 g/100g), then *S. budgetti* (15. 9 ± 1.5 g/100g) in that order. The least ash content was recorded in *S. filamentosus* (9.5 ± 1.7 g/100g). The organic matter was also significantly different P<0.05) among the species. The highest content was recorded in *S. filamentosus* (86.0 ± 1.20g/100g), followed by *S. schall* (84.7 ± 1.0g/100) then *S. clarias* (82.3 ± 1.33 g/100g) and *S. budgetti* (87.0 ± 1.87 g/100g) in that order. The least organic matter was recorded in *S melanopterus* (76.1 ± 1.30g/100g).

There was no significant difference (P>0.05) in the contents of carbohydrate in all six species. The highest carbohydrate value was observed in *S. filamentosus* (10.4 ± 0.80g/100g), followed by *S. schall* (9.5 ± 1.2g/100g) and the least was observed in *S. melanopterus* (9.3 ± 1.12g/100g).

The lipid content was also not significantly different (P>0.05) in all six species. The highest lipid value was however recorded in *S. schall* (33.3 ± 0.6g/100g) and *S. budgetti* (33.4 ± 0.31g/100g) while the least was observed in *S. filamentosus* (29.6 ± 1.70g/100g). Protein content was highest in *S. filamentosus* (45.7 ± 0.8g/100g), followed by *S. clarias* (43.7 ± 1.88g/100g) and *S. schall* (43.3 ± 1.04g/100g) while the least protein content was

recorded in *S. melanopterus* (36.1 ± 3.21g/100g).

The caloric value was relatively high in all six species and there was no significant difference (P>0.05) in the calories value. The highest calory was recorded in *S. schall* (593.45kcal/100g), followed by *S. budgetti* (580.79kcal/100g), then *S. clarias* (577.06kcal/100g) in that order and the least caloric value was observed in *S. melanopterus* (522.63kcal/100g).

(b) **Amino acid composition of the family Mochokidae (g/100g) protein**

The amino acid composition of *S. schall, S. clarias, S. budgetti, S. membranaceus, S. melanopterus* and *S. filamentosus* are shown in Table 4.11. The profiles of the amino acids were the same in all six species, however, there was significant difference (P<0.05) in the quantities of the various amino acid contents. The highest amino acid observed in all the species was glutamic acid (15.12 - 16.04g/100g), followed by lysine (9.80 - 10.20g/100g), aspartic acid (8.40 - 10.40g/100g), leucine (5.02 - 6.02g/100g) and the least was methionine (1.65 - 2.10g/100g). *S. schall* contained low values of most amino acids except isoleucine (4.46g/100g). *S. clarias* contained the highest aspartic acid (10.40g/100g) and tyrosine (3.82g/100g) while *S. budgetti* recorded the highest lysine (10.20g/16gN), histidine (3.40g/100g), threonine (3.80g/100g), serine (3.00g/100g), proline (3.80g/100g), valine (4.24g/100g), methionine (2.10g/100g) and phenylalanine (3.40g/16gN). *S. membranaceus* recorded the highest glutamic acid (16.04g/100g) and alanine (4.96g/100g). *S. melanopterus* recorded the highest arginine (4.15g/100g) and serine (2.40g/100g) while *S. filamentosus* recorded the highest glycine (4.80g/100g), methionine (2.04g/100g) and leucine (6.02g/100g).

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(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAi) and the chemical/protein scores (C.S/P.S) values for the six species of the family Mochokidae are presented in Table 4.12. The E:N ratio was highest in *S. clarias* (1.04), closely followed by *S. Schall* (1.00) and the least E:N ratio was recorded in *S. filamentosus* (0.85). The highest E:T ratio was also recorded in *S. clarias* (51.18) while the least E:T value was recorded in *S. filamentosus*. The EAAI values were generally high in all six species, however, the highest was recorded in *S. budgetti* (129.44) followed by *S. clarias* (125.24) and the least values were recorded in *S. melanopterus* (116.28) and *S. filamentosus* (116.38). The C.S/P.S in the six species were low but the highest value was recorded in *S. budgetti* (59.85) followed by *S. clarias* (57.65) and *S. schall* (56.43) in that order while the least value of C.S/P.S was recorded in *S. melanopterus* (53.53). The E:P was above 1.00 in two species, *S. schall* (1.29) and *S. filamentosus* (1.02). The least E:P value was recorded in *S. membranaceus* (0.85).

(d) **Mineral content of the family Mochokidae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *S. schall, S. clarias, S. budgetti, S. membranaceus, S. melanopterus* and *S. filamentosus* are presented in Table 4.13. In the six species, the highest mineral observed was Calcium (3898.0 ± 244.6 - 4822.1 ± 188.3mg/100g) followed by Potassium (740.0 ± 88.7 - 880.3 ± 53.4mg/100g) then Sodium (372.0 ± 32.7 - 457.5 ± 21.1mg/100g), Magnesium (142.3 ± 28.4 - 153.8 ± 13.6mg/100g) in that order while the least mineral observed was Copper (1.8 ± 08 - 3.6 ± 1.0mg/100g).

S. clarias contained the highest Calcium (4.822.1 ± 188.3mg/100g) followed by *S. budgetti* (4560.6 ± 168.7mg/100g) then *S. membranaceus* (4022.0 ± 164.0mg/100g) and the least Calcium (3898.0 ± 244.6mg/100g) was recorded in *S. melanopterus*. The highest content of Potassium (883.0 ± 32.4mg/100g) was recorded in *S. filamentosus* followed by *S. melanopterus* (880.3 ±29.9mg/100g) and the least Potassium (740.0 ± 88.7mg/100g) was contained in *S. clarias*. The highest Iron content (51.3 ± 1.8mg/100g) was observed in *S. filamentosus*, followed by *S. membranaceus* (40.4 ± 3.6mg/100g) and *S. melanopterus* (40.2 ± 2.5mg/100g) while the least Iron content was observed in *S. schall* (33.8 ± 3.2mg/100g). The highest Magnesium (153.8 ± 13.6mg/100g) was observed in *S. filamentosus*, followed by *S. membranaceus* (151.0 ± 18.9mg/100g) then *S. melanopterus* (150.6 ± 19.3mg/100g), *S. budgetti* (150.1 ± 20.3mg/100g) in that order while the least Magnesium content was observed in *S. schall* (142.3 ± 28.4mg/100g).

Sodium was highest in *S. filamentosus* (461.1 ± 16.9mg/100g) followed closely by *S. budgetti* (457.5 ± 21.1mg/100g), then *S. schall* (408.9 ± 20.6mg/100g), and *S. melanopterus* (408.7 ± 19.9mg/100g) in that order and the least Sodium was observed in *S. membranaceus* (372.0 ± 32.7mg/100g). The highest Copper content (3.6 ± 1.0mg/100g) was recorded in *S. schall*, followed by *S. melanopterus* (3.4 ± 0.6mg/100g) then *S. membranaceus* (3.0 ± 0.7mg/100g) and the least Copper content was recorded in *S. clarias* (1.8 ± 0.8mg/100g).

Phosphorus content (23.6 ± 4.2mg/100g) was highest in *S. schall*, followed by *S. clarias* (22.2 ± 5.1mg/100g), *S. melanopterus* (22.1 ± 4.8mg/100g) in that order and the least Phosphorus content (20.0 ± 6.2mg/100g) was recorded in *S. budgetti*. The highest content of Zinc (22.2 ± 1.3mg/100g) was recorded in *S. clarias*, followed by *S. membranaceus* (22.0 ± 0.9mg/100g), *S. melanopterus* (21.3 ± 1.0mg/100g), *S.*

filamentosus (21.4 ± 1.2mg/100g) in that order and the least zinc was recorded in *S. budgetti* (20.6 ± 0.7mg/100g).

Table 4.10

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (kcal/100g) OF SIX SPECIES OF THE FAMILY MOCHOKIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Synodontis schall	76.04	15.5 ± 1.4	84.7 ± 1.00	9.5 ± 1.12	31.3 ± 0.6	43.3 ± 1.04	593.45	100.00
S. clarias	77.02	14.6 ± 1.3	85.3 ± 1.33	9.6 ± 0.80	32.3 ± 1.32	43.7 ± 1.88	577.06	100.00
S. budgetti	78.04	15.9 ± 1.5	84.0 ± 1.87	9.4 ± 0.62	33.7 ± 0.31	40.9 ± 1.31	580.79	100.00
S. membranaceus	76.40	22.1 ± 1.1	78.0 ± 1.63	9.4 ± 1.30	20.0 ± 1.22	39.5 ± 1.01	547.44	100.00
S. melanopterus	76.88	19.7 ± 0.3	80.3 ± 1.30	9.3 ± 1.12	30.1 ± 1.67	40.6 ± 3.21	522.63	100.00
S. filamentosus	77.90	14.0 ± 1.7	86.0 ± 1.20	10.4 ± 1.70	29.9 ± 1.70	45.7 ± 0.81	571.09	100.00

Table 4.11

AMINO ACID COMPOSITION OF SIX SPECIES OF THE FAMILY MOCHOKIDAE (g/16gN)

Fish Species	Lys	His	Art	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
Synodontis schall	9.87	3.01	3.80	9.00	2.22	2.06	15.12	2.50	2.90	3.48	3.32	3.12	1.85	4.46	5.40	2.86	3.04
S. clarias	9.80	3.12	4.00	10.40	3.48	2.34	16.02	3.02	2.99	4.06	3.34	4.03	1.65	2.66	5.02	3.82	3.08
S. budgetti	10.20	3.40	3.96	8.40	3.80	3.00	16.00	3.80	3.10	4.26	3.50	4.24	2.10	2.50	5.30	2.90	3.40
S. membranaceus	9.88	3.14	4.00	8.46	3.50	2.08	16.04	3.02	2.96	4.96	3.36	3.04	1.98	2.70	5.04	2.78	3.08
S. melanopterus	9.88	3.20	4.15	8.66	2.30	2.40	16.00	3.06	2.95	4.92	3.20	3.05	1.97	2.62	5.08	2.82	3.04
S. filamentosus	9.86	3.02	3.85	9.12	3.02	2.08	15.99	2.96	4.80	4.86	2.56	3.06	2.04	2.06	6.02	2.48	3.05

Table 4.12

THE E:N, E:T, E:P EAAI, AND C.S/P.S OF SIX SPECIES OF THE FAMILY MOCHOKIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
Synodontis schall	1.00	50.18	122.58	56.43	1.29
S. clarias	1.04	51.12	125.24	57.65	0.91
S. budgetti	0.94	48.71	129.44	59.85	0.94
S. membranaceus	0.92	48.11	120.54	55.49	0.85
S. melanopterus	0.88	48.84	116.28	53.53	0.94
S. filamentosus	0.85	45.98	116.38	53.57	1.02

a - Essential to non-essential amino acid ratio

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio

Table 4.13

MINERAL CONTENT OF SIX SPECIES OF THE FAMILY MOCHOKIDAE (g/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
Synodontis schall	4004.2±196.6	815.2±32.6	33.8±3.2	142.3±28.4	408.9±20.6	3.6 ± 1.0	23.6±4.2	21.0 ± 1.1
S. clarias	4822.1±188.3	740.0±88.7	38.6±3.3	144.0±22.2	404.2±27.5	1.8 ± 0.8	22.2±5.1	22.2 ± 1.3
S. budgetti	4564.6±168.7	844.3±29.9	36.8±4.2	150.1±20.3	457.5±21.1	2.3 ± 0.7	20.0±6.2	20.6 ± 0.7
S. membranaceus	4022.0±164.0	784.1±103.2	40.4±3.6	15.0±18.9	372.0±32.7	3.0 ± 0.7	21.0±5.1	22.0 ± 0.9
S. melanopterus	3898.0±244.6	880.3±53.4	40.2±2.5	150.6±19.3	408.7±19.9	3.4 ± 0.6	22.1±4.8	21.3 ± 1.0
S. filamentosus	4006.4±126.7	883.0±32.4	51.3±1.8	150.8±13.6	461.1±16.9	2.8 ± 0.9	22.0±3.6	21.4 ± 1.2

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4.8 (a) Proximate components of the family Cyprinidae (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Labeo coubie, Labeo senegalensis* and *Barbus occidentalis* are shown in Table 4.14. The highest proximate component was protein (34.7 ± 1.88 - 40.3 ± 1.66g/100g) in all three species, followed by lipid (23.7 ± 1.30 - 27.2 ± 1.80g/100g) and the least contained was carbohydrate (12.6 ± 2.60 - 13.6 ± 3.60g/100g). The carbohydrate lipid and protein were in the ratio of 1:2:3. The ash content was significantly different ($P<0.05$) in the three species. The highest ash (30.1 ± 4.3g/100g) was contained in *L. senegalensis*, followed by *L. coubie* (32.4 ± 3.5g/100g) and the least was observed in *B. occidentalis* (16.4 ± 4.2g/100g). The organic matter was also significantly different ($P<0.05$) in all three species. The highest organic matter (83.7 ± 4.60g/100g) was observed in *B. occidentalis*, followed by *L. senegalensis* (73.2 ± 1.82g/100g) and the least was recorded in *L. coubie* (71.6 ± 1.61g/100g). Carbohydrate was not significantly different ($P>0.05$) in the species, however the highest carbohydrate (13.6 ± 3.60g/100g) was recorded in *B. occidentalis*, followed by *L. senegalensis* (12.8 ± 2.45g/100g) and the least was observed in *L. coubie* (12.6 ± 2.60g/100g). The highest lipid was also recorded in *B. occidentalis* (29.2 ± 1.8g/100g) followed by *L. coubie* (26.3 ± 1.87g/100g) and the least was observed in *L. senegalensis* (23.7 ± 1.30g/100g). Protein content was significantly different ($P<0.05$) in the three species, however, the highest protein content was observed in *B. occidentalis* (40.3 ± 1.66g/100g) followed by *L. coubie* (36.1 ± 3.16g/100g) and the least was recorded in *L. senegalensis* (34.7 ± 1.89g/100g). The calories were generally high in all three species. The highest calory was recorded in *B. occidentalis* (535.81kcal/100g), followed by *L. coubie* (500.06kcal/100g) and the least was recorded in *L. senegalensis* (468.48kcal/100g).

(b) **Amino acid composition of the family cyprinidae (g/100g) protein**

The amino acid composition of *L. coubie, L. senegalensis and B. occidentalis* are shown in Table 4.15. The profiles of the amino acids were the same in all three species but theere were significant differences ($P<0.05$) in the quantities of the various amino acids contained. The highest amino acid contained in the three species was glutamic acid (15.85 - 18.02g/100g), followed by lysine (9.68 - 11.0g/100g) and the least recorded was methionine (1.64 - 2.45g/100g). *L. coubie* contained the highest lysine (11.0g/100g), arginine (6.38g/100g), proline (3.09g/100g), valine (4.89g/100g), methionine (2.45g/100g), isoleucine (2.98g/100g) and leucine (5.99g/100g). *L. senegalensis* contained the highest histidine (3.18g/100g), aspartic acid (11.38g/100g), threonine (4.06g/100g), glycine (5.60g/100g) and cysteine (3.68g/100g), while *B. occidentalis* contained the highest histidine (3.18g/100g), serine (4.66g/100g), glutamic acid (18.02g/100g), alamine (7.06g/100g), cysteine (3.68g/100g) and phenylalanine (3.58g/100g).

(c) ***Chemical indices***

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for the three species of the family cyprinidae are presented in Table 4.16. The E:N ratio was highest in *L. senegalensis* (0.80), followed by *L. coubie* (0.74) and the least was recorded in *B. occidentalis* (0.73). The highest E:T ratio was also recorded in *L. senegalensis* (44.49) followed by *L. coubie* (42.72) and the least value was recorded in *B. occidentalis* (42.35). The EAAI values were generally high in the three species, however, the highest value was recorded in *L. coubie* (136.07) followed by *B. occidentalis* (124.99) and the least was recorded in *L. senegalensis*

(130.94). The highest C.S/P.S was recorded in *L. coubie* (62.64) followed by *L. senegalensis* (59.80) and the least was recorded in *B. occidentalis* (57.81).

The E:P values were above 1.0 in *L. coubie* (1.20) and *L. senegalensis* (1.20) while the least was recorded in *B. occidentalis* (0.99).

(d) Mineral content of the family cyprinidae (mg/100g) ash

The mean values and standard deviations of the mineral contents of *L. coubie, L. senegalensis* and *B. occidentalis* are presented in Table 4.17. The highest mineral contained in the three species was Calcium (2908.3 ± 148.8 - 3424.0 ± 84.1mg/100g), followed by Potassium (808.2 ± 103.5 - 1044.2 ± 202.6mg/100g), then Sodium (270.3 ± 50.2 - 324.4 ± 54.7mg/100g), Magnesium (246.4 ± 23.6 - 312.2 ± 63.2mg/100g) in that order while the least mineral recorded was Copper (3.3 ± 1.2 - 6.4 ± 1.8mg/100g).

L. coubie contained the highest Calcium content (3424.0 ± 84.1mg/100g), followed by *L. senegalensis* (3202.2 ± 96.7mg/100g) and the least was recorded in *B. occidentalis* (2908.3 ± 148.8mg/100g. The highest Potassium content (1044.2 ± 202.6mg/100g) was recorded in *L. coubie*, followed by *L. senegalensis* (824.0 ± 87.1mg/100g) and the least was recorded in *B. occidentalis* (808.2 ± 103.5mg/100g). The highest iron content (22.0 ± 17.4mg/100g) was recorded in *L. coubie*, followed by *L. senegalensis* (20.3 ± 13.3mg/100g) and the least was recorded in *B. occidentalis* (17.0 ± 11.0mg/100g). Magnesium content was also highest in *L. coubie* (312.2 ± 17.4mg/100g) followed by *L. senegalensis* (246.4 ± 23.6mg/100g) and the least was recorded in *B. occidentalis* (259.2 ± 43.7mg/100g). Sodium was highest in *L. coubie* (324.4 ± 54.7mg/100g) and the least was recorded in *B. occidentalis* (270.3 ± 50.2mg/100g). The Copper content was also highest in *L. coubie* (6.4 ± 1.8mg/100g) and least in *L. senegalensis* (3.3 ± 1.2mg/100g).

Phosphorus (29.3 ± 3.4mg/100g) was highest in *B. occidentalis* and the least was recorded in *L. coubie* (27.2 ± 4.1mg/100g) while zinc was higher in *L. coubie* (18.6 ± 0.8mg/100g) and *L. senegalensis* (18.6 ± 0.7mg/100g) and least in *B. occidentalis* (17.0 ± 0.5mg/100g).

Table 4.14

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF THE THREE SPECIES OF THE FISH FAMILY CYPRINIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrates	Lipid	Protein	Calory	Total
Labeo coubie	76.40	30.0 ± 3.5	70.0 ± 1.61	12.6 ± 2.60	21.3 ± 1.87	36.1 ± 3.16	500.06	100.00
L. Senegalensis	77.80	30.0 ± 4.3	70.0 ± 1.82	12.8 ± 2.45	23.5 ± 1.30	34.7 ± 1.89	468.48	100.00
Barbus occidentalis	76.34	16.4 ± 4.2	83.7 ± 4.60	13.6 ± 3.60	29.8 ± 1.80	40.3 ± 1.66	535.81	100.00

Table 4.15

AVERAGE AMINO ACID COMPOSITION OF THREE SPECIES OF THE FAMILY CYPRINIDAE (g/100g)

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
L. coubie	11.0	2.82	6.38	10.10	3.60	4.64	15.85	3.09	4.33	3.98	3.35	4.89	2.45	2.98	5.99	2.86	3.52
L. senegalensis	10.88	3.18	6.16	11.38	4.06	3.08	16.04	2.86	5.60	7.05	3.68	4.88	1.92	1.04	5.90	2.80	3.48
B. occidentalis	9.68	3.18	5.90	10.42	3.57	4.66	18.02	2.77	5.50	7.06	3.68	3.96	1.64	2.06	5.89	2.68	3.58

Table 4.16

THE E:N E:T E:P RATIOS EAAI AND C.S/P.S OF THREE SPECIES OF THE FAMILY CYPRINIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
L. coubie	0.74	42.72	136.07	62.64	1.20
L. senegalensis	0.80	44.49	130.94	59.80	1.20
B. occidentalis	0.73	42.35	124.99	57.81	0.99

a - Essential to non-essential amino acid ratio

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

Table 4.17

MINERAL CONTENTS OF THREE SPECIES OF THE FAMILY CYPRINIDAE (mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
L. coubie	3424.0±84.1	1044.2±202.6	22.0±17.4	312.2±63.2	324.4±54.7	6.4±1.8	27.2±4.1	18.6±0.8
L. senegalensis	3202.2±96.7	824.0±87.1	20.3±13.3	246.4±23.6	270.8±8.6	3.3±1.2	28.0±6.2	18.6±0.7
B. occidentalis	2908.3±148.8	808.2±103.5	17.2±11.0	259.2±43.7	270.3±50.2	5.8±1.9	29.3±3.4	17.0±0.5

4.9 (a) Proximate tissue composition of the family Characidae (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Alestes nurse, Hydrocynus brevis, Alestes macrolepidotus* and *Hepsetus odoe* are shown in Table 4.18. The highest proximate component in the four species was lipid (40.0 ± 0.34 - 40.8 ± 0.80g/100g), followed by protein (30.3 ± 0.47 - 32.4 ± 1.15g/100g) and the least recorded was carbohydrate (9.1 ± 0.33 - 10.8 ± 1.12g/100g).

The carbohydrate, lipid and protein ratio was 1:4:3. The highest ash content (17.8 ±1.9g/100g) was recorded in *H. odoe*, followed by *H. brevis* (16.0 ± 1.3g/100g) then *A. macrolepidotus* (16.0 ± 0.8g/100g) in that order while the least ash content was recorded in *H. brevis* (14.4 ± 0.7g/100g). The organic matter was highest in *A. nurse* (84.0 ± 1.92g/100g), followed by *A. macrolepidotus* (82.9 ± 1.72g/100g) then *H. brevis* (82.3 ± 2.10g/100g) and the least organic matter was recorded in *H. odoe* (2.2 ± 1.80g/100g).

Carbohydrate was generally low in all four species, however, the highest was observed in *H. odoe* (10.8 ± 1.12g/100g) followed by *H. brevis* (9.8 ± 0.83g/100g) and the least was observed in *A. nurse* (9.1 ± 0.33g/100g).

The highest lipid value (40.8 ± 0.80g/100g) was observed in *A. macrolepidotus*, followed by *A. nurse* (40.7 ± 2.60g/100g and the least was observed in *H. odoe* (40.0 ± 0.34g/100g). The protein content was highest in *A. nurse* (35.4 ± 1.15g/100g) then closely followed by *A. macrolepidotus* (32.1 ± 1.91g/100g) and the least protein was observed in *H. odoe* (30.3 ± 0.47g/100g). The caloric value was highest in *A. macrolepidotus* (605.14kcal./100g) followed by *A. nurse* (603.38kcal./100g) and the least was observed in *H. odoe* (590.93kcal./100g). The organic matter, carbohydrate, lipid, protein and caloric values were not significantly different (P>0.05) in all four species.

(b) **Amino acid composition of the family characidae (g/100g) protein**

The amino acid composition of *A. nurse*, *H. brevis*, *A. macrolepitdotus* and *H. odoe* are shown in Table 4.19. The profiles of the amino acids were the same in all the four species but there was significant difference ($P<0.05$) in the quantities of the respective amino acid content. The highest amino acid content in all four species was glutamic acid (12.30 - 16.26g/100g), followed by lysine (8.70 - 12.54g/100g) and aspartic acid (8.0 - 12.40g/100g) then leucine (5.20 - 8.32g/100g) and the least amino acid values recorded were methionine (2.54 - 3.33g/100g) and isoleucine (2.0 - 3.0g/100g).

A. nurse recorded the highest values of glutamic acid (16.26g/100g), arginine (6.15g/100g), proline (3.66g/100g) and leucine (8.32g/100g), while *H. brevis* recorded the highest value of serine (6.44g/100g), glycine (7.99g/100g), alanine (8.0g/100g), isoleucine (3.0g/100g) and tyrosine (3.90g/100g).

H. odoe recorded the highest value of histidine (4.64g/100g), aspartic acid (12.40g/100g), threonine (4.83g/100g), alanine (8.0g/100g) and valine (5.36g/100g). *A. macrolepidotus* recorded the highest value of lysine (12.54g/100g), proline (4.02g/100g), valine (5.08g/100g), methionine (2.62g/100g) and phenylalanine (4.05g/100g)

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and the essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *A. nurse, H. brevis, A. macrolepidotus* and *H. odoe* are presented in Table 4.20.

The E:N ratio was highest in *A. macrolepidotus*, (0.95), followed by *H. brevis* (0.89) and the least was recorded in *H. odoe* (0.85). The E:T ratio was also highest in *A. macrolepidotus*

(48.33), followed by *H. brevis* (47.24) and the least was recorded in *H. odoe* (46.16). The EAAI values were generally high in all four species, the highest value was recorded in *A. macrolepidotus* (149.54), followed by *A. nurse* (143.27) and the least was recorded in *H. odoe* (137.23).

The C.S/P.S values were not significantly different (P>0.05) in all four species, however, the highest value was recorded in *A. macrolepidotus* (68.84), followed by *A. nurse* (65.96) and the least was recorded in *H. odoe* (63.17). The E:P values were generally above 1.00 in all four species. The highest value was recorded in *A. macrolepidotus* (1.47), then *H. odoe* (1.44) and the least value was recorded in *A. nurse* (1.42) and *H. brevis* (1.42).

(d) **The mineral contents of the family characidae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *A. nurse*, *H. brevis*, *A. macrolepidotus* and *H. odoe* are presented in Table 4.21. The highest mineral content recorded in all four species was Calcium (20.80.6 ± 189.3 - 2410.3 ± 689.3mg/100g), followed by Potassium (455.1 ± 28.7) - 582.0 ± 55.7mg/100g), then Sodium (278.6 ± 19.8mg/100g) and the least observed was Copper (1.0 ± 0.2 - 1.8 ± 0.3mg/100g) in that order.

A. nurse recorded the highest Potassium (582.0 ± 55.7mg/100g), Iron (43.0 ± 3.6mg/100g), Sodium (314.6 ± 16.5mg/100g), Copper (1.8 ± 0.3mg/100g), Phosphorus (15.0 ± 4.2mg/100g) and Zinc (18.7 ± 2.4mg/100g) contents while *H. odoe* recorded the highest values of Calcium (2410.3 ± 689.3mg/100g) and Magnesium (162.0 ± 23.1mg/100g). *H. brevis* and *A. macrolepidotus* recorded the lowest values of the minerals. The contents of Calcium, Potassium, Iron, Magnesium and Sodium were signifantly different (P<0.05) in all four species.

Table 4.18

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF FOUR SPECIES OF THE FAMILY CHARACIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Alestes nurse	79.50	16.0 ± 1.3	84.0 ± 1.92	9.8 ± 0.83	40.7 ± 2.60	35.4 ± 1.91	603.38	100.00
Hydrocynus brevis	78.60	7.7 ± 0.7	82.3 ± 2.10	10.5 ± 0.33	40.3 ± 1.78	31.5 ± 1.67	593.41	100.00
Alestes macrolepidotus	78.04	16.1 ± 0.8	82.9 ± 1.72	10.6 ± 0.40	40.8 ± 0.80	32.4 ± 1.15	605.16	100.00
Hepsetus odoe	79.00	17.8 ± 1.9	2.2 ± 1.80	10.8 ± 1.12	40.0 ± 0.34	31.3 ± 0.47	590.93	100.00

Table 4.19

AMINO ACID COMPOSITION OF FOUR SPECIES OF THE FAMILY CHARACIDAE(g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
Alestes nurse	11.08	3.00	6.15	10.20	3.85	4.92	16.26	3.66	5.68	4.90	3.84	5.06	2.54	2.00	8.32	3.04	3.11
Hydrocynus brevis	8.70	3.86	4.00	8.00	4.03	6.44	12.30	3.02	7.99	8.00	4.02	4.02	2.38	3.00	7.50	3.90	3.08
Alestes macrolepidotus	12.54	3.01	5.30	9.90	3.84	4.68	15.32	4.02	5.69	4.92	4.46	5.08	2.62	2.30	6.86	3.00	4.05
Hepsetus odoe	9.89	4.89	3.60	12.40	4.83	4.60	14.89	2.98	4.85	8.00	3.24	5.36	3.33	2.04	5.20	2.30	3.00

Table 4.20

THE E:N, E:T, E:P, EAAI AND C.S/P.S OF FOUR SPECIES OF THE FAMILY CHARACIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
Alestes nurse	0.88	46.88	143.27	65.96	1.42
Hydrocynus brevis	0.89	47.24	139.49	64.21	1.42
Alestes macrolepidotus	0.95	48.16	137.23	68.84	1.47
Hepsetus odoe	0.85	50.50	100.00	63.17	1.44

a - Essential to non-essential amino acid ratio
b - Essential amino acid to total nitrogen ratio
c - Essential amino acid index
d - Chemical or protein score
e - Essential amino acid to protein ratio

Table 4.21

MINERAL CONTENT OF FOUR SPECIES OF THE FAMILY CHARACIDAE(mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
Alestes nurse	2198.6±230.0	582.0±55.7	43.0 ± 3.6	136.2 ± 27.5	314.6 ± 16.5	1.8 ± 0.3	15.0 ± 4.2	18.7 ± 2.4
Hydrocynus brevis	2080.6±189.3	494.0±62.0	30.2 ± 6.4	158.6 ± 26.4	289.7 ± 21.2	1.0 ± 0.2	15.0 ± 3.1	15.0 ± 0.6
Alestes macrolepidotus	2334.7±553.1	482.9±44.3	31.2 ± 6.4	158.7 ± 18.8	298.7 ± 23.9	1.6 ± 0.5	13.4 ± 2.3	16.0 ± 1.3
Hepsetus odoe	2410.3±689.3	455.1±28.7	33.8 ± 6.5	162.0 ± 23.1	278.6 ± 19.8	1.0 ± 0.4	13.3 ± 1.6	15.2 ± 0.8

4.10 (a) Proximate Components of the family mormyridae (g/100g) dry matter

The mean values and standard deviations for the proximate components and caloric values of *Mormyrus rume*, *Mormyrops deliciosus* and *Hyperopisus bebe* are presented in Table 4.22. The highest constituent observed in all three species was protein (50.6 ± 0.73 - 51.3 ± 2.04g/100g), followed by lipid (36.0 ± 0.81 - 40.1 ± 0.34g/100g) and the least recorded was carbohydrate (8.4 ± 1.86 - 9.2 ± 0.64g/100g). The carbohydrate, lipid and protein were in the ratio of 1:4:5.

The highest ash was observed in *H. bebe* (15.2 ± 0.5g/100g), followed by *M. rume* (14.6 ± 0.46g/100g) and the least was recorded in *M. deliciousus* (13.6 ± 1.7g/100g).

The organic mather values were: *M. deliciosus* (86.4 ± 2.30g/100g) e.g *M. rume* (85.4 ± 1.33g/100g) *H. bebe* (84.2 ± 1.00g/100g). The carbohydrate was not significantly different (P>0.05), however, the highest was recorded in *M. deliciosus* (9.0 ± 0.64g/100g) followed by *M. rume* (9.0 ± 1.20g/100g) and the least was recorded in *H. bebe* (8.4 ± 1.86g/100g). The lipid content of the three species were significantly different (P<0.05). The highest was observed in *M. rume* (40.1 ± 0.34g/100g), followed by *M. deliciosus* (38.7 ± 2.53g.100g) and the least was recorded in *H. bebe* (36.0 ± 0.81g/100g). Protein was not significantly different (P>0.05) in the three species, but the highest was observed in *M. deliciosus* (57.3 ± 2.04g.100g), then *H. bebe* (51.1 ± 1.08g/100g) and the least was recorded in *M. rume* (50.6 ± 0.73g/100g). The caloric values were not significantly different (P>0.05) in the three species. The highest value however was recorded in *M. rume* (696.15kcal./100g) followed by *M. deliciosus* (687.52kcal./100g) and the least was recorded in *H. bebe* (657.49kcal./100g).

(b) **Amino acid composition of the family mormyridae (g/100g) protein**

The amino acid composition of *M. rume*, *M. deliciosus* and *H. bebe* are presented in Table 4.23. The amino acid profiles were the same for the three species, however, the quantities were significantly different ($P<0.05$).

The highest amino acid observed was glutamic acid (14.97 - 15.04g/100g), followed by lysine (9.18 - 9.76g/100g), aspartic acid (8.80 - 8.89g/100g) and arginine (4.10 - 4.95g/100g) while the least observed was methionine (1.56 - 1.60g/100g).

M. rume recorded the highest value of lysine (9.76g/100g), threonine (2.40g/100g), cysteine (3.20g/100g), valine (3.20g/100g), isoleucine (2.60g/16gN), leucine (4.68g/16gN) and phenylalanine (3.01g/100g). *M. deliciosus* recorded the highest values of histidine (2.95g/100g), aspartic acid (8.89g/100g), proline (2.40g/100g), glycine (2.85g/100g) and tyrosine (3.00g/100g). *H. bebe* recorded the highest value of arginine (4.95g/100g), serine (2.24g/100g), glutamic acid (15.04g/100g) alanine (5.55g/100g) and methionine (1.60g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and the essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *M. rume*, *M. deliciosus* and *H. bebe* are presented in Table 4.24.

The (E:N) ratio was highest in *M. deliciosus* (0.90) followed by *M. rume* (0.89) and the least was observed in *H. bebe* (0.84). The E:T value was highest in *M. deliciosus* (47.50) then *M. rume* (47.35) and the least was recorded in *H. bebe* (45.66). The EAAI

was generally above 100.00 in all three species. The highest value was recorded in *M. rume* (112.56) followed by *M. deliciosus* (109.62) and *H. bebe* (109.30). The highest C.S/P.S was also recorded in *M. rume* (51.81) followed by *M. deliciosus* (50.55) and *H. bebe* (50.36). The E:P value was highest in *M. rume* (0.71) then *H. bebe* (0.68) and *M. deliciosus* (0.63) in that order. There was generally no significant difference ($P>0.05$) in the E:N, E:T, EAAI, C.S/P.S and the E:P values of the three species.

(d) **Mineral content of the family mormyridae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *M. rume*, *M. deliciosus* and *H. bebe* are presented in Table 4.25. The highest mineral observed in the three species was Calcium (2018.0 ± 99.8mg/100g - 2698.7 ± 108.3mg/100g) followed by Potassium (728.2 ± 27.9 - 770.3 ± 34.1mg/100g), then Sodium (278.6 ± 18.7 - 318.0 ± 80.1mg/100g), Magnesium (209.0 ± 16.7 - 248.4 ± 32.8mg/100g) in that order and the least mineral observed was Copper (7.8 ± 0.9 - 9.4 ± 1.2mg/100g).

M. rume only contained the highest Phosphorus (40.2 ± 3.7mg/100g), while *M. deliciosus* recorded the highest Potassium (770.3 ± 34.1mg/100g), Iron (32.4 ± 3.6mg/100g) and Zinc (22.4 ± 1.6mg/100g. *H. bebe* recorded the highest Calcium (2698.7 ± 108.3mg/100g), Magnesium (248.4 ± 32.8mg/100g) and Sodium (318.0 ± 80.1mg/100g). There was significant different ($P<0.05$) in the contents of Calcium, Potassium, Iron, Magnesium and Phosphorus of the three species.

Table 4.22

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF THREE SPECIES OF THE FAMILY MORMYRIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Mormyrus rume	79.60	14.6 ± 0.4	85.4 ± 1.33	9.0 ± 1.20	36.1 ± 0.34	40.3 ± 0.73	696.15	100.00
Mormyrops deliciosus	78.80	12.6 ± 1.7	86.4 ± 2.30	9.2 ± 0.64	35.7 ± 2.53	41.3 ± 2.04	687.52	100.00
Hyperopisus bebe	78.92	15.2 ± 0.5	84.8 ± 1.00	8.4 ± 1.86	36.0 ± 0.81	40.1 ± 1.08	657.49	100.00

Table 4.23

AVERAGE AMINO ACID COMPOSITION OF THREE SPECIES OF THE FAMILY MORMYRIDAE (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
Mormyrus rume	9.76	2.86	4.90	8.80	2.40	2.22	15.00	2.30	2.80	4.00	3.20	3.20	1.60	2.60	4.68	2.64	3.01
Mormyrops deliciosus	9.18	2.95	4.10	8.89	2.26	2.10	14.97	2.40	2.85	3.50	3.16	3.18	1.56	2.18	4.60	3.00	3.00
Hyperopisus bebe	9.36	2.90	4.95	8.80	2.25	2.24	15.04	2.26	2.80	5.55	3.16	3.18	1.60	2.18	4.64	2.60	3.00

Table 4.24

THE E:N, E:T, E:P RATIOS, EAAI AND C.S/P.S OF THREE SPECIES OF THE FAMILY MORMYRIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
Mormyrus rume	0.89	47.35	112.56	51.81	0.71
Mormyrops deliciosus	0.90	47.50	109.62	50.55	0.63
Hyperoisus bebe	0.84	45.66	109.30	50.36	0.68

a - Essential to non-essential amino acid ratios
b - Essential amino acid to total nitrogen ratios
c - Essential amino acid index
d - Chemical or protein score
e - Essential amino acid to protein ratio

Table 4.25

MINERAL CONTENTS OF THREE SPECIES OF THE FAMILY MORMYRIDAE (mg/100g)

Fish Species	Calcium	Potasssium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
Mormyrus rume	2018.0±99.8	728.2±27.9	26.8±3.8	209.0±16.7	209.0±83.5	7.9 ± 0.9	40.2 ± 3.7	19.0 ± 1.0
Mormyrops deliciosus	2358.0±86.9	770.3±34.1	32.4±3.6	213.3±28.4	278.6±18.7	8.0 ± 1.1	30.2 ± 1.6	22.4 ± 1.6
Hyperopisus bebe	2698.7±108.3	768.7±28.4	25.1±4.2	248.4±32.8	318.0±80.1	9.4 ± 1.2	32.3 ± 1.6	20.0 ± 1.1

4.11 (a) Proximate components of the family Clariidae (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Clarias gariepinus* and *Clarias anguillaris* are shown in Table 4.26. The highest proximate component observed in the two species was protein (52.4 ± 0.49 - 55.7 ± 0.83g/100g), followed by lipid (26.3 ± 1.45 - 27.6 ± 1.30g/100g) and the least observed was carbohydrate (10.1 ± 0.80 - 10.2 ± 1.00g/100g). The carbohydrate, lipid and protein were in the ratios of 1:2:5.

The ash content was not significantly different (P>0.05) in the two species, however, the higher content was observed in *C. gariepinus* (10.5 ± 0.2g/100g) and the lower content in *C. anguillaris* (9.3 ± 0.7g/100g). The organic matter was not significantly different (P>0.05) in the two species, but the higher content was observed in *C. anguillaris* (91.1 ± 1.32g/100g and lower content in *C. gariepinus* (89.0 ± 1.40g/100g). The carbohydrate contents were also not significantly different (P>0.05) in the two species. The higher value was observed in *C. gariepinus* (10.2 ± 1.00g/100g) and the lower value in *C. anguillaris* (10.1 ± 0.80g/100g). The lipid content was not significantly different (P>0.05) in the two species. However, *C. gariepinus* (27.6 ± 1.30g/100g) recorded higher content than *C. anguillaris* (26.3 ± 1.45g/100g). The protein content was significantly different (P<0.05) in the two species. Higher value was recorded in *C. anguillaris* (54.7 ± 0.83g/100g) and the lower value in *C. gariepinus* (52.4 ± 0.49g/100g). The caloric value was observed not significantly different (P>0.05) in the two species, however, higher value was recored in *C. anguallaris* (597.61kcal./100g) and lower value in *C. gariepinus* (592.22kcal./100g.

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(b) **Amino acid composition of the family Clariidae (g/100g) protein**

The amino acid composition of *C. gariepinus* and *C. anguillaris* are shown in Table 4.27. The profiles of the amino acids in the two species were observed to be the same but the quantities of the respective amino acids varied significantly (<0.05). The highest amino acid observed in the two species were observed to be the same but the quantities of the respective amino acids varied significantly (P<0.05). The highest amino acid observed in the two species was glutamic acid (15.20 - 14.85g/100g), followed by lysine (10.13 - 10.15g/100g), then aspartic acid (8.30 - 8.46g/100g), leucine (5.64 - 6.88g/100g), alanine (3.95 - 4.90g/100g) and arginine (3.95 - 4.40g/100g) and the least observed was methionine (1.97 - 2.05g/100g).

C. gariepinus recorded higher (histidine (2.84g/100g), arginine (4.40g/100g), serine (2.07g/100g), proline (2.54g/100g), glycine (8.86g/100g), alanine (4.90g/100g), valine (3.02g/100g) and tyrosine (2.96g/100g) while *C. anguillaris* recorded higher lysine (10.15g/100g), aspartic acid (8.46g/100g), threonine (3.98g/16gN), glutamic acid (15.20g/100g), cysteine (2.76g/100g), methionine (2.05g/100g), isoleucine (3.00g/100g), leucine (6.88g/16gN) and phenylalanine (3.00g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and the essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *C. gariepinus* and *C. anguillaris* are shown in Table 4.28.

The E:N ratio was higher in *C. anguillaris* (0.99) and lower in *C. gariepinus* (0.85). The

E:T ratio was higher also in *C. anguillaris* (49.83) and lower in *C. gariepinus* (46.07). The EAAI were above 100.00 in both species, the higher value was recorded in *C. anguillaris* (124.71) and lower in *C. gariepinus* (122.83). The C.S/P.S in both species were below 100.00, but the higher value was recorded in *C. anguillaris* (57.41) and lower in *C. gariepinus* (56.54). The E:P was higher in *C. gariepinus* (0.84) and lower in *C. anguillaris* (0.71).

(d) **Mineral content of the family Clariidae (mg/100g) ash**

The mean values and standard deviations of the mineral content of *C. gariepinus* and *C. anguillaris* are shown in Table 4.29. The highest mineral content observed in the two species was Calcium (3910.2 ± 102.9 - 4000.6 ± 100.4mg/100g), followed by Potassium (638.7 ± 22.6 - 648.4 ± 20.8mg/100g), then Sodium (260.6 ± 16.7 - 317.0 ± 20.3mg/100g), Iron (52.7 ± 5.6 - 57.6 ± 9.3mg/100g), Magnesium (31.2 ± 5.6 - 31.3 ± 6.4mg/100g) and Zinc (18.7 ± 1.8 - 18.9 ± 1.6mg/100g) in that order while the least mineral observed was Copper (2.0 ± 0.3 - 2.4 ± 0.4mg/100g). *C. gariepinus* recorded higher values of Magnesium (31.3 ± 6.4mg/100g), Copper (2.4 ± 0.4mg/100g, Phosphorus (16.2 ± 1.7mg/100g) and Zinc (18.9 ± 1.6mg/100g), while *C. anguillaris* recorded higher content of Calcium (4000.6 ± 100.4mg/100g), Potassium (648.4 ± 20.8mg/100g), Iron (57.6 ± 9.3mg/100g) and Sodium (317.0 ± 20.3mg/100g). There was significant difference ($P<0.05$) in the contents of Calcium, Potassium, Iron and Sodium of the two species.

Table 4.26

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF TWO SPECIES OF THE FAMILY CLARIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Clarias gariepinus	75.00	10.5 ± 0.2	89.5 ± 1.40	10.2 ± 1.00	27.1 ± 1.30	52.2 ± 0.49	592.22	100.00
C. anguillaris	78.40	9.0 ± 0.7	91.1 ± 1.32	10.1 ± 0.80	26.3 ± 1.45	54.7 ± 0.83	597.61	100.00

Table 4.27

AMINO ACID COMPOSITION OF TWO SPECIES OF THE FAMILY CLARIDAE (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
C. gariepinus	10.13	2.84	4.40	8.30	2.89	2.07	14.85	2.54	8.86	4.90	2.62	3.02	1.97	5.16	5.64	2.96	2.00
C. arguiltris	10.14	2.15	3.95	8.46	3.98	2.06	15.20	2.40	2.85	3.95	2.76	3.00	2.05	3.00	6.88	2.60	3.00

Table 4.28

THE E:N, E:T, E:P, EAAI AND C.S/P.S RATIO OF TWO SPECIES OF THE FAMILY CLARIDAE

Fish species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
C. gariepinus	0.85	46.07	122.83	56.54	0.84
C. anguillaris	0.99	49.83	124.71	57.41	0.71

a - Essential to non-essential amino acid ratio
b - Essential amino acid to total nitrogen ratio
c - Essential amino acid index
d - Chemical or protein score
e - Essential amino acid to protein ratio.

Table 4.29

MINERAL CONTENT OF TWO SPECIES OF THE FAMILY CLARIDAE(mg/100g ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
C. gariepinus	3910.2±102.9	638.7±22.6	52.7 ± 5.6	31.3 ± 6.4	260.6±16.7	2.4 ± 0.4	16.2 ± 1.7	18.9 ± 1.6
C. anquillaris	4000.6±100.4	648.4±20.8	57.6 ± 9.3	31.2 ± 5.6	317.0±20.3	2.0 ± 0.3	16.0 ± 1.3	18.7 ± 1.8

4.12 (a) Proximate components of the family Schilbeidae (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Eutropius niloticus* and *Schilbe mystus* are presented in Table 4.30. The highest proximate component observed in the two species was lipid (36.5 ± 2.1 - 40.3 ± 2.31g/100g), followed by protein (32.1 ± 3.11 - 38.9 ± 0.08g/100g) and the least observed was carbohydrate (11.4 ± 1.30 - 12.8 ± 1.40g/100g). The carbohydrate lipid and protein were in the ratio of 1:4:3.

The ash content was significantly different ($P<0.05$) in the two species. The higher value was in *E. niloticus* (13.4 ± 0.9g/100g) and the lower value was observed in *S. mystus* (10.7 ± 1.3g/100g). The organic matter was not significantly different ($P>0.05$) in the two species, however, the higher value was observed in *S. mystus* (89.3 ± 1.30g/100g) and lower value in *E. niloticus* (86.6 ± 1.60g/100g). The carbohydrate contents were also not significantly different ($P>0.05$) but higher value was recorded in *E. niloticus* (12.8 ±1.40g/100g) and lower value in *S. mystus* (11.4 ± 1.30g/100g). The lipid content was significantly different ($P<0.05$) in the two species. The higher value was observed in *E. niloticus* (33.3 ± 2.31g/100g) and lower value in *S. mystus* (30.5 ± 2.1g/100g). The protein content was also significantly different ($P<0.05$) in the two species. The higher protein content was observed in *S. mystus* (49.1 ± 0.08g/100g) and lower value in *E. niloticus* (39.5 ± 3.11g/100g).

The caloric value was also significantly different ($P<0.05$) in the two species, with the higher value recorded in *E. niloticus* (649.28kcal.100g) and lower calory in *S. mystus* (270.04kcal./100g).

(b) **Amino acid composition of the family schilbeidae (g/100g) protein**

The amino acid composition of *E. niloticus* and *S. mystus* are presented in Table. 4.31. The profiles in the two species were observed to be the same but the quantities of the respective amino acids varied significantly ($P<0.05$). The highest amino acid observed in the two species was glutamic acid (12.30 - 15.02g/100g), followed by lysine (9.6 - 10.81g/100g), aspartic acid (9.00 - 9.02g/100g), leucine (6.10 - 6.99g/100g) and arginine (4.15g/100g) in that order. The least amino acid observed was serine (2.02 - 2.66g/100g).

E. niloticus recorded higher lysine (10.81g/100g), histidine (3.86g/100g), arginine (4.15g/100g), aspartic acid (9.02g/100g), serine (2.66g/100g), glutamic acid (15.02g/100g), proline (3.02g/100g), glycine (3.00g/100g), alanine (4.80g/100g), cysteine (4.00g/100g), valine (2.95g/100g), methionine (3.22g/100g), isoleucine (3.06g/100g), leucine (6.99g/100g), tyrosine (3.00g/100g) and phenylalanine (3.05g/100g). *S. mystus* only contained higher threonine (3.00g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for the two species in the family schilbeidae are presented in Table 4.32.

The (E:N) ratio was higher in *S. mystus* (1.08) and lower in *E. niloticus* (1.05). In both species, the (E:N) were above (1.0). The E:T values were in both species above 50.50, the higher value was recorded in *S. mystus* (51.99) while the lower value was recorded in *E. niloticus* (51.26). The EAAI was above 100.00 in both species, the higher value was recorded in *E. niloticus* (137.26) and the lower value was observed in *S. mystus*

(119.73). The C.S/P.S value was below 100.00 in both species, however the higher value was observed in *E. niloticus* (63.19) and the lower value in *S. mystus* (55.12). The E:P value was above 1.00 in both species, the higher value however was recorded in *S. mystus* (1.18) and the lower value was observed in *E. niloticus* (1.12). The values of E:N, E:T, EAAI, C.S/P.S and E:P were not significantly different (P>0.05) in the two species.

(d) **Mineral content of the family Schilbeidae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *E. niloticus* and *S. mystus* are presented in Table 4.33. The highest mineral content observed in both species was Calcium (3290.0 ± 233.8 - 3782.0 ± 266.1mg/100g), followed by Potassium (517.5 ± 23.7 - 616.3 ± 73.2mg/100g), Sodium (280.6 ± 24.7 - 313.7 ± 18.2mg/100g), Magnesium (132.6 ± 32.1 - 145.4 ± 28.3mg/100g) in that order and the least mineral content observed was Copper (3.0 ± 0.6 - 3.6 ± 0.6mg/100g).

E. niloticus recorded higher values of Potassium (161.3 ± 73.2mg/100g), Iron (12.2 ± 2.3mg/100g), Sodium (313.7 ± 18.2mg/100g) and Phosphorus (23.3 ± 2.1mg/100g) while *S. mystus* recorded higher values of Calcium (3782.0 ± 266.1mg/100g), Magnesium (145.4 ± 28.3mg/100g), Copper (3.6 ± 0.6mg/100g) and Zinc (12.0 ± 1.3mg/100g).

There was significant difference (P<0.05) in the contents of Calcium, Potassiu, Iron, Magnesium, Sodium, Copper, Phosphorus and zinc of the two species.

Table 4.30

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF *E. Niloticus* AND *S. Mystus* (SCHILBEIDAE)

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
E. niloticus	75.44	13.4 ± 0.9	86.6 ± 1.60	12.8 ± 1.40	33.3 ± 2.31	39.5 ± 0.08	649.28	100.00
S. mystus	94.72	10.7 ± 1.3	89.3 ± 1.30	10.4 ± 1.30	30.0 ± 2.1	49.1 ± 3.11	570.04	100.00

Table 4.31

AMINO ACID COMPOSITION OF *E. niloticus* AND *S. mystus* (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
E. niloticus	10.81	3.86	4.15	9.02	2.90	2.66	15.02	3.02	3.00	4.80	4.00	2.95	3.22	3.06	6.99	3.00	3.05
S. mystus	9.6	3.60	4.15	9.00	3.00	2.02	12.30	2.10	2.34	3.40	3.70	2.20	3.00	2.90	6.10	2.10	2.04

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Table 4.32

THE E:N E:T E:P RATIO, EAAI AND C.S/P.S OF THE *E. niloticus AND S. mystus*

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
E. niloticus	1.05	51.26	137.26	63.19	1.12
S. mystus	1.08	51.99	119.73	55.12	1.18

a - Essential to non-essential amino acid ratios
b - Essential amino acid to total nitrogen ratio
c - Essential amino acid index
d - Chemical or protein score
e - Essential amino acid to protein ratio.

Table 4.33

MINERAL CONTENTS OF THE FAMILY SCHILBEIDAE (*E. niloticus and S. mystus*)*mg/100g) ASH*

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
E. niloticus	3290.0±233.8	616.3±73.2	12.2±2.3	132.6±32.1	313.7±18.2	3.0±0.6	23.3±2.1	10.1 ± 0.7
S. mystus	3782.0±266.1	517.5±23.7	9.6±1.4	145.4±28.3	280.6±24.7	3.6±0.6	19.7±3.3	12.0 ± 1.3

4.13 (a) Proximate components of the family Citharinidae (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Citharinus citharus* and *Citharinus latus* are present in Table 4.34. The highest proximate component observed in the two species was protein (39.3 ± 1.46 - 40.8 ± 0.88g/100g), followed by lipid (27.7 ± 1.60 - 30.1 ± 0.31g/100g) while the least observed was carbohydrate (16.3 ± 1.70 - 16.7 ± 0.97g.100g. The carbohydrate, lipid and protein were in the ratio of 1:2:3.

The ash content was significantly different ($P<0.05$) in the two species. The higher ash value was recorded in *C. citharinus* (15.1 ± 1.3g/100g) and the lower value in *C. latus* (4.4 ± 0.8g/100g). The organic matter was not significantly different ($P>0.05$) but the higher value was recorded in *C. latus* (85.1 ± 1.06g/100g) and the lower value in *C. citharus* (84.0 ± 1.08g/100g). The carbohydrate content was also not significantly different ($P>0.05$) in the two species, however, the higher value was observed in *C. latus* (16.7 ± 0.97g/100g) and the lower value in *C. citharus* (16.0 ± 1.70g/100g). The lipid content was significantly different ($P<0.05$) in the two species, but the higher value was recorded in *C. citharus* (28.7 ± 0.31g/100g) and the lower value in *C. latus* (28.1 ± 1.60g/100g). The protein content was not significantly different ($P>0.05$) in the two species, but the higher value was observed in *C. latus* (40.8 ± 0.88g/100g) and the lower value in *C. citharus* (39.3 ± 1.46 g/100g). The caloric value was not significantly different ($P>0.05$) in the two species, however, the higher value was observed in *C. latus* (578.82 kcal./100g) and the lower value in *C. citharus* (546.13 kcal./100g).

(b) **Amino acid composition of the family citharinidae (g/100g) protein**

The amino acid corhposition of *C. citharus* and *C. latus* are presented in Table 4.35. The amino acid profiles in the two species were observed to be the same, the quantities varied significantly ($P<0.05$). The highest amino acid observed in the two species was glutamic acid (14.20 - 16.02g/100g), followed by lysine (12.15 - 12.35g/100g), then aspartic acid (8.96 - 10.30g/100g), leucine (6.90 - 7.40g/100g), isoleucine (6.02 - 6.10g/100g) in that order and the least observed was methionine (1.78 - 1.89g/100g).

C. citharus recorded the higher values of lysine (12.35g/100g), serine (5.03g/100g), proline (2.9g/100g), glycine (3.00g/100g), cysteine (5.66g/100g), isoleucine (6.10g/100g) and phenylalanine (4.88g/100g), while *C. latus* recorded higher values of histidine (4.36g/100g), threonine (3.68g/100g), glutamic acid (16.02g/100g), alanine (4.85g/100g), valine (3.89g/100g), methionine (1.89g/100g), leucine (7.40g/100g) and tyrosine (2.50g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for the two species, *C. citharus* and *C. latus* are presented in Table 4.36. The E:N ratio was higher in *C. latus* (1.08) and lower in *C. citharus* (1.02). Both values were above 1.01. The E:T values were also above 50.50 in both species. Higher values was recorded in *C. citharus* (54.95) and lower value in *C. latus* (52.04).

The EAAI value in both species were high, the higher value was recorded in *C. citharus* (153.73) and the lower value in *C. latus* (149.19). The C.S/P.S was higher in *C.*

citharus (70.77) and lower in *C. latus* (68.68). The E:P was also observed higher in *C. citharus* (1.24) and lower in *C. latus* (1.16). The E:N, E:T, E:P, EAAI and C.S/P.S values were generally not significantly different (P>0.05) in the two species.

(d) **Mineral content of the family Citharinidae (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *C. citharus* and *C. latus* are presented in Table 4.37. The higher mineral observed in both species was Calcium (1982.0 ± 110.2 - 1987.7 ± 06.3mg/100g), followed by Potassium (729.4 ± 34.9 - 795.0 ± 36.3mg/100g) then Sodium (309.7 ± 60.3 - 318.7 ± 66.1mg/100g), Iron (44.0 ± 22.7 - 54.2 ± 17.0mg/100g) and Magnesium (40.1 ± 9.9 - 41.0 ± 13.7mg/100g) in that order and the least observed was Copper (23.0 ± 1.4mg/100g).

C. citharus recorded higher values of Iron (54.2 ± 17.0mg/100g), Magnesium (41.0 ± 13.7mg/100g), Phosphorus (23.0 ± 1.4mg/100g) and Zinc (23.6 ± 1.3mg/100g, while *C. latus* recorded higher values in Calcium (1987.7 ± 106.3mg/100g), Potassium (795.0 ± 36.3mg/100g), Sodium (318.7 ± 66.1mg/100g) and Copper (7.2 ± 1.3mg/100g). There was significant different (P<0.05) in the contents of Calcium, Potassium, Iron, and Sodium of the two species.

Table 4.34

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF TWO SPECIES OF THE FAMILY CITHARINIDAE

	g/100 wet weight							
Fish Species	Moisture	Ash	Organi matter	Carbohydrate	Lipid	Protein	Calory	Total
Citharinus citharus	76.82	15.1 ± 0.8	84.3 ± 1.08	16.3 ± 1.70	28.7 ± 1.60	39.3 ± 1.46	546.13	100.00
C. Latus	76.31	14.4 ± 1.3	85.1 ± 1.06	16.7 ± 0.97	28.1 ± 0.31	40.8 ± 0.88	578.82	100.00

Table 4.35

AMINO ACID COMPOSITION OF TWO SPECIES OF THE FAMILY CITHARINIDAE (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Thr	Phe
C. citharus	12.35	3.34	4.90	10.30	2.88	5.03	14.20	2.90	3.00	4.80	5.66	3.11	1.78	6.10	6.90	2.10	4.88
C. latus	12.15	4.36	3.80	8.96	3.68	4.84	16.02	2.46	2.98	4.85	2.76	3.89	1.89	6.02	7.40	2.50	3.00

Table 4.36

THE E:N, E:T, E:P, EAAI AND C.S/P.S RATIO OF TWO SPECIES OF THE FAMILY CITHARINIDAE

Fish Species	E:P[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
C. citharus	1.02	54.95	153.73	70.77	1.24
C. latus	1.08	52.04	149.19	68.68	1.16

a - Essential to non-essential amino acid ratios

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

Table 4.37

MINERAL CONTENT OF TWO SPECIES OF THE FAMILY CITHARINIDAE (mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
C. citharus	1982.0±110.2	729.4±34.9	54.2±13.7	44.0±13.7	309.7±60.3	6.5 ± 0.9	23.0 ± 1.4	23.6 ± 1.3
C. latus	1987.7±106.3	795.0±36.3	44.0±22.7	40.1±9.9	318.7±66.1	7.2 ± 1.3	23.0 ± 1.4	22.6 ± 1.2

4.14 (a) Proximate components of *Lates niloticus* (Family Centropomidae) (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Lates niloticus* are presented in Table 3.48. The highest proximate component observed was protein (46.4 ± 3.21g/100g), followed by lipid (25.4 ± 1.70g/100g) and the least was carbohydrate (10.8 ± 0.89g/100g).

The ash content was relatively low (17.4 ± 0.7g/100g) but recorded high organic matter (82.6 ± 1.44g/100g). The calory was high (546.53 kcal./100g). The carbohydrate, lipid and protein were in the ratio of 1:2:4.

(b) **Amino acid composition of *Lates niloticus* (Family Centropomidae) (g/100g) protein**

The amino acid composition of *Lates niloticus* is shown in Table 4.39. Seventeen amino acids were recorded in *L. niloticus*. The highest amino acid observed was glutamic acid (15.15g/100g), followed by lysine (9.96g/100g), then aspartic acid (8.02g/100g), leucine (5.26g/100g), alanine (4.80g/100g), histidine (3.97g/100g) and glycine (3.90g/100g) in that order and the least observed was isoleucine (2.16g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *L. niloticus* are presented in Table 4.40.

The E:N value (0.96) was also observed to be close to 50.50. The EAAI (122.08) was above 100.00. The C.S/P.S value was 56.20 while the E:P value was 1.03.

(d) Mineral content of *L. niloticus* (family Centropomidae) (mg/100g)

The mean values and standard deviations of the mineral contents of *L. niloticus* are shown in Table 4.41. The highest mineral observed was Calcium (3978.2 ± 107.9mg/100g), followed by Potassium (632.0 ± 28.8mg/100g), then Sodium (353.7 ± 24.1mg/100g), Iron (97.0 ± 8.3mg/100g) and Magnesium (24.7 ± 10.3mg/100g) in that order and the least mineral observed was Copper (1.8 ± 0.4mg/100g).

Table 4.38

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF *L. niloticus* (FAMILY CENTROPOMIDAE)

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
Lates niloticus	75.76	17.4 ± 0.7	82.6 ± 1.44	10.8 ± 0.97	25.4 ± 1.70	46.4 ± 3.21	546.53	100.00

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Table 4.39

AMINO ACID COMPOSITION OF *L. niloticus* (FAMILY CENTROPOMIDAE) (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
L. niloticus	9.96	3.97	2.95	8.02	2.94	2.70	15.15	2.90	3.90	4.80	2.54	3.00	3.04	2.16	5.26	3.12	3.00

Table 4.40

THE E:N E:T E:P EAAI AND C.S/P.S RATIO OF *L. niloticus* (FAMILY CENTROPOMIDAE)

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
L. niloticus	0.96	49.09	122.08	56.20	1.03

a - Essential to non-essential amino acid ratios

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

Table 4.41

MINERAL CONTENT OF *L. Niloticus* (FAMILY CENTROPOMIDAE)

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
L. niloticus	3978.2±107.9	632.0±28.8	97.0±8.3	24.7±10.3	353.7±24.1	1.8±0.4	16.7±2.7	17.8±1.3

4.15 (a) **Proximate components of the family Distichodontidae (g/100g) dry matter**

The mean values and standard deviations for the proximate components and calory of *Distichodus rostratus* and *Distichodus engycephalus* are shown in Table 4.42. The highest proximate component observed in the two species was protein (40.8 ± 2.01 - 41.1 ± 1.66g/100g), followed by lipid (25.3 ± 1.71 - 26.7 ± 2.30g/100g) and the least observed was carbohydrate (10.6 ± 2.00 - 11.3 ± 1.40g/100g). The carbohydrate, lipid and protein were in the ratio of 1:2:4.

The ash content was not significantly different ($P>0.05$) in the two species. The higher value was recorded in *D. engycephalus* (20.0 ± 1.7g/100g) and the lower value in *D. rostratus* (19.9 ± 1.6g/100g). The organic matter was also not significantly different ($P>0.05$) in the two species, however, higher value was recorded in *D. engycephalus* (80.1 ± 1.87g/100g) and the lower value in *D. rostratus* (80.0 ± 3.20g/100g). Carbohydrate content was not significantly different ($P>0.05$). The higher value was observed in *D. engycephalus* (11.3 ± 1.40g/100g) and the lower value in *D. rostratus* (10.6 ± 2.0g/100g). The two species had relatively high lipid contents and was not significantly different ($P>0.05$). Higher lipid content was observed in *D. rostratus* (26.7 ± 2.30g/100g) and lower in *D. engycephalus* (26.6 ± 1.71g/100g). Protein content was not significantly different ($P>0.05$) in the two species, but higher content was recorded in *D. engycephalus* (43.1 ± 1.66g/100g) and lower content in *D. rostratus* (42.8 ± 2.01g/100g). The two species had high calory values. The higher calory value was recorded in *D. rostratus* (521.51 kcal./100g) and lower calory in *D. engycephalus* (512.73 kcal./100g).

(b) **Amino acid composition of the family Distichodontidae (g/100g) protein**

Amino acid composition of *D. rostratus* and *D. engycephalus* are presented in Table 4.43. The amino acid profiles were the same in the two species but the quantities were not significantly different (P>0.05).

The highest amino acid observed in the two species was glutamic acid (12.86 - 14.60g/00g), followed by lysine (10.98 - 11.00g/100g) then aspartic acid (11.38 - 11.40g/100g), alanine (8.00 - 8.92g/100g), valine (5.08 - 5.41g/100g), arginine (5.20 - 60.00g/100g) and the least observed was tyrosine (2.00 - 3.15g/100g).

D. rostratus recorded higher values of lysine (11.00g/16gN), histidine (4.02g/100g), threonine (3.68g/100g), serine (4.85g/100g), glycine (8.41g/100g), alanine (8.92g/100g), cysteine (4.02g/100g), valine (5.41g/100g), methionine (3.88g/100g) and leucine (5.80g/100g), while *D. engycephalus* recorded higher arginine (6.00g/100g), aspartic acid (11.40g/100g), glutamic acid (14.60g/100g), proline (3.10g/100g), isoleucine (5.00g/100g), tyrosine (3.15g/100g) and phenylalanine (3.25g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *D. rostratus* and *D. engycephalus* are presented in Table 4.44.

The E:N ratio was higher in *D. rostratus* (0.82) and lower in *D. engycephalus* (0.81). The E:T ratio however, was higher in *D. engycephalus* (49.44) and lower in *D. rostratus* (45.33). The EAAI were above 100.00 in both species, but higher in *D. rostratus* (141.93) and lower in *D. engycephalus (140.83.* The C.S/P.S were below 100.00 in both

species, but higher in *D. rostratus* (65.34) and lower in *D. engycephalus* (64.83). The E:P were above 1.00 in both species. The higher value was recorded in *D. rostratus* (1.11) and lower value in *D. engycephalus* (1.09.

The values of E:N, E:T, EAAI, C.S/P.S and E:P were not significantly different (P>0.05) in the two species.

(d) Mineral content of the family Distichodontidae (mg/100g)

The mean values and standard deviations of the mineral contents of *D. rostratus* and *D. engycephalus* are presented in Table 4.45. The highest mineral observed in the two species was Calcium (5186.0 ± 118.3 - 5242.0 ± 107.7mg/100g), followed by Potassium (768.0 ± 26.5 - 780.2 ± 25.3mg/100g), then Sodium (350.7 ± 11.3 - 360.2 ± 18.1mg/100g), Iron (54.9 ± 20.3 - 54.9 ± 21.6mg/100g) and Magnesium (37.8 ± 8.2 - 40.3 ± 6.8mg/100g) while the least mineral observed was Copper (4.5 ± 0.3 - 5.3 ± 0.8mg/100g).

D. rostratus recorded higher contents of Magnesium (40.3 ± 6.8mg/100g), Sodium (360.2 ± 18.1mg/100g), Copper (5.3 ± 0.8mg/100g, Phosphorus (14.9 ± 1.1mg/100g) and Zinc (17.1 ± 1.0mg/100g), while *D. engycephalus* recorded higher contents of Calcium (5242.0 ± 107.7mg/100g), Potassium (780.2 ± 25.3mg/100g) and Iron (54.9 ± 21.6mg/100g).

The contents of calcium, Potassium and Sodium were significantly different (P<0.05) in the two species.

Table 4.42

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF TWO SPECIES OF THE FAMILY DISTICHODONTIDAE

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
D. Rostratus	72.86	19.9 ± 1.6	80.1 ± 3.20	10.6 ± 2.00	26.7 ± 2.30	42.8 ± 2.01	521.51	100.00
D. engycephalus	73.46	20.0 ± 1.7	10.0 ± 1.87	11.3 ± 1.40	25.6 ± 1.71	42.1 ± 1.66	512.73	100.00

Table 4.43

AMINO CID COMPOSITION OF TWO SPECIES OF THE FAMILY DISTICHODONTIDAE (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
D. rostratus	11.00	4.02	5.20	11.38	3.68	4.85	12.86	3.04	8.41	8.92	4.02	5.41	3.88	2.46	5.80	2.00	3.02
D. Engycephalus	10.98	3.96	6.00	11.40	2.60	3.96	14.60	3.10	7.85	8.00	3.00	5.08	2.40	5.00	4.96	3.15	3.25

Table 4.44

THE E:N, E:T, E:P, EAAI AND C.S/P.S RATIO OF FAMILY DISTICHODONTIDAE

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
D. Rostratus	0.82	45.33	141.93	65.34	1.11
D. Engycephalus	0.81	49.44	140.83	64.83	1.09

a - Essential to non-essential amino acid ratios
b - Essential amino acid to total nitrogen ratio
c - Essential amino acid index
d - Chemical or protein score
e - Essential amino acid to protein ratio.

Table 4.45

MINERAL CONTENT OF TWO SPECIES OF THE FAMILY DISTICHODONTIDAE(mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
D. Rostratus	5186.0±118.3	768.0±26.5	54.9±20.3	40.3±6.87	360.2±18.1	5.3 ± 0.8	14.9 ± 1.11	17.1 ± 1.0
D. Engycephalus	5242.0±107.7	780.2±25.3	54.9±21.6	37.8±8.2	350.7±11.3	4.5 ± 0.3	14.8 ±1.2	16.2 ± 0.8

4.16 (a) Proximate components of *Gymnarchus niloticus*

(Family Gymnarchidae) (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Gymnarchus niloticus* are presented in Table 4.46. The highest proximate component observed was protein (38.1 ± 2.15g/100g), followed by lipid (30.0 ± 3.10g/100g) and the least observed was carbohydrate (11.5 ± 1.30g/100g). The ash content was relatively low (19.7 ± 1.2g/100g) but the organic matter was high (80.3 ± 2.06g/100g). The carbohydrate, lipid and protein contents were in the ratio of 2:5:6. The calory was high (541.70 kcal./100g).

(b) **Amino acid composition of *Gymnarchus niloticus***

(family Gymnarchidae) (g/100g) protein

The amino acid composition of *G. niloticus* is shown in Table 4.7. Seventeen amino acids were recorded in *G. niloticus*. The highest amino acid observed was glutamic acid (12.63g/100g), followed by lysine (8.48g/100g) then aspartic acid (8.98g/100g), leucine (5.46g/100g), alanine (4.90g/100g), arginine (4.75g/100g) and serine (4.29g/100g) in that order, while the least amino acid observed was threonine (2.45g/100g).

(c) **Chemical indices**

The essential to non- essential amino acid (E:N), the essential to total nitrogen (E:T) and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *G. niloticus* are presented in Table 4.48. The E:N value (1.03) was higher than 1.01, while the E:T value (51.10) was also above 50.50. The EAAI (140.33) was also above 100.00. The C.S/P.S value (64.60) was below 100.00 while the E:P value (1.17) was above 1.00.

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(d) **Mineral contents of *G. niloticus* (family Gymnarchidae) (mg/100g)**

The mean values and standard deviations of the mineral contents of *G. niloticus* are shown in Table 4.49. The highest mineral observed was Calcium (2672.0 ± 117.5mg/100g), followed by Potassium (955.4 ± 44.9mg/100g), then Sodium (358.3 ± 17.9mg/100g), Iron (56.7 ± 11.5mg/100g), Magnesium (44.6 ± 6.4mg/100g) and the least mineral observed was Copper (6.5 ± 0.8mg/100g).

Table 4.46

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF *G. niloticus*

(FAMILY GYMNARCHIDAE)

	g/100 wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
G. niloticus	78.89	19.7 ± 1.2	80.3 ± 2.06	11.5 ±1.30	30.0 ± 3.10	38.1 ± 2.15	541.70	100.00

Table 4.47

AMINO ACID COMPOSITION OF *G. niloticus* (FAMILY CENTROPOMIDAE) (g/100g) PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
G. niloticus	9.96	3.97	2.95	8.02	2.94	2.70	15.15	2.90	3.90	4.80	2.54	3.00	3.04	2.16	5.26	3.12	3.00

Table 4.48

THE E:N, E:T, E:P, EAAI AND C.S/P.S RATIO OF *G. niloticus* (FAMILY GYMNARCHIDAE)

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
G. niloticus	1.03	51.10	140.33	64.60	1.17

a - Essential to non-essential amino acid ratios

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

Table 4.49

MINERAL CONTENT OF *G. niloticus* (FAMILY GYMNARCHIDAE)(mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
G. niloticus	2672.0±177.5	955.4±44.9	56.7±11.5	44.6±6.4	358.2±17.9	6.5±0.8	13.2±1.5	22.0±1.2

4.17 (a) **Proximate components of *Heterotis niloticus***

(family Osteoglossidae) (g/100g) dry matter

The mean values and standard deviations for the proximate components and calory of *Heterotis niloticus* are presented in Table 4.50. The highest proximate component observed was protein (39.3 ± 1.11g/100g), followed by lipid (25.4 ± 1.90g/100g) while the least observed was carbohydrate (22.2 ± 1.03g/100g). The ash content was relatively high (15.n7 ± 0.9g/100g). The organic matter was also high (84.3 ± 1.08g/100g). The carbohydrate, lipid and protein were in the ratio of 2:2:3. The calory was high (540.12 kcal./100g).

(b) **Amino acid composition of *Heterotis niloticus***

(Family osteoglossidae) (g/100g) protein

The amino acid composition of *H. niloticus* is shown in Table 4.51. Seventeen amino acids were recorded. The highest observed was glutamic acid (18.00g/100g), followed by lysine (12.04g/100g), then aspartic acid (9.70g/100g), isoleucine (6.12g/100g), leucine (6.02g/100g), serine (5.02g/100g) and glycine (4.88g/100g), the least observed was tyrosine (2.30g/100g).

(c) **Chemical indices**

The essential to non-essential amino acid (E:N), the essential to total nitrogen (E:T), and essential amino acid to protein (E:P) ratios, the essential amino acid index (EAAI) and the chemical/protein scores (C.S/P.S) values for *H. niloticus* are shown in Table 4.52. The E:N value (0.91) was below 1.01, while the E:T value (47.73) was also below 50.50. The EAAI (138.70) was above 100.00, however, the C.S/P.S value (63.85) was below 100.00. The E:P value (1.15) was above 1.00.

(d) **Mineral content of *H. niloticus* (family Osteoglossidae) (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *H. niloticus* are shown in Table 4.53. The highest mineral observed was Calcium (2100.8 ± 115.6mg/100g), followed by Potassium (782.4 ± 57.7mg/100g) then Sodium (476.6 ± 26.4mg/100g), Iron (55.6 ± 16.6mg/100g), Magnesium (42.7 ± 5.2mg/100g) in that order and the least mineral observed was Copper (6.8 ± 1.3mg/100g).

Table 4.50

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF *H. niloticus* (FAMILY OSTEOGLOSSIDAE)

	g/100g wet weight							
Fish Species	76.42	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
H. niloticus		15.7 ± 0.9	84.3 ± 1.08	22.2±1.03	25.4 ±1.90	38.3 ± 1.11	540.12	100.00

Table 4.51

AMINO ACID COMPOSITION OF *H. niloticus* (FAMILY OSTEOGLOSSIDAE) (g/100g PROTEIN

Fish Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
H. niloticus	12.04	2.60	4.00	9.70	2.41	5.02	18.00	2.90	4.88	4.00	2.50	4.85	2.46	6.12	6.02	2.30	3.00

Table 4.52

THE E:N, E:T, E:P, EAAI AND C.S/P.S RATIO OF *H. niloticus* (FAMILY OSTEOGLOSIDAE)

Fish Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P[e]
H. niloticus	0.91	47.73	138.70	63.85	1.15

a - Essential to non-essential amino acid ratios

b - Essential amino acid to total nitrogen ratio

c - Essential amino acid index

d - Chemical or protein score

e - Essential amino acid to protein ratio.

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Table 4.53

MINERAL CONTENT OF *H. niloticus* (FAMILY OSTEOGLOSIDAE)(mg/100g) ASH

Fish Species	Calcium	Potassium	Iron	Magnesium	Sodium	Copper	Phosphorus	Zinc
H. niloticus	2100.0±115.6	782.4±57.7	55.6±16.6	42.7±5.2	476.6±26.4	6.8±1.3	9.6 ±1.0	25.8±2.3

4.18 (a) **Proximate components of *Malapterurus electricus* (family Malapteruridae) (g/100g) dry matter**

The mean values and standard deviations for the proximate components and calory of *M. electricus* are presented in Table 4.54. The highest proximate component observed was lipid (32.0 ± 1.00g/100g), followed by protein (37.6 ± 5.30g.100g) and the least was carbohydrate (18.5 ± 1.30g/100g). The ash content was relatively low (12.1 ± 3.2g/100g) while the organic matter was high (88.0 ± 0.23g/100g). The calory was also very high (713.00 kcal./100g). The carbohydrate, lipid and protein were in the ratio of 1:2:2.

(b) **Mineral content of *M. electricus* (family Malapteruridae) (mg/100g) ash**

The mean values and standard deviations of the mineral contents of *M. electricus* are shown in Table 4.55. The highest mineral observed was Calcium (1490.2 ± 208.4mg/100g), followed by Potassium (445.5 ± 90.6mg/100g) then Sodium (270.1 ± 25.2mg/100g), Magnesium (68.1 ± 9.3mg/100g) and Iron (28.6 ± 3.7mg/100g) and the least observed was Copper (2.1 ± 0.4mg/100g).

Table 4.54

PROXIMATE COMPONENTS (g/100g) DRY MATTER AND CALORY (k.cal/100g) OF *M. electricus*

(FAMILY MALAPTERURIDAE)

	g/100g wet weight							
Fish Species	Moisture	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory	Total
M. electricus	74.83	12.1 ±3.2	80.0 ± 0.23	18.5 ±1.30	38.0 ±1.00	37.6 ± 5.30	713.00	100.00

4.19 Effects of selected locations and seasons on the nutrient composition of fresh water fish families

(a) **Locations**

There were generally no significant differences ($P>0.05$) in the contents of the proximate components, amino acids and minerals in the fourteen fresh water fish families viz: *Cichlidae*, Bagridae, Mochokidae, Cyprinidae, Characidae, Mormyridae, Clariidae, Schilbeidae, Citharinidae, Centropomidae, Distichodontidae, Gymnarchidae, Osteoglossidae and Malapteruridae from the four locations (Niger - Benue confluence, Shiroro dam, Zaria dam and Tiga dam).

(b) **Seasons (June - September rainy period, December - March dry period**

(i) Family Cichlidae

The ash, carbohydrate and calory were highly significant ($P<0.05$) in the four species during the rainy season, while the organic matter, lipid and protein were highly significant ($P<0.05$) during the dry season.

The quantities of lysine, aspartic acid, threonine, glutamic acid, proline, glycine, cysteine, valine, methionine, isoleucine and tyrosine were unaffected by the two seasons in the four species, however, histidine, serine, leucine and phyenylalanine were significantly ($P<0.05$) higher during the rainy seasons in the four species. Calcium, Potassium and Zinc contents were highly significant ($P<0.05$) during the dry season in four species. Iron, Magnesium, Sodium, Copper and Phosphorus contents were

unaffected by the two seasons in the four species (Appendices 1 - 12).

(ii) Family Bagridae

The organic matter, lipids, protein and calory were highly significant ($P<0.05$) during the rainy season. The contents of ash and carbohydrate in the eight species were unaffected by the two seasons.

The quantities of histidine, arginine, glycine, methionine and phenylalanine were highly significant ($P<0.05$) during the rainy season in the eight species. Other amino acids were unaffected by the two seasons.

The contents of Potassium, Iron, Magnesium, Sodium, Copper, Phosphorus and Zinc were highly significant ($P<0.05$) during the rainy season. Calcium content was unaffected by the two seasons in all eight species. (Appendices 1 - 12).

(iii) Family Mochokidae

The organic matter, ash, carbohydrate, lipid and calory were not significantly ($P>0.05$) higher during the rainy season. However, the protein was highly significant ($P<0.05$) during the rainy season in the six species. The lysine, histidine, arginine, aspartic acid, threonine, alanine, cysteine, valine, methionine, isoleucine and tyrosine were unaffected by the two seasons in the six species. The glutamic acid was highly significant during the dry season while proline, glycine, leucine, and phenylalanine were highly significant ($P<0.05$) in the six species during the rainy season.

The contents of Calcium, Iron, Magnesium, Copper, and Zinc were significantly ($P<0.05$) higher in the six species during the rainy season while Potassium, Sodium and Phosphorus in the six species were unaffected by the two seasons.

(iv) Family Cyprinidae

The contents of ash, organic matter and carbohydrate in the three species were unaffected by the two seasons. The lipid and protein were highly significant ($P<0.05$) in the three species during the rainy season. The contents of histidine, arginine, serine, glycine and phenylalanine in the three species were highly significant ($P<0.05$) during the rainy season. The rest amino acids were unaffected by season. The contents of calcium, potassium, sodium, magnesium, phosphorus, iron, copper and zinc were highly significant ($P<0.05$) in the three species during the rainy season.

(v) Family Characidae

The contents of ash, organic matter, lipid, protein and calory were highly significant ($P<0.05$) in the four species during the rainy season. Only carbohydrate was highly significant ($P<0.05$) in the four species during the dry season. The contents of arginine, serine, glycine, alanine, isoleucine, leucine, tyrosine and phenylalanine were highly significant ($P<0.05$) in the four species during the rainy season. All the other amino acids were unaffected by the two seasons in the four species.

The contents of calcium, potassium, sodium, copper, and zinc in the four species were found to be highly significant ($P<0.05$) during the rainy season, other minerals were unaffected by season.

(vi) Family Mormyridae

The content of ash and carbohydrate in the three species were unaffected by the two seasons. However, the content of organic matter, lipids, protein and calory were highly significant ($P<0.05$) during the rainy season in the three species.

The contents of lysine, histidine, aspartic acid, threonine, serine, glutamic acid, proline, alanine, cysteine, valine, methionine, isoleucine, tyrosine, and phenylalanine does not change in the three species during the two seasons. Arginine and leucine were highly significant ($P<0.05$) in the three species during the rainy season, while glycine was higher during the dry season. The contents of calcium, iron, magnesium, sodium, copper and phosphorus were highly significant ($P<0.05$) during the rainy season while potassium was higher during the dry season and zinc was unaffected by season in the three species.

(vii) Family Claridae

The contents of ash, organic matter, carbohydrate, lipid and calory were unaffected by the two seasons in the two species, protein was however, higher during the rainy season but insignificant ($P>0.05$).

The contents of arginine, serine, glycine, isoleucine, and phenylalanine were highly significant ($P<0.05$) during the rainy season, all other amino acids were unaffected by the two seasons in the two species.

The contents of calcium, potassium, magnesium, copper and phosphorus were highly significant ($P<0.05$) in the two species during the rainy season while iron and sodium were highly significant ($P<0.05$) during the dry season.

(viii) Family Schilbeidae

The contents of ash, organic matter, carbohydrate, lipid, protein and calory were unaffected by the two seasons in the two species.

The contents of histidine, serine, glycine and phenylalanine were highly

significant ($P<0.05$) during the rainy season, all other amino acids were unaffected by season in the two species.

There were no significant differences ($P>0.05$) in the contents of calcium, potassium, iron, magnesium, sodium, copper, phosphorus and zinc in the two species for the two seasons.

(ix) *Family Citharinidae*

The contents of ash, organic matter, and protein were highly significant ($P<0.05$) during the rainy season while the contents of carbohydrate, lipid and calory were unaffected significantly ($P>0.05$) in the two species for the two seasons.

The contents of histidine, serine, glycine, cysteine and isoleucine were highly significant ($P<0.05$) during the rainy season, while all the other amino acids were not significantly ($P>0.05$) affected by the two seasons.

The contents of calcium, potassium, sodium, phosphorus, magnesium, copper and zinc were highly significant ($P<0.05$) during the rainy season.

(x) Family Centropomidae

There were generally no significant differences ($P>0.05$) in the contents of ash, organic matter, lipid, carbohydrate, protein and calory in *L. niloticus* for the two seasons. The contents of histidine, arginine, serine, glycine, leucine and phenylalanine were highly significant ($P<0.05$) during the rainy season. All other amino acids were unaffected by the seasons. The contents of iron, magnesium, and zinc were insigificantly ($P>0.05$) higher during the dry season, while calcium, sodium, phosphorus, potassium and copper were highly significant ($P<0.05$) during the rainy season.

(xi) Family Distichodontidae

The content of ash was highly significant ($P<0.05$) during the dry season in the two species, however, the contents of organic matter, lipid, protein and calory were highly significant ($P<0.05$) during the rainy season in the two species.

The contents of glycine and leucine were highly significant ($P<0.05$) during the rainy season, all the other amino acids were unaffected by the two seasons.

The contents of iron, magnesium and phosphorus were highly significant ($P<0.05$) during the rainy season. Calcium, sodium, copper and zinc were unaffected by the two seasons. Potassium was highly significant ($P<0.05$) during the dry season.

(xii) Family Gymnarchidae

The contents of ash, organic matter, carbohydrate, protein and calory were highly significant ($P<0.05$) during the rainy season in *G. niloticus*. The lipid content was highly significant ($P<0.05$) during the dry season. The contents of arginine, serine, leucine and phenylalanine were highly significant ($P<0.05$) during the rainy season. All other amino acids were unaffected by the two seasons. The contents of calcium, magnesium, phosphorus and zinc were highly significant ($P<0.05$) during the rainy season while iron, potassium and sodium were significantly higher ($P<0.05$) during the dry season.

(xiii) Family Osteoglossidae

The contents of ash, organic matter, carbohydrate, lipid, protein and calory of *H. niloticus* were highly significant ($P<0.05$) during the rainy season. The contents of arginine, serine, glycine, tyrosine and phenylalanine were highly significant ($P<0.05$)

during the rainy season. Only isoleucine was higher during the dry season. All other amino acids were unaffected by the two seasons.

The contents of calcium, sodium, potassium, phosphorus, magnesium, copper and zinc were highly significant ($P<0.05$) during the rainy season.

(xiv) Family Malapteruridae

The contents of ash, organic matter, lipid, protein and calory in *M. electricus* were highly significant ($P<0.05$) during the rainy season while the carbohydrate content was unaffected by season. The contents of calcium, potassium, sodium and phosphorus were highly significant ($P<0.05$) during the rainy season. Magnesium, copper and zinc were unaffected by season.

CHAPTER FIVE

5.0 DISCUSSION

The results of this study indicated that fresh water fish families generally contain high protein, lipid and ash but low contents of carbohydrate. The nutrient components were generally in the ratios of 1:1:3:5 of ash, carbohydrate, lipid and proteins. The dominance of crude protein and the least contents of carbohydrate showed that they are not suitable as ready sources of dietary carbohydrate. The results of the nutrient contents did not differ very much from those reported in some families by Afolabi et al (1984) on Clariidae, Abolude (1988) on Bagridae, Mochokidae, Characidae, Clariidae and Cichlidae, Otitologbon et al (1997) on Cichlidae, Mormyridae and Clariidae and Eyo (1990) on Cichlidae.

The ash contents were generally in the range of (10.6 - 26.0mg/100g) of dry matter, this was attributed to the high contents of Calcium - Potassium - Phosphorus complex which form the major components of the bony structures (Adegboye, 1980). The fresh water fish families are therefore good sources of dietary minerals. However, the low ash contents recorded in the families Claridae and Malapteruridae were similarly reported (Otitologbon et al, 1997). This was attributed to the higher contents of organic matter which could act as dispersing medium, thereby reducing the ash content per 100g of the homogenous dry matter, since the families are known to have enormous skeletal system as reported by Ogbe (1985). However, Adegboye (1980) argued that the quantity of ash in the dry matter is not synonymous to the skeletal system but the tissues and organs analysed. Similarly, Oni (1979) attributed the low ash contained in the families Characidae, Cichlidae and Centropomidae to the protein-rich muscles

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analysed.

The high protein content (25.6 - 56.4g/100g) in the fresh water fishes coupled with the low carbohydrate (12.0 - 24.6g/100g) makes the fresh water fishes ready sources of dietary protein since high carbohydrate spare protein for maximum utilization (Ufodike and Matty, 1983). The high carbohydrate contents of the family Cichlidae except species *Hemichromis fasciatus* was attributed to the secretion of cellulose and galactosidase enzymes by members of the family (Chow and Halver, 1980). This leads to higher digestion of the vegetable matter consummed and subsequent assimilation of products into body tissues (Chow and Halver, 1980). Since carbohydrate is a more effective energy source, the Cichlids are dependable and easily metabolised, and ready sources of dietary energy.

Similar quantities of carbohydrate were reported in some families. Afolabi et al (1984) in Clariidae and Cichlidae and Olatunde (1980) in Schilbeidae.

The range of lipid (23.6 - 41.4g/100g) indicated that fresh-water fishes are good sources of dietary fish oils and subsequently fat soluble vitamins A,D,E,K, (Bhuiyan et al, 1993 and Qyvind et al, 1994) most especially in the families Characidae and Malapteruridae. The report of the present work differs from those of Lagler et al (1962) in which the families Schilbeidae and Clariidae were reported to contain more fat than any other fresh water fish. The whole de-gutted body used in the present work could be responsible for the variation. However, the present result is in the range of those reported by Olatunde (1980) in Schilbeidae, Al-Ogaily et al (1996) in Cichlidae and Eyo (1990). The higher lipid contents reported by Abolude (1988) in Bagridae, Mochokidae, Characidae, Clariidae and Cichlidae was attributed to the protein-rich muscles used rather than the whole eviscerated body. Fishes with

very high lipid are known for poor storage due to oxidative rancidity (Otitologbon et al, 1996), but as good source of energy they also help to spare protein in the diets (Deelstra et al, 1974).

The high calories (480 - 620 kcal/100g) recorded in the fresh-water fish families, suggests that even though the carbohydrate contents were low, the lipid contents contributes a lot to the energy values. The values for the calories were comparable with that of Olatunde (1980) in Schilbeidae, Eyo (1990) in Cichlidae and Abolude (1988) in Bagridae, Mochokidae, Characidae and Clariidae respectively but lower than reported by Oni (1979) in Cichlidae, Characidae and Mochokidae because of the protein rich muscles used.

The importance of protein depends on its component amino acids especially the essential amino acids (Freedhand and Briggs, 1977). The results of this study showed that the fresh-water fish families contained high quantities of essential amino acids in good proportions for human beings and other animals (Peterson, 1978). The dominance of glutamic acid in the amino acid pool and the presence of methionine as minor amino acid in the fresh-water fish families except Malapteruridae agreed with those reported by Duggal and Eggum (1977) in marine fish species, Otitologbon et al (1997) and Afolabi et al (1984) in Clariidae, and Cichlidae. However, the present results are not comparable with the reports of Sadiku and Oladimeji (1989) on amino acid contents of *L. niloticus*, *S. schall* and *S. galilaeus* in which cysteine and tryptophan were in minor quantities. This is attributable to the methods used (acid hydrolysis) which does not recover all cysteine and tryptophan in the hydrolysate. The high nutritive values based on the high contents of the essential amino acids and the nitrogen of the non essential amino acids was further confirmed from the calculated values of the chemical scores and indices which were above the standard egg values (FAO/WHO, 1973). Higher

protein content does not indicate higher essential amino acid content (Peterson, 1978). Species differences were also indicated by differences in the quantities of amino acids.

The results showed that fresh-water fish families contain higher proportions of essential amino acids than is the case reported in other animal proteins reported by Maynard et al (1978) and also fall within the limits of those recommended for children and adult by FAO/WHO, (1973)

Calcium contributes more to the mineral pool of the fresh-water fishes while the least importance was copper which invariably is a heavy metal. The quantities of the minerals especially Calcium, Potassium and Phosphorus were comparable with those reported by Adegboye (1980) in Cichlidae, Adeyeye et al (1996), Gwaza (1992), Oshodi and Ipimoroti (1994) and Oritologbon et al (1997) in Cichidae, Clariidae and Mormyridae respectively.

Although the level of zinc and copper were relatively high in Mormyridae, Osteoglossidae and Citharinidae, they fall below the recommended safe level by FAO/WHO (1962). It is possible that such metals could have been trapped in the gills during feeding and or taken along with sediments containing them in the diets.

Seasonal variations in nutrient contents of fishes is essentially a reflection of nutrient availability and physiological activities such as gonad development and egg production (Quayam, 1984). The results of this study indicated that variations exist in the nutrient contents of the various families and species in the two seasons. The higher contents of the proximate component in the fresh-water fish families except the families Schilbeidae, Cyprinidae and Clariidae in the wet season suggests higher intake of the available dietary items, their digestion and subsequent deposition in the body tissues. Qasim (1988) similarly reported

the deposition of lipids around the gonads during the wet season in *Ophicephalus punctatus* and attributed this to increased intake of dietary items.

Seasonal variation in amino acids content were prominent, as in the higher contents of arginine, histidine, serine, methionine, phenylalanine cysteine, isoleucine and tyrosine during the wet season. This was probably due to break-down of protein to their respective amino acid components and their selective utilization for physiological processes such as gonad development and egg formation. Sadiku and Oladimeji (1989) similarly reported such variation in amino acid contents of the families Centropomidae, Mochokidae and Cichlidae. The variations in the amino acid content demonstrated the possibility of higher requirements for certain amino acids during the wet seasons. Mineral contents in the fishes were also variable in the two seasons, especially the higher contents of Calcium, Potassium, Magnesium and Phosphorus during the wet season. Apart from the fact that run offs from surrounding environments introduce minerals into the water bodies, there could be accumulation in some tissues like the gills arising from feeding processes. Besides, there could be increased demand by fishes for such minerals to meet up changes in physiological activities during the wet season.

Locations generally does not show remarkable effects on the nutrient contents of the fresh-water fish families, the nutrient composition of the body tissues are reflections of available diets consummed. Adeniji and Mbagwu (1990) observed that available diets to fishes are influenced by a combination of limnological and meteorological factors and that any water body in similar geographical location, stand to have very little variation in fish diets hence the nutrient compositions.

CHAPTER SIX

SUMMARY AND CONCLUSION

The nutrient composition of fourteen fresh-water fish families comprising of forty species from four locations of Northern Nigeria were analysed using standard procedures for both rainy and dry seasons. The fourteen families investigated were Cichlidae, Bagridae, Mochokidae, Cyprinidae, Characidae, Mormyridae, Claridae, Schilbeidae, Cithanrinidae, Centropomidae, Osteoglossidae, and Malapteruridae in their order of numerical magnitude of total sample collected.

The dry matter composition of the fresh-water fish families indicated high protein content, followed by lipid, carbohydrate and the least contained was ash. The caloric values were generally high in all the fish families. The profiles of amino acids were the same in all the fish families and species, however variations occured in the quantities of amino acids betwen species of the same family. Although the highest amino acid contained was glutamic acid, then lysine, the quantities of the essential amino acids were within the FAO/WHO (1973) recommended range for humans of all ages. The superiority of the fish proteins, over other sources was confirmed by the high values of the chemical scores and indices. The mineral composition also revealed that Calcium dominated the mineral pool followed by Potassium and the least was Copper. The fishes were a dependable source of dietary minerals.

The respective nutrients were observed in highest quantities or significantly higher out of the fourteen families, in different families such as, ash (Cyprinidae), organic matter (Claridae), carbohydrate (Cichlidae, lipid (Characidae), protein (Mormyridae, calory (Schilbeidae). The amino acids were in highest quantieis as, histidine (Bagridae), lysine (Citharinidae), arginine (Cyprinidae), aspartic acid (Distichodontidae), threonine (Characidae), serine (Osteoglossidae), glutamic acid (Steoglossidae), proline (Chichlidae), alanine (Distichodontidae), cystine (Characidae), glycine (Distichodontidae), valine (Distichodontidae),

methionine (Gymnarchidae), isoleucine (Osteoglossidae), leucine (Characidae), (Gymnarchidae).

The mineral contents were in highest quantities in the following families as follows: calcium (Distichodontidae), Potassium (Gymnarchidae,), Iron (Gymnarchidae), Magnesium (Cyprinidae), Sodium (Cyprinidae), Copper (Osteoglossidae), Phosphorus (Mormyridae), Zinc (Mormyridae and Osteoglossidae).

Apart from the families Cyprinidae, Schilbeidae, Mochokidae, Centropomidae, Claridae and Distichodontidae all other families contained higher proximate components during the wet seasons, however all fourteen families were observed to contain higher histidine, arginine, serine, glycine, leucine, isoleucine and phenylalanine, as well as Calcium, Potassium, Magnesium and Phosphorus during the wet season. These reveal that these nutrients were probably required for the physiological activities during the wet season and could have fed better with availability of more food during the wet season.

RECOMMENDATIONS

In view of the high rate of infant mortality in developing nations, including Nigeria resulting from malnutritional disorders, it is recommended as immediate remedy the incorporation of fresh-water fish in the diets of infants and mal-nurished adults.

The food industrialists should consider the use of fresh-water fish in supplimenting the plant sources of nutrients in the preparation of infant formulated food because of the high nutritional values of the fresh-water fishes.

The high contents of methione and lysine should also be used in the supplimentation of animal feeds in short supply of these amino acids.

The fresh-water fish families contain all ten essential amino acids in desirable concentrations for human beings, as well as excellent source of fish oils for various uses by human beings.

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KEY TO APPENDICES I - 12

FAMILY	SPECIES
A Cyprinidae	A1 *Labeo coubie (Ruppell)* A2 *Labeo senegalensis* (Cuvier) A3 *Barbus occidntalis* (Boulenger)
B Mormyridae	B1 *Mormyrus rume* (Cuvier and Valenciennes) B2 *Mormyrops deliciosus* (Leach) B3 *Hyperopisus bebe* (Gunther)
C Bagridae	C1 *Auchenoglanis occidentalis* (Cuvier and Valenciennes) C2 *Chrysichthys nigrodigitatus* (Lacepede) C3 *Chrysichthys furcatus* (Gunther) C4 *Chrysichthys auratus* (Pfaff) C5 *Bagrus bayad* (Daget) C6 *Bagrus docmac* (Daget) C7 *Bagrus filamentosus* (Daget) C8 *Clarotes laticeps* (Ruppell)
D Schilbadae	D1 *Eutropius niloticus* (Ruppell) D2 *Schilbe mystus* (Linnaeus)
E Characidae	E1 *Alestes nurse* ((Rupppell) E2 *Hydrocynus brevis* (Gunther) E3 *Alestes macrolepidotus* (Peters) E4 *Hepsetus odoe* (Bloch)
F Mochodidae	F1 *Synodontis schall* (Bloch and Schneider) F2 *Synodontis clarias* (Linnaeus) F3 *Synodontis budgetti* (Boulenger) F4 *Synodontis membranaceus* (Geoffroy) F5 *Synodontis melanopteus* (Boulenger) F6 *Synodontis filamentosus* (Boulenger)
G Malapteruridae	G1 *Malapterurus electricus* (Gmelin)
H Centropomidae	H1 *Lates niloticus* (Linnaeus)
I Claridae	I1 *Clarias gariepinus* (Linnaeus) I2 *Clarias anguillaris* (Geoffroy)

J Cichlidae	J1 *Oreochronis niloticus* (Peters) J2 *Tilapia zilli* (Gervais) J3 *Sarotherodon galilaeus* (Artedi) J4 *Hemichromis fasciatus* (Peters)
K Osteoglossidae	K1 *Heterotis niloticus* (cuvier)
L Citharinidae	L1 *Citharinus citherus* (Geoffroy) L2 *Citharinus latus* (Muller and Troshel)
M Gymnarchidae	M1 *Gymnarchus niloticus* (cuvier)
N Distichodontidae	N1 *Distochodus rostratus* (Gunther) N2 *Distochodus engycephalus* (Gunther)

KEY– Amino acids

Lys	Lysine
Ala	Alanine
Cys	Cystine
Val	Valine
Met	Methionine
Iso	Isoleucine
Leu	Leucine
Tyr	Tyrosine
Phe	Phenilalanine
Gly	Glycine
His	Histidine
Arp	Argunine
Asp	Aspartic acid
Thr	Threonine
Ser	Serine
Glu	Glutamic acid
Pro	Proline

Key minerals

Ash	Ash
Ca	Calcium
K_2O	Potassium
Iron	Iron
Mg	Magnesium
Na	Sodium
Cu	Copper
P	Phosphorus
Zn	Zinc

APPENDIX 1(a): **Biodata, Food items and proximate composition of fresh water fishes from Tiga dam (Dry Season Dec-March)**

	BIODATA AND FOOD OF FISH TIGA DAM (DRY SEASON, DEC-MARCH)					AVERAGE PROXIMATE COMPOSITION in G/100g Dry Weight				
Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt. (GM)	Stomach Contents	Organic Matter	CH20	Lipids	Protein	Cal. value
A	A1	12	20.50	160.20	Immature Insects, insects	67.60	5.40	32.00	30.20	492.2
	A1i	13	22.60	170.10	plant materials, grains.	70.10	6.70	33.10	30.30	508.6
	A1ii	11	23.50	189.60	" " "	71.50	8.40	33.00	30.10	513.5
	A2	14	23.00	270.70	" " "	67.10	8.00	31.00	28.10	481.9
	A3	11	25.00	225.40	Immature insects (chrironms) Molli-SC (Gyraulus) Plant materials	90.20	10.50	35.00	44.70	651.4
E	B1	14	20.00	186.60	worms, mud immature insects	82.00	9.70	21.30	51.00	522.6
	B1i	11	56.00	2520.00	digested products	83.70	11.00	22.70	50.00	535.8
	B2	13	23.00	1120.60	" "	86.70	10.30	25.10	51.30	568.53
	B3	12	28.00	2300.00	" "	85.70	6.40	27.30	52.00	571.6
C	C1	16	30.00	500.00	Insects parts, immature insects.	83.20	11.30	34.90	37.00	81.40
	C2	14	28.00	540.00	Fish parts and eggs	80.40	11.00	28.30	41.10	540.00
	C2i	12	24.00	530.00	" " " "	77.30	11.30	26.70	39.30	516.1
	C3	12	25.00	380.00	" " " "	80.40	12.10	26.30	42.00	530.5
	C4	13	26.00	400.00	" " " "	80.80	12.10	26.40	42.30	533.1
	C5	12	60.00	1500.00	" " " "	73.10	13.70	20.90	38.50	466.5
	C6	13	80.00	1780.00	" " " "	77.40	13.60	27.10	36.70	515.1
	C7	14	40.00	800.00	" " " "	75.00	13.70	24.30	37.00	490.5
D	D1	12	35.00	450.00	Fish parts, Insects, fish eggs.	88.50	5.40	40.40	42.70	640.8
	D2	12	25.00	185.00	" " " "	87.70	14.70	31.00	42.00	585.8
E	E1	18	15.00	300.00	Insects, immature insects.	80.80	10.10	40.00	30.70	590.3
	E2	11	22.00	380.00	Fish parts, fish eggs & dig. prod.	83.10	11.00	39.70	32.40	600.5
	E3	17	20.00	410.00	" " " " "	85.70	9.10	40.30	36.30	619.8
	E4	13	25.00	475.00	" " " " "	81.90	9.10	38.30	34.50	728.9
F	F1	12	14.00	64.00	Fish eggs, mud, plant parts, grains	81.10	10.10	33.70	37.30	566.7
	F1i	13	15.00	95.30	" " " " "	80.30	10.00	34.30	36.00	564.9
	F2	18	16.60	87.00	Molluse, Gyraulus & insect parts.	82.90	9.60	25.00	48.30	542.5
	F3	14	17.00	158.40	" " "	82.80	9.10	30.60	43.10	565.1
	F4	-	-	-	- - -	-	-	-	-	-
	F5	-	-	-	- - -	-	-	-	-	-
	F6	-	-	-	- - -	-	-	-	-	-
G	G1	-	-	-	- - -	-	-	-	-	-
H	H1	11	25.00	2580.00	Fish parts, Grains & dig. Materials.	86.30	10.10	21.30	54.90	545.7
I	I1	12	22.00	72.00	Fish parts, plants parts, seeds, & zooplankton & crustaceans.	88.30	10.00	24.70	53.60	570.5
	I2	13	21.00	83.00	" " "	88.10	9.10	25.00	54.00	571.8
	I3	12	38.00	194.30	" " "	90.8	9.80	25.90	55.10	589.3
J	J1	10	13.00	79.00	Phytoplankton, algae & other plant parts, mud, grains.	84.70	21.00	25.30	38.40	537.7
	J2	12	18.00	322.00	" " " "	91.20	26.40	26.10	38.70	569.0
	J3	18	20.00	350.00	" " " "	86.20	20.40	27.50	38.30	555.5
	J4	14	17.00	190.00	Fish part, insect part, & plant materials & grains.	80.4	19.60	24.30	36.50	512.0
K	k1	-	-	-	- - -	-	-	-		
L	L1	-	-	-	- - -	-	-	-		
	L2	-	-	-	- - -	-	-	-		
M	M1	11	650.00	1680.00	Fish parts, eggs & dig Materials	85.30	8.90	40.30	36.10	617.9
N	N1	12	20.00	415.00	Phytoplankton, plant materials	68.70	9.00	22.40	37.40	454.9
	N2	12	24.00	440.00	Seed/grains, plants & materials.	72.80	9.10	27.70	36.00	498.5

APPENDIX 1(b): **Biodata, Food items and Proximate Composition of fresh water fishes from Tiga dam (Rainy Season, July - September)**

BIODATA AND FOOD OF FISH

TIGA DAM (RAINY SEASON, JULY-SEPTEMBER)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight: Organic Matter	CH2O	Lipids	Protein	Cal. Value
A	A1	13	20.5	168.6	Insect parts, immature insects, plants materials.	67.90	6.69	30.21	31.00	484.8
	A1i	14	22.6	187.7	" " " "	67.00	6.70	26.80	33.50	466.4
	A1ii	13	23.5	192.0	" " " "	68.10	6.60	26.90	34.60	473.0
	A2	12	20.0	188.6	" " " "	60.90	7.00	31.00	28.90	482.2
	A2i	12	21.0	224.6	" " " "	65.90	7.00	30.00	28.90	472.7
	A2ii	11	23.0	274.2	" " " "	65.00	7.00	29.00	29.00	463.7
	A3	11	20.3	120.4	Immature insects (Chiromonous) molluse, Gyraulus	90.60	9.9	33.3	47.4	617.7
	A3i	12	25.0	225.3	and some plant materials	90.60	9.9	33.3	47.4	617.7
B	B1	18	20.0	86.5	worms, organic matter, mud &	85.43	8.28	25.20	51.95	559.1
	B1i	13	56.0	2500.0	immature insects & dig. products	85.43	8.28	25.20	51.95	559.1
	B2	16	23.0	1122.6	" " " "	88.48	10.20	24.42	54.23	572.0
	B3	12	28.0	2300.0	" " " "	84.80	4.6	28.2	52.0	572.8
C	C1	13	30.00	520.0	Insects parts, immature &	93.10	12.00	42.64	38.42	670.4
	C1i	12	35.00	540.0	fish parts and fish eggs	93.10	12.00	42.64	38.42	670.4
	C2	16	28.0	560.0	" " " " "	85.0	15.40	26.80	42.80	553.1
	C2i	17	24.0	520.0	" " " " "	85.0	15.40	26.80	42.80	553.1
	C3	15	25.0	380.0	" " " " "	83.80	14.60	28.30	40.90	553.7
	C3i	14	20.0	360.0	" " " " "	87.20	18.20	27.00	42.00	562.1
	C4	18	26.0	320.0	" " " " "	84.50	14.30	28.2	42.00	557.5
	C5	11	60.0	1580.0	Fish part, dig. products.	67.20	8.00	22.4	36.80	448.0
	C5i	12	50.0	1550.0	" " " "	64.10	9.00	20.40	35.60	426.5
	C6	15	80.0	2000.0	" " " "	88.60	12.00	38.60	38.00	529.9
	C6i	13	60.0	1600.0	" " " "	79.20	12.80	27.40	39.00	527.3
	C6ii	12	40.0	1500.0	" " " "	79.80	13.00	27.00	39.80	528.7
	C7	16	40.0	880.0	" " " "	77.00	12.20	26.80	38.00	513.4
	C7i	12	36.0	860.0	" " " "	77.00	12.20	26.80	38.00	513.4
D	D1	20	35.0	480.0	Fish parts(Alestes), insects fish eggs.	91.2	5.2	56.4	30.6	600.6
	D2	17	25.0	230.0	" " " "	88.6	15.0	32.3	41.3	593.5
E	E1	10	15.0	310.0	Immature insects, Adults insects remains & dig. prod.	84.00	8.40	43.00	32.60	622.2
	E2	13	22.0	380.0	Fish part (Alestes), fish eggs.	85.60	9.10	46.30	30.20	433.3
	E3	10	20.0	410.0	Fish parts, eggs & immature ins.	82.00	8.00	40.80	33.20	567.0
	E4	18	25.0	480.0	Fish parts, (Alestes), fish egg & dig. prod.	82.50	10.10	42.10	30.30	680.0
F	F1	13	13.80	64.0	Molluse; Gyraulus,immature insect (Chironomouse) plant part	89.00	14.40	36.00	38.60	613.3
	F1i	12	15.00	96.0	Zooplankton, immature insects,	89.00	14.40	36.00	38.60	613.3
	F2	12	16.80	86.0	& dig. prod. fish eggs	85.4	8.3	25.20	51.62	557.2
	F2i	11	19.00	96.0	" " " " "	85.4	8.3	25.20	51.62	557.2
	F3	11	17.00	162.0	Immature insect, matture insect part, dig. prod.	84.1	8.00	30.60	45.50	573.8
	F3	11	19.00	321.0	" " " " "	84.1	8.00	30.6	45.50	573.8
	F4	11	32.00	704.0	Phytoplankton, immature insect & dig. prod.	78.90	10.10	22.00	46.80	507.8
	F5	12	20.00	320.0	" " " "	79.30	8.20	25.10	46.00	525.1
	F5i	11	14.00	180.0	" " " "	81.30	9.20	26.00	46.10	538.3
	F6	12	18.00	160.0	" " " "	91.47	9.15	30.10	52.22	610.7
G	G1	-	-	560.0	insect part, fish & dig. prod.	98.9	20.40	38.90	40.60	676.5
H	H1	13	54	2580.0	Immature insects, (Odonata), small insect parts	87.2	8.62	22.90	55.63	558.9
	H1i	12	36	1860.0	Prawns	86.1	9.00	22.00	55.10	548.9
	H1ii	11	25	590.0	"	86.1	10.10	21.30	54.70	503.2
	H1iii	11	15	614.0	"	85.1	11.30	21.70	54.10	550.0
I	I1	12	40.0	900.0	Fish parts, mud, plants part insect.	85.6	8.60	28.70	58.3	628.56
	I1i	13	32.0	860.0	seeds & dig. prod.	86.8	9.00	20.10	58.10	613.9
	I1ii	12	12.0	760.0	Zooplankton & Crustaceans.	87.00	10.10	26.30	51.6	591.6
	I1iii	16	8.0	610.5	" "	90.70	10.30	26.30	54.10	589.6
	12	14	20.5	84.0	Fish part, plant part, insect zoonplankton.	94.3	8.70	27.30	58.30	615.7

APPENDIX 1(b) (CONTINUED): **Biodata, Food items and Proximate Composition of fresh water fishes from Tiga dam (Rainy Season, July - September)**

BIODATA AND FOOD OF FISH

TIGA DAM (RAINY SEASON, JULY-SEPTEMBER)

AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight

Family	Species	Fish No.	Standard Lgt.(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
	I3	13	38.0	196.0	" "	94.6	9.60	27.20	57.80	616.6
J	J1	13	22.0	440.0	Phytoplankton & other plant mat.	82.70	25.40	21.20	36.10	504.1
	J1i	16	18.0	360.0	" " " "	84.80	26.00	22.00	36.80	518.0
	J1ii	14	13.0	1740.0	" " " "	89.00	27.00	24.10	37.90	548.1
	J2	10	20.0	330.6	Plant part & algae, phytoplankton	80.90	26.20	20.70	34.00	491.1
	J2i	16	18.0	310.5	" "	82.40	27.00	19.60	35.80	493.8
	J2ii	12	12.0	230.5	" "	82.70	27.60	19.00	36.10	492.2
	J2iii	10	8.8	136.0	" "	84.20	28.20	19.00	36.90	499.5
	J3	16	21.5	428.0	Phytoplankton & other plant parts.	81.10	26.00	20.80	34.30	492.9
	J3i	18	18.6	340.0	" " "	82.80	26.80	21.00	35.00	501.9
	J3ii	12	13.6	285.0	" " "	83.50	27.00	21.30	35.20	506.7
	J3iii	16	7.0	132.0	" " "	86.70	27.70	22.70	36.30	528.9
	J4	16	16.5	188.6	Fish part, insect parts, plant part. including others	76.00	24.70	18.60	32.70	457.8
K	K1	11	80.0	3000.0	Phytoplankton, plant part, fish eggs, & dig. prod.	89.00	18.30	21.10	49.60	548.3
L	L1	16	25.0	350.0	Mud, immature insect, plant parts.	86.90	18.60	26.80	41.50	559.1
	L2	15	25.0	360.0	Phytoplankton, insect, plant parts.	86.50	18.70	26.40	41.40	555.2
M	M1	11	90.0	360.0	Fish part & dig. prod. only.	89.10	12.60	34.70	41.80	601.2
N	N1	13	20.0	420.0	Phytoplankton, plant parts & dig prod.	86.90	9.70	29.70	47.50	583.2
	N2	12	24.0	460.0	Phytoplankton, plant parts, & dig. prod.	86.30	9.80	30.10	46.40	581.3

APPENDIX 2(a): **Biodata, Food items and Proximate Composition of fresh water fishes from Zaria dam (Dry Season, Dec-March)**

		BIODATA/STOMACH CONTENTS				AVERAGE PROXIMATE COMPOSITION (g/100g dry weight).				
		ZARIA DAM (DRY SEASON DEC-MARCH)								
Family	Species	Fish No.	Standard Lgt (cm)	Fresh Wt. (gm)	Stomach Content	Organic Matter	CH20	Lipids	Protein	CAL VAL.
A	A1	13	23.60	2.00	Immature insect, part plant	70.4	18.6	15.8	36.0	591.86
	A1i	14	22. 0	172.0	Materials & grains	71.4	18.8	18.6	33.8	439.68
	A1ii	18	20.42	164.0	" "	72.2	20.0	18.6	33.6	443.50
	A2	22	23.2	280.0	" "	67.0	21.4	16.4	34.4	431.10
	A3	9	25.4	230.0	Immature insects (chironomus) plant materials, molluse (Gyraulus)	88.4	26.3	18.7	43.4	524.18
B	B1	23	56.0	2500.0	Worms, Mud, Immature Insects & dig. prod.	83.60	9.9	18.4	55.3	515.54
	B1i	24	20.0	188.2	" "	82.00	11.8	17.6	52.6	504.88
	B2	18	23.0	1140.0	" "	87.0	10.3	25.4	51.3	565.68
	B3	20	28.0	2300.0	" "	86.0	7.0	27.0	52.0	571.20
C	C1	16	30.0	504.0	Insect part, Immature insect, fish parts.	83.2	10.0	34.9	38.3	583.20
	C2	11	28.00	540.0	Fish part & egg,	80.0	10.0	29.0	41.0	542.00
	C2i	13	24.0	530.0	" "	78.2	10.3	26.0	41.9	519.68
	C3	21	25.0	380.0	" "	80.4	13.10	26.3	41.0	529.06
	C4	19	26.0	402.0	" "	80.2	12.1	26.0	42.1	528.16
	C5	22	60.0	1500.0	" "	76.1	13.7	23.3	39.1	492.57
	C6	18	80.0	1780.0	" "	77.3	13.5	27.1	36.7	514.65
	C7	18	41.0	850.0	" "	76.2	13.7	24.3	38.2	497.12
D	D1	26	35.0	452.0	Fish part, insect parts fish egg & organic matters	86.2	6.2	37.4	42.6	615.02
	D2	28	26.0	190.0	" " " "	87.11	14.1	31.0	42.0	583.31
E	E1	25	15.0	302.0	Insect part, immature dig. food	78.9	10.0	38.0	30.9	571.95
	E2	8	22.0	378.0	Fish part, eggs, & dig. food.	79.2	11.0	39.2	30.0	582.50
	E3	22	20.0	400.0	" " "	84.6	10.0	39.6	35.0	609.70
	E4	9	25.0	476.0	" " "	80.9	9.9	38.0	33.0	583.09
F	F1	16	14.0	65.0	Fish eggs, mud, grains plant parts.	80.8	10.1	34.0	36.7	566.26
	F1i	12	15.0	93.0	" " "	80.3	10.0	34.3	36.0	564.85
	F2	13	16.6	86.2	Mollusc (Gyraulus) insects parts, organic matter.	82.9	9.6	25.0	48.3	542.51
	F3	17	17.0	157.0	" "	82.8	9.1	30.6	43.1	565.06
	F4	2	14.2	115.0	" "	80.3	10.1	33.7	37.3	566.71
	F5	4	17.6	126.0	" "	78.6	10.0	34.0	34.6	554.30
	F6	5	16.3	138.0	" "	79.7	11.0	34.7	35.0	567.25
G	G1	-	-	-	- -	-	-	-	-	-
H	H1	8	25.2	2600.0	Fish prawns & dig. materials.	86.2	10.0	21.3	54.9	545.30
I	I1	9	22.0	71.8	Fish parts, plant materials, seeds Zooplankton, & Crussacans	86.3	12.0	24.3	52.0	566.05
	I2	10	21.0	83.2	" " "	86.4	11.6	26.2	48.6	563.76
	I3	8	38.0	192.8	" " "	87.0	11.8	26.2	49.0	566.78
J	J1	28	13.0	80.0	Phytonplankton, algae, mud, & grains	84.60	21.0	25.2	38.4	536.70
	J2	26	18.0	320.0	" "	90.2	25.4	26.1	38.7	564.94
	J3	30	20.0	330.0	" "	86.0	20.2	27.5	38.3	554.72
	J4	22	17.2	191.0	" "	80.4	19.6	24.3	36.5	511.96
K		-	-	-	- -	-	-	-	-	-
L		-	-	-	- -	-	-	-	-	-
M	M1	08	650.0	1680.0	Fish part, eggs, & dig,mat.	85.0	9.0	40.0	36.0	614.90
N	N1	6	20.0	410.0	Phytonplankton, plants mat, grains	68.0	9.0	22.0	37.0	449.40
	N2	5	24.0	440.0	" " "	70.2	9.2	25.0	36.0	473.22

APPENDIX Z(b): **Biodata, Food items and Proximate Composition of fresh water fishes from Zaria dam (Rainy Season, July - September)**

BIODATA/STOMACH CONTENTS — AVERAGE PROXIMATE COMPOSITION (g/100g dry weight).

ZARIA DAM (DRY SEASON DEC-MARCH)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wt.(gm)	Stomach Content	Organic Matter	CH2O	Lipids	Protein	C.V
A	A1	16	20.5	167.5	Insects parts, immatute insect	67.60	8.2	82.4	31.0	473.92
	A1i	12	23.0	188.0	& plant mat., grains	67.80	7.0	28.4	34.4	487.70
	A1ii	8	23.8	193.2	" " "	68.20	7.0	28.1	33.1	477.70
	A2	10	20.0	190.0	" " "	60.8	8.0	22.3	30.5	412.40
	A2i	10	21.4	226.0	" " "	60.20	7.0	23.0	30.2	413.30
	A2ii	8	23.0	275.0	" " "	60.00	7.0	20.0	33.0	400.20
	A3	8	22.6	140.4	Immature insects, (chironomus)	88.90	9.0	31.0	48.9	600.35
	A3i	6	26.0	226.4	Molluse, (gyraulur), plant	88.60	9.4	31.1	48.1	598.54
	A3ii	8	26.8	228.0	Materials, (gyraulur), plant	88.00	9.4	30.4	48.2	592.44
B	B1	12	20.0	187.0	Worms, organic matter, mud.	86.00	7.2	26.1	52.7	567.34
	B1i	12	55.8	2500.0	Immature insects, dig, prod.	83.60	7.6	26.0	50.0	553.16
	B2	20	23.4	1130.0	" " " "	85.00	10.2	19.6	55.2	531.62
	B3	10	28.0	2300.0	" " " "	86.0	8.2	26.8	51.0	568.72
C	C1	18	30.0	530.0	Insects parts, immature insect	90.3	6.0	38.0	46.3	640.25
	C1i	14	36.0	560.0	Fish part, fish eggs, Insect	88.4	6.2	39.2	44.0	639.82
	C2	13	24.6	520.4	" " " "	86.0	8.0	36.7	41.3	608.60
	C2i	9	28.0	560.2	" " " "	87.2	12.2	33.6	41.4	596.92
	C3	12	21.0	390.0	" " " "	86.6	12.2	33.8	40.6	594.42
	C3i	18	25.0	362.0	" " " "	82.70	11.0	30.1	41.6	559.85
	C4	13	26.4	321.0	" " " "	83.3	12.0	29.0	42.3	557.35
	C5	23	51.0	1554.0	Fish parts, eggs, dig. prod.	66.8	8.2	23.2	38.0	463.02
	C5i	21	60.2	1586.0	" " " "	64.4	8.4	22.6	33.4	432.84
	C6	13	40.0	1480.0	" " " "	86.0	09.2	36.0	40.8	604.12
	C6i	18	60.0	1605.0	" " " "	77.4	10.4	28.0	39.0	523.14
	C6ii	16	80.0	2010.0	" " " "	76.8	10.4	28.0	38.4	519.84
	C7	22	36.0	862.4	" " " "	76.9	11.2	27.5	38.2	514.27
	C7i	10	40.0	881.2	" " " "	76.2	11.0	26.8	38.2	509.80
D	D1	24	36.0	480.0	Fish part,insects, fish egg.	89.6	9.8	40.0	39.8	639.08
	D2	21	24.6	275.0	" " " "	88.0	11.8	40.2	36.0	628.28
E	E1	28	16.0	315.0	Immature insect, insect part & dig. prod.	83.6	8.2	42.8	31.0	610.72
	E2	18	22.5	383.2	Fish part, fish egg of Alestes	86.0	9.0	46.0	31.0	644.40
	E3	12	21.0	415.0	Fish part, fish egg & immature insect.	84.0	9.8	44.0	30.2	624.28
	E4	14	26.0	482.0	Fish parts, eggs, (Aleste)	83.3	10.0	40.3	33.0	605.35
F	F1	18	14.0	64.0	Molluce (Gyraulus) immature insect, plant part.	88.6	14.0	36.0	38.2	609.50
	F1i	19	16.5	96.2	Zooplankton, & insect parts, plant part.	88.0	14.4	36.0	37.6	607.84
	F2	08	16.8	86.0	" " "	84.8	8.0	25.2	51.6	556.00
	F2i	12	18.6	94.6	" " "	84.0	8.2	25.2	50.6	551.32
	F3	12	17.0	162.4	" " "	78.2	8.2	30.8	39.2	541.82
	F3i	10	19.0	284.4	" " "	77.4	8.0	30.6	38.8	536.90
	F4	14	32.0	614.0	Phytonplankton, immature insects, & dig. part.	74.2	10.0	24.0	39.8	487.90
	F5	16	20.4	205.0	" "	76.0	9.3	25.5	41.2	506.98
	F6	09	18.2	200.0	" "	82.3	10.1	31.2	41.0	563.31
G	G1	06	38.0	570.0	Insect part, fish part, dig. prod.	94.6	18.0	40.8	35.8	650.30
H	H1	16	55.0	2586.0	Imm.insects, (Odonata) insect	85.6	9.6	25.0	51.0	557.36
	H1i	8	36.0	1900.0	Parts & prawns (Odonata)	73.4	9.4	22.9	41.1	471.69
	H1ii	10	26.0	720.0	" " "	70.2	8.8	22.2	39.2	462.58
	H1iii	12	14.0	610.0	" " "	68.6	8.7	21.2	38.7	449.92
I	I1	14	40.0	902.0	Fish part, mud, Org. matter, insect.	82.6	8.6	28.6	55.4	611.66
	I1i	8	33.0	860.0	Parts, plant materials seeds & dig prod.	86.0	9.0	28.3	48.7	573.60
	I1ii	10	12.6	760.0	" "	94.6	9.3	28.0	57.3	619.28
	I1iii	11	10.2	615.0	" "	95.2	9.6	27.8	57.6	620.26
	I2	16	21.0	185.2	Parts, crustacean & Zooplankton	92.2	9.8	32.2	50.2	622.18
	I3	16	38.0	197.0	" " "	90.6	9.8	33.0	47.8	612.18
J	J1	22	22.2	456.0	Phytoplankton, org, matter & plant material	80.1	25.3	20.2	34.7	486.48
	J1i	20	18.0	360.0	" "	83.6	25.2	23.4	35.0	325.62
	J1ii	05	13.0	1840.4	" "	88.8	25.4	24.2	38.0	543.04
	J2	22	20.0	331.0	Plant part, algae, Phyplankton	80.0	25.8	20.2	34.0	484.68

KASUM

APPENDIX 2(bCONT'D): **Biodata, Food items and Proximate Composition of fresh water fishes from Zaria dam (Rainy Season, July - September)**

			BIODATA/STOMACH CONTENTS ↓ ZARIA DAM (DRY SEASON DEC-MARCH)			AVERAGE PROXIMATE COMPOSITION (g/100g dry weight).				
Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wt.(gm)	Stomach Content	Organic Matter	CH20	Lipids	Protein	C.V
	J2i	18	18.0	312.0	& org, matter/mud. phyplankton	80.6	25.6	20.2	34.8	488.26
	J2ii	26	12.0	236.2	" "	81.6	25.8	20.7	35.1	495.48
	J2iii	24	8.0	136.0	" "	82.4	26.0	20.0	36.0	494.60
	J3	10	21.0	428.0	" "	79.8	26.0	20.5	33.8	487.25
	J3i	16	19.0	342.0	" "	82.0	25.2	22.0	34.8	503.72
	J3ii	18	14.0	286.0	" "	83.0	26.8	22.2	34.0	507.78
	J3iii	14	7.0	132.0	" "	86.0	26.6	23.0	36.4	527.76
	J4	26	17.0	190.2	Fish part, ins. part & plant parts, (Hemichronus)	76.0	26.0	18.0	32.0	453.60
K	K1	8	82.0	3000.0	Phytoplankton, plant materials fish eggs.	85.0	21.4	24.2	40.0	537.64
L	L1	22	26.0	365.0	Mud, org. mat. phytoplankton	84.6	16.8	24.4	41.4	528.38
	L2	24	25.4	365.8	Immature insect & plant parts	84.0	16.8	24.0	43.2	534.48
M	M1	10	90.0	3640.0	Fish part, eggs	88.2	12.4	34.8	41.0	606.94
N	N1	18	24.0	462.0	phytoplankton, plant materials & dig prod.	85.2	12.2	27.0	46.0	559.52
	N2	12	20.0	421.0	" " "	87.0	12.3	28.3	46.4	574.48

APPENDIX 3(a): **Biodata, Food items and Proximate Composition of fresh water fishes from Shiroro dam (Dry Season, Dec-March)**

BIODATA/STOMACH CONTENTS — AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight

SHIRORO DAM (DRY SEASON, DEC-MARCH)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH20	Lipids	Protein	Cal. Value
A	A1	8	23.60	202.0	Immature insect, plant materials & grains.	70.0	18.2	15.8	36.0	422.72
	A1i	6	22.0	171.3	" " "	71.2	18.6	18.6	38.8	466.36
	A1ii	7	20.5	164.0	" " "	71.6	19.4	18.0	34.2	438.64
	A2	10	23.2	278.6	Immature insect, (chironomus) Plant materials	67.0	21.4	16.4	34.4	432.74
	A3	6	25.0	228.2	& mollusc (Gyraulus),	87.2	25.1	18.7	43.4	519.26
B	B1	14	56.0	2600.0	Worms, mud, org. mat., immature insects.	84.0	10.0	18.4	55.6	521.60
	B1i	16	20.0	189.0	& dig. prod.	82.0	11.8	17.6	52.6	504.88
	B2	21	23.0	1136.0	" " "	86.8	10.3	25.2	51.3	563.78
	B3	13	28.0	2320.0	" " "	86.0	7.0	27.0	52.0	571.20
C	C1	12	30.0	510.0	Insect parts, immature insect, fish parts.	83.4	10.4	34.7	38.3	588.94
	C2	14	28.0	542.0	& eggs, insect, immature insec. fish parts	81.0	10.0	29.6	41.4	549.90
	C2i	18	24.0	530.0	" " "	78.4	10.3	26.2	41.9	521.58
	C3	14	25.0	380.0	" " "	80.6	13.1	26.5	41.0	530.96
	C4	20	26.0	400.0	" " "	80.2	12.1	26.0	42.1	528.16
	C5	10	60.0	1500.0	" " "	76.2	13.6	23.3	39.1	442.36
	C6	15	80.0	1780.0	" " "	78.0	13.5	27.8	36.7	521.30
	C7	19	41.0	850.0	" " "	76.4	13.7	24.5	38.2	499.02
D	D1	15	34.8	540.0	Fish part, insect parts, fish eggs & org. mat.	86.2	26.2	37.4	42.6	615.02
	D2	12	26.0	210.0	" " "	87.0	14.0	31.0	42.0	582.90
E	E1	28	15.2	304.0	Insect part, immature insect, & dig. food	78.8	10.0	38.0	30.8	571.4
	E2	9	22.0	376.8	Fish part, eggs & dig food.	79.0	11.0	39.0	30.0	580.6
	E3	21	20.1	401.0	" " " " "	84.6	10.0	39.6	35.0	609.0
	E4	12	25.0	476.2	" " " " "	81.0	9.9	38.0	33.1	583.64
F	F1	20	14.0	66.0	Fish eggs, mud, grains/seeds & plant materials.	80.8	10.1	34.0	36.7	566.26
	F1i	26	15.0	93.0	" "	80.2	10.0	34.2	36.0	563.90
	F2	24	16.5	86.4	Molluse, (Gyraulus) insect parts, & org. mat.	82.9	9.6	25.0	48.3	542.51
	F3	24	17.0	158.0	" " "	82.7	9.1	30.5	43.1	564.11
	F4	8	14.1	118.0	" " "	80.3	10.1	33.7	37.3	566.71
	F5	12	18.0	126.0	" " "	78.6	10.0	34.0	34.6	554.30
	F6	9	16.2	138.0	" " "	80.0	11.0	34.7	35.3	568.9
	G1	-	-	-	- - -	-	-	-	-	-
H	H1	6	25.2	2580.0	Immature insect, insects parts & prawns.	86.2	10.0	21.3	54.9	545.30
I	I1	16	22.0	72.6	Fish part, plant materials, seeds, Crustaceans & zooplankton	86.2	12.0	24.2	52.0	565.10
	I2	12	21.0	83.2	" " "	86.4	11.6	26.2	48.6	563.76
	I3	12	38.0	193.0	" " "	87.0	11.8	26.2	49.0	566.78
J	J1	30	13.0	82.0	Phytoplankton, algae, mud & grains	84.6	21.0	25.2	38.4	536.7
	J2	24	18.0	320.0	" " "	90.0	25.2	26.1	38.7	564.12
	J3	32	20.0	330.0	" " "	86.0	20.2	27.5	38.3	554.72
	J4	26	17.4	192.0	" " "	80.4	19.6	24.3	36.5	511.96
K	-	-	-	-	- - -	-	-	-	-	-
L	L1	3	25.0	320.0	Mud, immature insect & plant Mat.	86.2	19.0	26.2	41.0	552.3
M	M1	4	650.0	3600.0	Fish egg, parts, dig. mat.	85.0	9.0	40.0	36.0	614.90
N	N1	3	20.0	410.0	Phytoplankton, plant mat. grains/seeds	68.0	9.0	22.0	37.0	449.40
	N2	2	24.0	440.0	" " "	70.0	9.0	25.0	36.0	472.40

APPENDIX 3(b): **Biodata, Food items and Proximate Composition of fresh water fishes from Shiroro dam (Rainy Season (July - September)**

		BIODATA/STOMACH CONTENTS				AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight				
	SHIRORO DAM (RAINY SEASON, JULY-SEPTEMBER)									
Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
	AI	18	20.0	168.0	Insect parts, immatute insect Grains & plant mat.	67.40	8.0	28.4	31.0	473.10
	AIi	18	23.2	188.3	" " "	68.0	7.0	28.6	32.4	478.60
	AIii	14	23.8	194.0	" " "	68.4	7.0	28.1	33.3	478.80
	A2	12	20.0	190.2	" " "	60.9	8.0	22.3	30.6	412.95
	A2i	18	21.4	228.0	" " "	62.4	7.0	25.0	30.4	433.40
	A2ii	10	23.0	276.2	" " "	60.8	7.0	20.6	33.2	407.00
	A3	12	22.6	142.1	Immature insect, (Choronomus) molluse & plant mat.	87.8	09.0	30.0	48.8	590.30
	A3i	8	26.0	224.0	" " "	88.5	09.4	31.0	48.1	597.59
	A3ii	14	26.4	226.2	" " "	88.2	09.4	30.6	48.2	594.34
B	B1	21	20.0	187.2	Worms, mud, org. mat. immature	84.8	7.0	25.1	52.7	557.00
	B1i	20	55.0	2480.0	insec. & dig. prod.	83.60	7.6	26.0	50.0	553.16
	B2	13	23.4	1135.0	" " "	85.0	10.2	19.6	55.2	531.62
	B3	12	28.0	2300.0	" " "	86.0	8.2	26.8	51.0	601.72
C	C1	21	30.0	532.0	Insect & fish parts, eggs immature insects.	86.2	6.0	38.0	36.2	584.71
	C1i	12	36.0	561.4	" " "	85.3	6.2	37.1	42.0	608.67
	C2	18	24.2	520.4	" " "	85.6	8.0	36.3	41.3	604.80
	C2i	14	28.0	560.3	" " "	86.2	13.2	31.6	41.4	582.02
	C3	8	21.0	390.0	" " "	86.6	14.2	31.8	40.6	583.62
	C3i	6	25.2	362.0	" " "	82.8	11.0	30.0	41.8	560.00
	C4	10	26.0	320.0	" " "	83.0	13.0	28.0	42.0	550.30
	C5	11	51.2	1556.0	Fish part, eggs & dig prod.	68.2	8.2	23.0	37.0	455.62
	C5i	12	60.0	1600.2	" " "	64.0	8.4	22.6	33.0	430.64
	C6	6	40.0	1450.0	" " "	86.2	11.2	37.0	38.0	606.42
	C6i	8	61.0	1600.0	" " "	77.2	11.4	26.8	39.0	515.84
	C6ii	6	80.4	2000.0	" " "	76.4	11.4	27.0	38.0	512.24
	C7	16	36.0	860.0	" " "	77.0	12.2	26.6	38.2	512.82
	C7i	18	42.0	880.0	" " "	76.0	12.2	25.6	38.2	503.32
D	D1	20	36.0	480.8	Fish part, eggs, ins. part &	88.8	6.8	44.0	30.0	610.88
	D2	12	24.6	480.0	org. matter, " " "	87.0	12.8	36.2	38.0	605.38
E	E1	22	16.0	300.0	Insect part, imm. insect.	82.8	8.0	42.8	30.0	604.40
	E2	14	22.6	380.0	Fish part, eggs, (Alestes)	86.0	9.0	46.0	31.0	644.40
	E3	18	21.0	410.0	" " "	84.0	9.8	44.0	30.2	624.28
	E4	10	26.0	483.0	" " "	84.0	10.2	40.8	33.0	610.92
F	F1	16	14.0	65. 0	Molluse (gyraulus) imm. insect.	88.6	14.0	36.0	38.2	609.50
	F1i	16	16.6	96.2	Insect part, zooplankton & plant mat.	88.0	14.4	36.0	37.6	607.84
	F2	15	17.0	86.0	" " "	85.0	8.2	25.2	51.6	556.82
	F2i	13	18.5	95.0	" " "	84.0	8.2	25.2	50.6	551.32
	F3	19	17.0	162.0	" " "	78.0	8.0	30.8	39.2	541.00
	F3i	20	19.4	285.0	" " "	76.8	8.0	30.6	38.2	533.60
	F4	11	32.2	650.0	Phytoplankton, imm. insec, Org mat	74.6	10.2	24.0	40.0	489.82
	F5	8	20.4	208.0	" " "	76.0	9.3	25.5	41.2	507.03
	F6	12	18.2	205.0	" " "	82.4	10.2	31.2	41.0	563.72
G	-	-	-	-	- - -	-	-	-	-	
H	H1	8	55.0	572.0	Imm. insect. (Odonata) ins. parts & grains.	85.0	9.0	25.0	51.0	554.90
	H1i	9	36.0	2580.0	" " "	73.0	9.0	22.9	41.0	480.50
	H1ii	11	26.0	820.0	" " "	70.0	8.8	22.2	39.0	461.48
	H1iii	16	14.0	640.0	" " "	68.5	8.8	21.0	38.7	448.43
I	I1	18	40.0	900.0	Fish parts, mud, org. mat. inse.	82.6	8.6	28.6	55.4	611.66
	I1i	9	33.0	860.0	parts, plant materials, seeds & dig. food. & crustaceans.	86.0	9.0	28.3	48.7	559.45
	I1ii	12	13.0	780.0	" " " "	95.0	9.3	28.0	57.7	621.48
	I1iii	14	10.0	620.0	" " " "	95.0	9.6	27.6	57.6	618.36
	I2	16	21.0	184.0	" " " "	90.1	8.8	32.2	49.1	612.03
	I3	21	38.0	205.0	" " " "	90.6	9.8	33.0	47.8	616.58
J	J1	28	22.4	458.0	Phytoplankton, alage, plant mat.	80.2	25.3	20.2	34.8	487.03
	J1i	18	18.0	360.0	Org. mat. " " "	84.0	25.6	23.4	35.0	519.76
	J1ii	32	13.0	180.0	" " " "	88.2	26.0	24.2	38.0	545.50
	J2	22	20.0	330.0	" " " "	80.0	25.8	20.2	34.0	484.68
	J2i	18	18.0	240.0	" " " "	81.2	26.0	20.4	34.8	491.80
	J2ii	26	12.0	186.0	" " " "	81.5	26.0	20.7	35.1	495.75
	J2iii	24	8.0	140.0	" " " "	82.4	26.3	20.1	36.0	496.78
	J3	30	21.0	420.0	" " " "	80.1	26.0	20.8	33.3	487.35

APPENDIX 3(bCONT'D): **Biodata, Food items and Proximate Composition of fresh water fishes from Shiroro dam (Rainy season July-September**

BIODATA/STOMACH CONTENTS | AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight

SHIRORO DAM (RAINY SEASON, JULY-SEPTEMBER)

Family	Species	Fish No.	Standard Lgt (cm)	Fresh Wgt. (gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
	J3i	18	19.0	345.0	" " " "	80.6	25.2	21.60	33.0	494.42
	J3ii	12	14.3	286.0	" " " "	83.0	26.8	22.2	34.0	507.76
	J3iii	22	7.2	140.0	" " " "	85.2	26.2	23.0	36.0	523.92
	J4	33	17.0	192.0	Fish part, (hemichronis), insect parts & plant mat.	78.0	26.0	19.0	33.0	468.60
K	K1	6	83.0	3000.0	phytoplankton, fish egg & plant materials	85.4	21.2	24.2	40.0	536.82
L	L1	32	26.2	364.0	Mud, org. mat., phytoplankton.	84.6	16.80	24.40	41.40	528.30
	L2	30	26.1	370.0	Immature insect & plant mat.	84.2	16.80	24.0	43.4	535.58
M	M1	6	980.0	3740.0	Fish part, eggs & dig. prod.	86.8	14.2	36.3	36.3	602.72
N	N1	19	24.0	460.0	Phytoplankton, plant mat &	85.2	10.2	29.0	46.0	570.32
	N2	22	21.0	430.0	dig prod., plant materials	87.0	10.3	30.3	46.4	585.28

APPENDIX 4(a): **Biodata, Food items and Proximate Composition of fresh water fishes from Niger-Benue Confluence (Dry Season, Dec-March)**

BIODATA/STOMACH CONTENTS

AVERAGE PROXIMATE COMPOSITION
IN G/100g Dry Weight

NIGER BENUE CONFLUENCE (DRY SEASON, DEC- MARCH)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
A	A1	6	20.5	204.0	Immature insects, plant mat. & grains.	70.0	18.2	15.8	36.0	422.72
	A1i	4	22.6	173.0	" " "	71.2	18.8	18.4	33.8	437.78
	A1ii	4	20.6	163.0	" " "	71.8	19.6	18.6	33.6	441.86
	A2	5	23.0	278.0	Immature insects, plant mat. molluse (Gyranlus)	67.0	21.4	16.4	34.4	432.74
	A3	6	25.0	229.1	" " " "	87.3	25.0	19.3	48.0	522.35
B	B1	7	56.0	2556.0	Worms, mud, org. mat, immt.insects & dig. pod	84.0	9.8	18.8	55.4	523.48
	B1i	6	20.0	230.4	" " " "	82.0	11.8	17.6	52.6	504.88
	B2	5	23.0	1140.0	" " " "	86.6	10.3	25.0	51.3	561.88
	B3	5	28.0	2310.0	" " " "	86.0	7.0	27.0	52.0	571.20
C	C1	8	30.0	506.0	Insect & fish parts, eggs & immature insects.	83.4	10.2	34.9	38.3	584.02
	C2	6	28.0	538.0	" " " "	81.0	10.0	30.0	41.0	521.50
	C2i	7	24.0	530.0	" " " "	78.6	10.3	26.4	41.9	523.48
	C3	12	25.0	380.0	" " " "	80.4	13.1	26.3	41.0	529.06
	C4	6	26.0	400.0	" " " "	80.2	12.1	26.0	42.1	528.16
	C5	8	60.0	1506.0	" " " "	76.2	13.6	23.3	39.1	492.16
	C6	10	80.0	1776.0	" " " "	78.2	13.5	27.1	37.6	519.60
	C7	11	40.6	860.0	" " " "	76.4	13.5	24.3	28.4	496.80
D	D1	16	34.6	532.0	Fish part, ins. part, eggs & org. mat.	86.2	6.2	37.4	42.6	615.02
	D2	12	26.0	215.0	" " " " "	87.0	14.0	31.0	42.0	582.90
E	E1	16	15.2	304.0	Insect part, eggs, fish part, & org. mat.	78.6	10.0	38.0	30.0	570.30
	E2	10	22.0	376.8	Fish part, eggs, & dig mat.	79.0	11.0	39.0	30.0	580.60
	E3	11	20.0	400.2	" " " "	84.6	10.0	39.6	35.0	609.70
	E4	8	25.2	476.2	" " " "	81.0	9.9	38.1	33.0	584.04
F	F1	16	14.0	66.0	Fish eggs, mud, grains, & plant materials	80.9	10.0	34.0	36.7	562.00
	F1i	8	15.0	93.6	" " " "	80.4	10.0	34.2	36.0	563.90
	F2	17	16.6	86.5	Molluse, insects parts, & org. mat.	82.8	9.6	25.0	48.2	541.96
	F3	12	17.2	160.0	" " "	83.0	9.3	30.6	43.1	565.88
	F4	6	14.2	120.0	" " "	80.3	10.1	33.7	37.6	566.71
	F5	5	18.0	126.0	" " "	78.5	10.0	34.0	34.5	553.75
	F6	7	16.0	138.0	" " "	80.0	11.0	34.7	35.3	568.90
G	G1	2	36.0	600.0	Fish & insec parts, & dig prod.	96.2	18.0	40.0	38.2	663.90
H	H1	3	25.0	2582.0	" " " "	86.0	10.0	21.1	54.9	543.40
I	I1	5	22.0	72.4	" " " "	86.1	12.0	24.1	52.0	564.15
	I2	6	21.0	83.2	" " " "	86.4	11.6	26.2	48.6	563.76
	I3	8	38.0	194.1	" " " "	87.0	11.8	26.2	49.0	566.78
J	J1	22	13.0	83.0	phytoplankton, algae, mud, & grains.	84.6	21.0	25.2	38.4	539.55
	J2	19	18.0	320.0	" " "	90.0	25.2	26.1	38.7	564.12
	J3	29	20.0	334.0	" " "	86.0	20.2	27.5	38.3	554.72
	J4	18	17.6	193.0	" " "	80.4	19.6	24.3	36.5	511.96
K	-	-	-	-	-	-	-	-	-	-
L	L1	6	25.0	321.6	Mud. immature insect, & plant mat.	84.2	18.8	26.0	39.4	540.78
	L2	12	26.0	372.2	" " " "	83.6	18.8	26.2	38.6	538.28
M	M1	2	650.0	3720.0	Fish part, eggs & dig. mat.	85.0	9.0	40.0	36.0	620.40
N	N1	6	20.0	400.0	Phytoplankton, plant mats./grains	68.0	9.0	22.0	37.0	449.40
	N2	3	24.0	460.0	" " " "	72.0	9.0	25.0	36.0	472.40

APPENDIX 4(b): **Biodata, *Food items and Proximate Composition of fresh water fishes from Niger-Benue Confluence* (Rainy Season, July-September)**

BIODATA/STOMACH CONTENTS

AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight

NIGER BENUE CONFLUENCE (RAINY SEASON, JULY-SEPTEMBER)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
A	A1	20	20.5	172.4	Insect parts, grains & plant part.	68.3	8.2	28.4	31.7	477.77
	A1i	18	22.6	190.0	" " " "	67.6	7.0	28.2	34.4	485.80
	A1ii	26	23.4	200.0	" " " "	68.8	7.0	28.2	34.6	486.90
	A2	16	20.1	190.0	" " " "	60.0	8.8	21.5	30.5	408.08
	A2i	18	21.2	230.0	" " " "	60.9	7.7	23.4	30.2	416.17
	A2ii	14	23.0	282.0	" " " "	60.1	7.1	20.0	33.0	400.61
	A3	12	20.4	125.0	Insects, larvae, molluse (Gyraulus)	89.2	9.0	31.3	48.9	603.20
	A3i	12	25.3	231.2	Grains & plant parts	86.2	9.4	30.6	46.2	583.34
B	B1	10	20.2	86.8	Worms, org. mat., mud.	86.1	7.2	26.2	52.7	568.27
	B1i	8	55.4	2506.0	immature insects & dig prod.	88.4	7.6	26.0	50.8	557.56
	B2	14	23.4	1120.0	" " "	84.8	10.2	19.4	55.2	529.72
	B3	9	28.2	2306.0	" " "	84.6	10.0	26.6	48.0	597.30
C	C1	12	30.0	522.2	insect part, fish parts, eggs, org. mat.	92.8	7.5	34.0	46.3	608.40
	C1i	12	35.0	541.0	" " " "	88.0	8.6	36.0	43.4	615.96
	C2	18	28.0	562.0	" " " "	85.2	8.0	36.0	41.2	605.00
	C2i	16	24.0	525.2	" " " "	86.8	12.0	33.4	41.4	594.20
	C3	12	25.0	376.0	" " " "	83.8	12.2	32.0	39.4	570.72
	C3i	13	20.0	360.0	" " " "	87.2	12.4	34.0	40.8	598.24
	C4	11	26.2	318.0	" " " "	84.6	12.0	30.0	42.6	568.50
	C5	8	60.1	1510.0	" " " "	68.0	9.0	21.0	38.0	445.40
	C51	6	50.0	1500.0	" " " "	64.0	8.4	22.2	33.4	429.04
	C6	9	78.6	1950.0	" " " "	87.8	9.8	37.0	41.0	617.18
	C6i	6	61.2	1600.0	" " " "	79.2	9.4	28.0	41.8	534.44
	C6ii	5	38.3	1500.0	" " " "	79.8	9.3	28.0	42.5	537.88
	C7	10	40.0	880.0	" " " "	77.2	11.0	28.0	38.2	521.20
	C7i	11	36.0	860.0	" " " "	77.9	11.8	26.0	40.1	515.93
D	D1	20	32.8	410.0	Fish part (Alestes) insects part fish eggs.	90.0	9.8	39.6	40.6	639.68
	D2	22	30.0	208.0	" " " "	88.4	11.8	40.0	36.6	629.68
E	E1	20	18.0	315.0	Immature insects, insects parts &	85.6	8.3	42.0	35.3	627.18
	E2	10	22.0	370.6	Dig. prod., fish part & eggs.	82.6	9.0	43.0	30.6	613.70
	E3	9	21.0	380.4	Fish parts, eggs, & immature insect.	84.8	9.4	42.8	32.6	624.44
	E4	14	25.3	482.1	Fish parts, (Alestes), egg, & dig. prod.	84.0	10.6	40.0	33.4	607.16
F	F1	08	14.1	64.1	Molluse (Gyranlus) immatute insect,	88.5	14.0	36.0	38.1	608.95
	F1i	6	16.5	96.5	Zooplankton & insects parts, plant mat.	88.0	14.4	36.0	37.6	607.84
	F2	11	16.8	86.8	" " "	84.6	8.6	25.0	51.0	553.26
	F2i	6	18.6	94.6	" " "	84.6	8.8	25.2	50.6	553.78
	F3	9	17.0	162.0	" " "	78.2	8.2	30.8	39.2	541.82
	F3i	5	19.0	284.4	" " "	78.2	8.2	30.0	39.8	543.22
	F4	7	32.0	614.0	phytoplankton, immature insect &	75.0	10.0	24.8	39.8	495.50
	F5	8	20.4	205.4	dig. prod. immatute insects	76.0	9.3	25.5	41.2	506.98
	F6	6	18.0	208.0	" " "	82.1	10.0	31.1	41.0	561.93
G	G1	10	38.0	571.2	Insect parts, fish parts, eggs & dig. prod.	94.2	17.6	40.8	35.8	656.66
H	H1	4	55.0	2584.0	immature insect, insect parts prawns	85.6	9.6	25.0	51.0	557.38
	H1i	6	36.0	1900.0	" " " " "	73.4	9.4	22.9	41.1	482.14
	H1ii	12	26.0	726.0	" " " " "	70.2	8.8	22.2	38.7	459.83
	H1iii	12	14.0	610.0	" " " " "	68.6	8.7	21.2	38.7	449.93
I	I1	11	40.0	900.0	Fish part, mud, insect part, plants.	82.6	8.6	28.6	55.4	611.66
	I1i	8	33.0	860.0	materials, seeds & dig. prod.	86.0	9.0	28.3	48.7	573.60
	1ii	6	12.6	780.0	" " "	94.0	9.3	28.0	56.7	615.90
	I1iii	8	10.5	620.0	" " "	95.2	9.6	27.8	57.6	620.26
	I2	8	21.0	185.2	" " "	92.2	9.8	32.2	50.2	622.18
	I3	6	38.0	198.0	" " "	90.6	9.8	33.0	47.8	616.56
J	J1	16	22.2	382.0	Phytoplankton, org. mat.	80.0	25.2	20.2	34.7	486.07
	J1i	18	18.0	320.0	plant materials & org. mat.	93.6	25.2	23.4	35.0	518.12
	J1ii	18	13.0	185.0	" " " "	88.6	25.4	24.0	38.0	541.14
	J2	18	20.0	330.0	plant mat, algae, phytoplankton	80.0	25.8	20.2	34.0	484.68
	J2i	16	18.0	310.0	Mud & org. mat.	80.6	25.6	20.2	34.8	488.26
	J2ii	14	12.0	235.0	" " "	81.6	25.8	20.7	35.1	451.48
	J2iii	14	8.0	136.0	" " "	82.4	26.3	20.1	36.0	496.78
	J3	21	21.0	420.0	" " "	80.0	26.2	20.5	33.3	544.5
	J3i	20	19.0	342.6	" " "	82.0	25.2	22.0	34.8	503.7
	J3ii	16	14.0	280.0	" " "	83.0	26.8	22.2	34.0	507.8
	J3iii	18	7.0	134.0	" " "	86.2	26.6	23.0	63.2	526.7
	J4	10	17.0	192.0	Fish part (Hemicharomis) insect & plant parts.	76.2	26.2	18.0	32.0	513.6
	K1	3	82.4	2860.0	phytoplankton, plant mat. & fish part	76.0	26.0	19.0	31.0	457.6
	L1	30	26.0	368.0	Mud, org. mat. phytoplankton	84.6	16.8	24.4	41.4	527.8

APPENDIX 4(b) cont'd: Biodata, Food items and Proximate Composition of fresh water fishes from Niger-Benue Confluence (Rainy Season, July-September)

BIODATA/STOMACH CONTENTS

AVERAGE PROXIMATE COMPOSITION IN G/100g Dry Weight

NIGER BENUE CONFLUENCE (RAINY SEASON, JULY-SEPTEMBER)

Family	Species	Fish No.	Standard Lgt(cm)	Fresh Wgt.(gm)	Stomach Contents	Organic Matter	CH2O	Lipids	Protein	Cal. Value
	L2	28	26.0	370.0	immatute & plant materials	84.0	16.8	24.0	43.2	534.5
	M1	2	900.0	3640.0	Fish parts, eggs, & dig prod.	86.0	11.2	33.8	41.0	604.6
	N1	16	24.0	464.0	Phytoplankton, plant mat. & dig prod.	85.2	12.2	27.0	46.0	559.5
	N2	12	21.0	422.0	" " " "	87.0	12.3	28.3	46.4	574.5

Appendix 5(a): **Amino Acid Composition of fresh water fishes from Tiga dam (Rainy Season, July-September)**

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	10.98	3.00	7.00	10.00	3.68	5.04	15.98	3.10	4.86	3.96	3.36	4.80	2.40	2.96	5.93	2.88	3.67
	A2	10.89	3.18	6.86	11.36	4.06	3.08	16.04	2.86	5.62	7.00	3.68	4.88	1.92	1.04	5.90	2.38	3.60
	A3	9.68	3.18	6.87	10.42	3.58	4.66	18.02	2.76	5.60	7.06	3.60	3.95	1.60	2.06	5.89	2.68	3.58
B	B1	9.90	2.86	5.00	8.80	3.30	2.22	15.02	2.50	2.80	3.49	3.20	3.18	1.60	2.18	4.64	2.98	3.02
	B2	10.00	2.95	5.01	8.99	2.30	2.10	14.98	2.39	2.88	3.52	3.16	3.17	1.54	2.16	4.62	2.60	3.00
	B3	9.18	2.90	9.03	8.80	2.24	2.24	15.00	2.26	2.86	3.50	3.18	3.62	1.70	2.17	4.64	2.60	3.04
C	C1	9.98	4.02	5.26	10.1	3.06	4.00	16.00	3.00	4.56	5.02	2.58	3.04	2.10	2.38	5.89	3.02	3.78
	C2	11.00	3.98	5.34	9.88	3.66	2.75	18.58	3.08	2.86	3.48	3.18	4.98	3.06	3.00	6.02	3.80	3.46
	C3	10.96	3.88	4.94	9.81	3.66	2.63	18.46	3.42	2.86	3.64	3.00	4.82	3.04	3.00	6.08	3.89	8.46
	C4	10.96	3.46	5.00	9.92	3.01	2.48	17.86	3.09	2.86	3.86	3.20	4.72	3.06	2.89	6.08	3.89	4.46
	C5	10.68	4.02	4.86	10.28	3.06	4.02	17.02	3.00	4.60	4.86	2.58	3.86	1.58	2.78	6.08	3.86	3.48
	C6	10.69	4.28	4.89	10.26	3.06	4.02	17.23	3.06	4.60	4.88	2.48	3.86	3.20	1.98	6.68	2.88	3.72
	C7	10.82	4.31	4.96	10.27	3.06	3.99	16.99	3.06	4.62	4.90	2.56	3.86	3.00	1.98	6.50	2.86	3.42
	C8	10.00	4.06	6.22	8.80	3.06	4.02	17.62	2.86	4.45	5.45	2.98	3.00	3.00	2.40	5.98	2.98	3.60
D	D2	10.65	3.86	6.70	8.97	2.89	2.66	14.98	3.02	2.99	4.86	2.24	2.96	3.22	2.00	6.48	2.86	3.40
E	E1	11.01	3.00	4.76	10.22	3.86	4.92	16.25	3.62	5.66	4.88	3.90	5.06	2.54	1.98	5.00	2.87	3.15
	E2	8.69	3.86	5.45	7.48	4.04	6.44	12.69	3.00	8.00	8.00	3.84	4.02	2.38	3.05	6.98	3.04	3.87
	E3	12.42	3.01	3.82	9.98	3.86	4.68	15.30	3.00	5.64	4.96	4.00	5.08	2.62	2.00	7.99	3.30	5.92
	E4	9.78	4.64	4.90	12.38	4.85	4.60	14.66	2.98	7.89	8.02	4.46	4.36	3.30	3.06	7.40	3.00	4.62
F	F1	9.89	3.01	4.84	9.02	2.22	2.06	15.12	2.31	2.92	3.48	3.24	3.12	1.85	2.04	5.18	2.86	3.12
	F2	9.80	3.12	4.76	10.41	3.48	2.34	16.04	3.02	3.00	4.03	3.34	4.03	1.65	2.46	5.54	3.83	3.08
	F4	9.88	3.14	4.80	8.46	3.40	2.08	16.03	3.02	2.94	4.88	3.34	3.04	1.98	2.66	2.02	2.78	3.08
	F5	9.86	3.20	4.81	8.50	3.52	2.40	16.04	3.00	2.96	4.79	3.30	3.05	1.98	2.66	5.04	2.82	3.08
	F6	9.88	3.02	4.90	9.04	2.30	2.08	16.00	2.96	2.68	4.80	3.22	3.06	2.04	2.62	5.08	2.48	3.12
H	H1	9.96	3.97	5.04	8.02	3.02	2.70	15.15	3.00	3.96	4.86	2.56	3.00	3.04	2.06	6.01	3.11	3.42
I	I1	10.12	2.84	4.92	8.32	2.94	2.07	14.85	2.54	2.85	3.97	2.50	3.02	1.97	2.12	5.27	2.96	3.01
	I2	10.15	2.75	5.04	8.50	2.88	2.06	15.20	2.39	2.84	3.91	2.60	3.02	2.02	2.15	5.60	2.83	3.00
J	J1	10.95	3.18	6.41	9.72	4.00	4.27	15.94	3.79	4.38	4.69	2.76	4.35	2.13	2.99	6.87	2.87	3.50
	J2	11.00	3.00	6.02	10.30	3.68	5.02	15.85	3.09	4.86	4.00	3.28	4.91	2.45	2.95	6.00	2.90	3.70
	J3	10.96	2.86	6.68	10.15	3.68	5.04	15.85	3.09	4.88	4.02	3.28	4.86	2.43	2.99	6.00	2.87	3.68
K	K1	12.03	2.60	5.96	9.70	3.98	5.02	18.02	2.90	4.86	4.80	2.50	4.28	2.44	2.30	6.86	2.30	3.60
L	L1	12.42	3.34	4.66	10.28	2.46	5.03	14.22	2.92	2.98	4.86	2.26	3.10	1.76	6.00	6.02	2.10	3.44
	L2	12.04	4.36	5.02	8.96	2.85	4.84	16.00	2.43	8.96	4.89	5.66	3.89	1.90	6.00	6.90	2.50	3.10
M	M1	8.36	2.96	6.00	8.98	3.66	4.29	12.63	2.99	2.86	4.89	2.76	2.99	4.02	6.00	7.40	3.04	5.04
N	N1	10.99	4.02	6.04	11.36	2.46	4.85	12.86	3.04	8.42	8.96	3.97	5.40	1.82	3.06	5.43	2.04	3.42
	N2	10.98	3.96	6.40	11.89	2.58	3.97	14.66	3.12	7.80	8.00	4.00	5.04	2.36	5.02	6.00	3.02	3.68

Appendix 5(b): **Amino acid Composition of fresh water fishes from Zaria day (Dry Season, Dec-MArch)**

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.00	2.06	6.10	10.02	3.66	4.00	15.98	3.10	4.06	3.97	3.36	4.89	2.45	2.96	5.04	2.88	3.58
	A2	10.89	3.08	5.16	11.36	4.06	3.00	16.06	2.86	4.60	7.00	3.68	4.88	1.92	1.04	5.02	2.88	3.00
	A3	9.68	3.08	5.86	10.42	3.58	4.00	18.00	2.76	4.50	7.06	3.68	3.96	1.64	2.06	4.89	2.68	2.68
B	B1	9.92	2.05	4.00	8.79	2.30	2.00	15.02	2.26	6.80	3.49	3.20	3.18	1.60	2.18	3.60	2.89	3.00
	B2	9.08	2.06	4.00	8.89	2.20	2.10	14.97	2.39	3.80	3.51	3.16	3.17	1.56	2.17	4.00	2.59	2.94
	B3	9.18	2.00	4.04	8.80	2.24	2.04	15.02	2.26	2.06	3.50	3.16	3.18	1.60	2.17	4.60	2.60	2.96
	C1	9.98	3.02	2.20	10.00	3.05	2.90	16.02	3.00	4.50	5.04	2.56	3.04	2.10	2.38	3.89	3.05	2.08
	C2	10.89	3.06	4.34	9.89	3.66	2.70	18.58	3.08	2.60	3.48	3.16	4.98	3.06	3.00	5.00	3.80	3.00
	C3	10.96	3.00	4.20	9.80	3.66	2.00	18.46	3.44	2.80	3.63	3.06	4.80	3.06	2.90	5.04	3.89	3.00
	C4	10.94	2.46	4.04	9.94	3.02	2.00	17.86	3.08	2.04	3.70	3.20	4.74	3.08	2.78	6.00	3.86	2.40
	C5	10.90	3.02	4.03	12.28	3.06	3.00	17.02	3.02	3.80	4.86	2.56	3.86	1.60	2.00	5.60	3.00	2.89
	C6	10.65	4.00	4.80	10.26	3.06	3.00	17.24	3.06	4.00	4.88	2.56	3.88	3.20	1.98	5.80	2.86	3.40
	C7	10.88	3.00	4.80	10.26	3.08	3.00	16.99	3.05	4.30	4.90	2.54	3.86	3.02	2.06	5.48	2.86	2.92
	C8	10.00	3.06	5.22	8.80	3.07	3.01	17.60	2.86	3.22	5.45	2.98	3.02	3.00	2.40	5.98	2.98	2.80
D	D2	10.80	2.86	4.90	8.96	2.90	2.00	14.98	3.02	2.02	4.87	2.26	2.95	3.22	1.96	3.92	2.88	3.08
E	E1	10.68	2.09	6.02	10.20	3.86	3.90	16.26	3.66	4.60	4.88	3.90	5.06	2.54	3.06	5.98	3.04	2.80
	E2	8.62	3.26	4.30	7.46	4.04	6.40	12.69	3.02	7.00	8.02	3.84	4.02	2.38	2.01	7.30	3.92	3.00
	E3	12.69	3.00	4.45	9.98	3.86	3.34	15.32	4.02	5.00	4.96	4.02	5.08	2.62	3.06	7.50	3.00	4.60
	E4	10.00	3.64	3.80	12.38	4.86	4.00	14.68	2.98	7.00	8.00	4.46	5.36	3.33	2.26	6.80	2.26	2.60
F	F1	9.89	2.02	3.84	9.02	2.22	1.66	15.12	2.50	1.90	3.48	3.24	3.12	1.85	2.04	4.48	2.86	3.02
	F2	9.81	3.02	4.70	10.40	3.48	1.30	16.00	3.02	2.90	4.01	3.32	4.03	1.65	2.46	3.90	3.82	3.00
	F4	9.88	2.64	4.00	8.46	3.40	1.08	16.04	3.02	2.90	4.88	3.34	3.04	1.98	2.66	4.00	2.78	2.08
	F5	9.86	3.00	3.80	8.48	3.50	1.40	16.02	3.00	3.00	4.79	3.34	3.05	1.97	2.66	4.00	2.82	3.00
	F6	9.85	3.00	3.90	9.10	2.30	1.68	15.99	2.96	2.60	4.80	3.20	3.06	2.04	2.62	4.08	2.48	3.02
H	H1	9.96	3.07	3.04	8.00	3.00	1.70	15.14	2.90	3.06	4.89	2.56	2.98	3.04	2.06	5.00	3.12	2.40
I	I1	10.12	2.14	4.03	8.33	2.94	1.07	14.85	2.54	6.80	3.97	2.52	3.02	1.97	2.16	6.88	2.96	3.00
	I2	10.15	2.06	3.03	8.46	2.89	2.00	15.20	2.39	2.80	3.90	2.62	3.01	2.05	2.15	4.68	2.82	2.05
J	J1	10.91	2.18	6.00	9.72	4.00	3.35	15.94	3.80	4.38	4.69	2.76	4.36	2.12	2.99	5.88	2.96	3.62
	J2	11.89	2.02	5.00	10.30	3.68	4.00	15.85	3.08	4.00	3.99	3.30	4.92	2.95	2.95	5.08	2.90	3.60
	J3	10.96	2.06	5.68	10.10	3.68	4.00	15.90	3.08	3.86	4.00	3.30	4.88	2.46	3.00	5.08	3.00	2.89
K	K1	12.78	2.14	3.94	9.72	3.98	3.94	18.02	2.90	4.00	4.80	2.60	4.85	2.46	5.90	5.90	2.10	2.80
L	L1	12.04	2.32	4.96	10.28	2.46	4.08	14.22	2.92	2.08	4.86	2.56	3.10	1.78	5.40	6.62	2.08	3.09
	L2	12.40	3.36	4.60	8.96	2.86	4.00	16.00	2.44	2.06	4.89	2.58	3.89	1.89	5.81	6.80	2.42	3.00
M	M1	8.04	2.06	4.00	8.98	3.65	3.36	12.02	3.00	2.06	4.90	2.76	2.99	4.02	5.99	6.80	3.03	4.03
N	N1	10.96	3.02	5.02	11.36	2.46	4.04	12.86	3.04	1.44	8.96	3.97	5.41	1.88	3.06	3.93	2.02	3.00
	N2	10.98	3.06	6.00	11.88	2.58	3.96	14.66	3.12	6.80	8.02	4.00	5.04	2.36	5.03	4.20	3.04	3.00

Appendix 6(a): Amino acid Composition of fresh water fishes from Zaria dam (Rainy Season, July-September) (g/16gN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.04	2.96	6.69	10.02	3.66	5.00	15.98	3.10	4.86	3.97	3.36	43.89	2.45	3.00	9.95	2.89	3.68
	A2	10.88	3.18	6.76	11.38	4.08	3.08	16.04	2.86	5.62	7.05	3.68	4.88	1.86	1.04	5.90	2.80	3.60
	A3	9.68	3.18	6.86	10.42	3.58	4.66	18.02	2.77	5.54	4.06	3.68	3.96	1.64	2.06	5.89	2.68	3.58
B	B1	10.02	2.84	5.02	8.80	2.30	2.30	15.00	2.30	8.80	3.50	3.20	3.18	1.68	2.60	4.68	2.64	3.02
	B2	9.08	2.96	5.00	8.89	2.40	2.16	14.97	2.40	2.76	2.50	3.16	3.18	1.58	2.18	4.60	3.00	3.06
	B3	9.20	2.90	5.04	8.80	2.24	2.25	15.04	2.26	2.86	3.50	3.16	3.20	1.60	2.18	4.64	2.60	3.04
C	C1	10.00	4.02	2.26	10.02	3.05	3.96	16.02	3.00	4.56	5.04	2.56	3.04	2.10	2.38	5.90	3.05	3.78
	C2	10.89	3.96	5.34	9.90	3.66	2.76	18.58	3.06	2.86	3.48	3.20	5.00	3.06	3.00	6.06	3.80	3.52
	C3	10.96	3.88	6.24	9.83	3.65	2.64	18.45	3.44	28.6	3.63	3.06	4.80	3.06	2.96	6.02	3.89	3.46
	C4	10.94	3.46	4.94	9.94	3.02	2.08	17.86	3.08	2.84	3.70	3.20	4.74	3.08	2.78	6.09	3.86	3.48
	C5	10.90	4.02	5.04	12.30	3.06	4.00	17.04	3.07	4.60	4.86	2.66	3.88	1.68	2.30	6.68	3.00	3.80
	C6	10.60	4.30	4.76	10.20	3.04	4.05	17.25	3.06	4.62	4.88	2.56	3.88	3.20	1.98	6.50	2.86	3.42
	C7	10.88	3.30	4.90	10.20	3.08	4.00	17.00	3.06	4.62	4.90	2.56	3.82	3.00	2.04	6.48	2.86	3.40
	C8	10.08	4.04	6.22	8.80	3.07	4.02	17.60	2.86	4.42	5.45	2.98	3.02	3.00	2.40	5.95	2.98	3.90
D	D2	10.78	3.86	5.00	9.02	2.98	3.00	15.02	3.02	2.98	4.84	3.00	3.30	3.30	2.00	5.02	3.02	3.15
E	E1	10.68	3.00	6.72	10.20	3.86	4.92	16.26	3.68	5.66	4.86	4.00	5.04	2.50	3.06	6.99	3.04	3.88
	E2	9.02	3.86	4.30	8.00	4.00	6.40	12.30	3.02	9.00	8.00	3.84	4.02	2.38	2.00	8.32	3.90	5.08
	E3	12.50	3.02	5.45	9.90	3.90	4.68	15.32	4.32	5.65	5.00	4.02	5.08	2.60	3.06	7.50	3.20	4.65
	E4	10.12	4.60	6.82	12.40	4.86	4.60	14.69	2.98	7.86	8.00	4.46	5.36	3.34	2.30	6.86	2.30	3.50
F	F1	9.90	3.04	4.80	9.00	2.22	2.06	15.12	2.50	2.92	3.48	3.24	3.14	1.86	2.04	5.20	2.86	3.14
	F2	9.80	3.12	4.78	10.40	3.48	2.34	16.02	3.02	3.02	4.02	3.32	4.00	1.65	4.46	5.40	3.82	3.08
	F4	9.88	3.14	4.80	8.46	3.40	2.08	16.04	3.02	3.00	4.88	3.34	3.04	1.98	2.66	5.02	2.78	3.08
	F5	9.86	3.20	4.90	8.56	3.50	2.40	16.00	3.02	3.00	4.80	3.34	3.05	1.98	2.70	5.04	2.82	3.08
	F6	9.85	3.02	4.94	9.12	2.30	2.08	15.99	2.96	2.68	4.84	3.20	3.06	2.04	2.62	5.08	2.48	3.14
	H1	9.96	3.98	5.04	8.02	3.01	2.72	15.15	2.90	3.96	4.89	2.56	2.98	3.04	2.06	6.02	3.12	3.45
	I1	10.12	2.84	4.94	8.30	2.94	2.08	14.85	2.94	8.86	3.96	2.54	3.02	1.96	2.16	5.26	2.96	3.08
	I2	10.15	2.76	5.03	8.46	2.89	2.06	15.20	2.40	2.85	3.90	2.62	3.00	2.05	5.16	5.64	2.80	3.05
J	J1	10.93	3.16	6.40	9.80	4.02	4.25	15.96	3.80	4.38	4.69	2.76	4.36	2.12	3.00	6.88	2.96	3.50
	J2	10.89	3.00	6.00	10.30	3.68	5.03	15.85	3.08	4.86	3.99	3.34	4.90	2.96	2.95	6.03	2.90	3.70
	J3	11.02	2.88	6.66	10.00	3.68	5.03	15.90	3.08	4.88	4.02	3.30	4.88	2.46	3.02	6.08	3.04	3.80
K	K1	12.04	2.62	5.98	9.70	3.98	5.02	18.00	2.90	4.86	4.80	2.60	4.82	2.44	3.00	6.86	2.32	3.61
L	L1	12.42	3.40	4.66	10.31	2.46	5.00	14.20	2.90	3.02	4.80	2.50	3.10	1.78	6.12	6.02	2.10	3.44
	L2	12.00	4.36	5.02	8.96	2.85	4.84	16.02	2.43	3.00	4.90	5.66	3.89	1.90	6.10	6.90	2.50	3.10
M	M1	9.00	3.01	6.02	8.98	3.66	4.29	12.63	3.02	3.02	4.89	2.76	3.02	4.02	6.02	7.40	3.04	5.04
N	N1	11.02	4.02	6.04	11.38	2.46	4.85	12.86	3.04	8.43	8.96	3.98	5.40	1.82	3.06	5.43	2.04	3.42
	N2	11.00	3.98	6.40	11.90	2.68	3.98	14.66	3.12	7.86	8.00	4.02	5.04	2.36	5.02	6.02	3.02	3.68

Appendix 6(b): Amino acid Composition of fresh water fishes from Zaria day (Dry Season, Dec-March) (g/16hN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.04	2.90	6.60	10.02	3.66	4.00	15.98	3.10	3.80	3.97	3.36	4.89	2.45	3.00	5.05	2.89	3.18
	A2	10.88	2.48	4.86	11.38	4.08	2.08	16.04	2.86	4.60	7.05	3.68	4.88	1.86	1.04	3.00	2.80	3.10
	A3	9.68	3.08	6.80	10.42	3.58	4.00	18.02	2.77	4.50	4.06	3.68	3.96	1.64	2.06	5.10	2.68	3.58
B	B1	10.02	2.04	5.04	8.80	2.30	1.36	15.00	2.30	6.80	3.50	3.20	3.18	1.68	2.60	4.60	2.64	3.01
	B2	9.08	2.60	3.00	8.89	2.40	2.00	14.97	2.40	2.70	3.50	3.16	3.17	1.58	2.18	4.60	3.00	3.00
	B3	9.20	2.30	3.08	8.80	2.24	2.00	15.04	2.26	2.80	3.50	3.16	3.20	1.60	2.18	4.60	2.60	3.04
	C1	10.00	4.00	2.20	10.02	3.05	3.06	16.02	3.00	3.50	5.04	2.56	3.04	2.10	2.38	5.10	3.05	3.08
	C2	10.89	3.20	3.30	9.90	3.66	2.06	18.58	3.06	2.10	3.48	3.20	5.00	3.06	3.00	6.00	3.80	2.50
	C3	10.96	3.80	5.20	9.82	3.66	2.00	18.46	3.44	18.0	3.63	3.06	4.80	3.06	2.96	6.00	3.89	3.40
	C4	10.94	2.40	3.90	9.94	3.02	2.00	17.86	3.08	2.14	3.70	3.20	4.74	3.08	2.78	6.00	3.86	3.40
	C5	10.90	3.00	3.04	12.30	3.06	3.10	17.04	3.07	4.00	4.86	2.66	3.88	1.60	2.30	6.18	3.00	3.10
	C6	10.60	4.10	4.20	10.20	3.04	4.00	17.25	3.06	4.12	4.88	2.56	3.88	3.20	1.98	6.00	2.86	3.02
	C7	10.88	3.10	4.20	10.20	3.08	4.00	17.00	3.06	3.12	4.90	2.56	3.82	3.00	2.04	4.48	2.86	2.90
	C8	10.08	4.00	5.42	8.80	3.07	4.02	17.60	2.86	4.70	5.45	2.98	3.02	3.00	2.40	3.08	2.98	3.30
	D2	10.78	3.30	5.00	9.02	2.98	3.00	15.02	3.02	2.90	4.84	3.00	3.00	3.30	2.00	3.02	3.00	3.05
	E1	10.68	3.00	4.70	10.20	3.86	4.02	16.76	3.66	4.00	4.86	4.00	5.04	2.50	3.06	4.98	3.04	3.11
	E2	9.02	3.16	4.40	8.00	4.00	4.00	12.30	3.02	6.00	8.00	3.84	4.07	2.38	2.00	6.32	3.90	3.08
	E3	12.50	3.00	3.45	9.90	3.90	3.58	15.32	4.02	3.05	5.00	4.02	5.08	2.60	3.06	6.50	3.00	4.05
	E4	10.00	4.00	6.80	12.40	4.86	4.00	14.69	2.98	6.80	8.00	4.46	5.36	3.34	2.30	4.80	2.30	3.0
F	F1	9.90	3.04	4.00	9.00	2.22	2.00	15.12	2.50	2.00	3.48	3.24	3.14	1.66	2.04	4.20	2.86	3.04
	F2	9.80	3.02	4.00	10.40	3.48	2.30	16.02	3.02	3.02	4.02	3.32	4.00	1.65	4.46	4.40	3.82	3.08
	F4	9.88	3.04	4.30	8.46	3.40	2.08	16.04	3.02	3.00	4.88	3.34	3.04	1.98	2.66	3.02	2.78	2.01
	F5	9.86	3.20	4.90	8.66	3.50	2.40	16.00	3.02	3.00	4.80	3.34	3.05	1.98	2.70	5.04	2.82	3.08
	F6	9.85	2.04	4.24	9.12	2.30	2.01	15.99	2.96	2.00	4.84	3.20	3.06	2.04	2.62	5.00	2.48	3.04
	H1	9.96	3.98	3.04	8.02	3.01	2.02	15.14	2.90	3.00	4.89	2.56	2.98	3.04	2.06	6.02	3.12	3.05
	J1	10.12	1.80	4.90	8.30	2.94	2.08	14.85	2.54	6.16	3.96	2.54	3.02	1.96	2.16	5.20	2.96	3.00
	J2	10.15	1.70	4.03	8.46	2.89	2.00	15.20	2.40	2.15	3.90	2.62	3.00	2.05	2.00	4.61	2.80	2.00
	J3	10.93	3.46	6.00	9.80	4.12	4.26	15.96	3.80	4.94	4.69	2.86	4.36	2.42	3.60	6.88	2.96	3.00
	J2	10.89	3.10	6.00	10.39	3.68	5.03	15.85	3.68	4.96	3.99	3.64	4.90	2.96	2.95	6.03	3.90	3.10
	J3	11.02	3.88	6.68	10.10	3.68	5.63	15.90	3.08	4.98	4.82	3.80	4.88	2.46	3.02	6.08	3.04	3.10
	K1	12.04	2.60	5.08	9.70	3.98	5.02	18.00	2.90	4.80	4.80	2.60	4.82	2.44	3.00	4.80	2.30	3.00
	L1	12.42	2.49	4.60	10.30	2.46	4.00	14.20	2.90	3.00	4.80	2.50	3.10	1.76	6.12	5.02	2.10	4.88
	L2	12.00	3.30	3.00	8.96	2.85	4.14	16.02	2.43	3.00	4.90	5.66	3.89	1.90	6.10	5.90	2.50	3.00
	M1	9.00	2.00	4.00	8.98	3.66	4.08	12.63	3.00	2.02	4.89	2.76	3.01	4.02	6.02	6.40	3.04	4.04
	N1	11.00	4.00	5.04	11.38	2.46	4.15	12.86	3.04	6.48	8.96	3.98	5.40	1.82	3.06	3.48	2.04	3.02
	N2	10.98	3.08	5.48	11.90	2.58	3.08	14.66	3.12	7.16	8.00	4.02	5.04	2.36	5.02	5.00	3.02	3.18

Appendix 7(a): Amino acid Composition of fresh water fishes from Shiroro dam (Dry Season, Dec-March) g/16gN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.00	2.95	6.84	10.10	3.67	5.00	16.00	3.03	4.89	4.00	3.32	4.90	2.44	3.00	5.00	2.88	6.65
	A2	10.91	3.20	6.80	11.36	4.07	3.09	16.00	2.85	5.60	7.00	3.72	4.92	1.90	1.02	5.91	2.89	3.60
	A3	9.70	3.20	6.85	10.42	3.60	4.63	18.01	2.74	5.50	7.06	3.68	3.96	1.60	2.08	5.88	2.68	3.59
B	B1	9.18	2.87	5.01	8.80	2.36	2.21	15.00	2.28	2.80	3.49	3.23	3.20	1.59	2.18	4.60	2.90	3.02
	B2	9.05	2.97	4.99	8.91	2.22	2.17	14.95	2.40	2.85	3.50	3.20	3.25	1.60	2.19	4.62	2.90	3.00
	B3	10.01	2.91	5.02	8.82	2.26	2.20	15.00	2.28	2.80	3.54	2.20	3.15	1.60	2.18	4.62	2.64	3.02
C	C1	10.04	4.00	5.25	10.02	3.06	4.01	16.02	3.02	4.58	5.06	2.62	3.04	2.10	2.40	5.86	3.02	3.78
	C2	10.97	4.01	5.34	9.91	3.62	2.73	18.60	3.10	2.88	3.50	3.16	4.94	3.05	3.00	6.02	3.82	3.48
	C3	10.95	3.89	6.20	9.79	3.66	2.65	18.45	3.42	28.7	3.65	2.99	4.81	3.05	2.90	6.10	3.90	3.40
	C4	10.70	3.46	4.92	9.91	3.03	2.50	17.88	3.08	2.84	3.73	3.20	4.75	3.08	2.82	6.10	3.87	3.46
	C5	10.60	4.02	4.99	10.30	3.04	4.05	17.00	2.98	4.63	4.88	2.60	3.88	1.60	2.02	6.66	2.90	3.70
	C6	10.82	4.31	4.88	10.25	3.08	4.02	17.25	3.02	4.63	4.88	2.51	3.89	3.20	2.00	6.50	2.87	3.40
	C7	10.70	3.30	4.90	10.28	3.04	4.01	17.00	3.00	4.61	4.93	2.56	3.88	2.99	1.99	6.50	2.86	3.42
	C8	11.10	4.05	6.18	8.78	3.05	4.03	17.26	2.88	4.45	5.50	3.00	3.02	2.99	2.41	6.00	3.020	3.46
D	D2	11.04	3.82	4.95	9.02	2.87	2.68	15.00	3.00	3.00	4.88	2.25	2.93	3.25	1.98	5.04	2.87	3.14
E	E1	11.80	3.00	6.70	10.23	3.87	4.90	16.23	3.65	5.68	4.90	3.92	5.05	2.54	3.04	7.01	3.03	3.87
	E2	8.46	3.85	4.26	7.50	4.03	6.46	12.70	3.00	7.99	8.01	3.86	4.05	2.40	2.00	8.27	3.90	5.04
	E3	12.80	3.02	5.48	9.95	3.88	4.64	15.32	4.00	5.69	4.92	4.01	5.08	2.65	3.08	7.40	3.00	4.65
	E4	9.83	4.66	3.85	12.36	4.84	4.59	24.70	3.00	4.85	8.02	4.45	5.36	3.30	2.27	6.88	2.22	3.65
F	F1	9.80	3.03	4.84	9.00	2.24	2.05	15.12	2.50	2.90	3.48	2.52	3.09	1.83	2.04	5.20	2.85	3.13
	F2	9.80	3.10	4.81	10.40	3.48	2.36	16.04	3.05	2.99	4.05	4.21	4.03	1.70	2.47	5.38	3.83	3.04
	F4	9.89	3.145	4.78	8.47	3.40	2.08	16.02	3.01	2.96	4.90	3.30	2.02	2.00	2.46	5.03	2.78	3.08
	F5	10.00	3.21	4.82	8.51	3.49	2.43	16.03	3.00	2.95	4.81	3.33	3.02	1.97	2.50	5.04	2.75	3.10
	F6	9.86	3.01	4.90	9.06	2.28	2.07	16.00	3.00	4.80	4.84	3.18	3.06	2.04	2.65	5.03	2.42	3.14
H	H1	9.97	3.99	5.02	8.02	3.02	2.71	15.15	2.90	3.90	4.90	2.58	3.00	3.02	2.09	6.02	3.12	3.42
I	I1	10.12	2.82	4.92	8.30	2.99	2.07	14.86	2.80	8.86	3.98	2.48	3.02	2.00	2.14	5.28	3.98	3.04
	I2	10.15	2.72	5.04	8.46	2.89	2.09	15.18	2.42	2.85	3.86	2.65	3.02	2.07	2.10	5.62	2.80	3.00
J	J1	10.97	3.19	6.40	9.75	4.00	4.26	15.90	4.80	4.40	4.60	2.72	4.32	2.16	3.02	6.85	2.94	3.55
	J2	10.92	2.99	6.02	10.33	3.65	4.99	15.81	3.12	4.81	4.00	3.28	4.90	2.48	2.96	6.00	2.92	3.68
	J3	10.96	2.87	6.70	10.12	3.70	5.01	15.80	3.06	4.86	3.99	3.30	4.90	2.46	3.00	6.00	2.88	3.73
K	K1	12.03	2.64	4.90	9.73	4.00	5.04	18.00	2.90	4.88	4.81	2.50	4.83	2.45	5.91	6.03	2.13	3.43
L	L1	12.40	3.34	5.98	10.30	2.45	5.01	14.24	2.90	3.00	4.88	2.55	3.13	1.79	5.40	7.01	1.99	3.77
	L2	12.03	4.35	4.67	8.95	2.87	4.85	16.02	2.45	2.98	4.85	2.58	3.90	1.90	5.58	6.90	2.43	3.05
M	M1	8.38	2.96	5.02	8.90	3.64	4.30	12.64	3.00	2.86	4.90	2.74	3.00	3.99	5.45	7.04	3.04	5.04
N	N1	11.00	4.00	6.03	11.38	2.44	4.81	12.84	3.05	8.41	8.93	4.01	5.40	1.88	3.07	5.03	2.00	3.41
	N2	10.90	3.90	6.44	11.89	2.60	4.01	14.65	3.10	7.90	8.00	3.59	5.06	2.38	5.00	5.30	3.00	3.70

Appendix 7(b): Amino acid Composition of fresh water fishes from Shirroro dam (Dry Season, Dec-March) (g/16gN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.00	2.90	6.10	10.10	3.68	4.35	16.00	3.05	4.18	4.05	3.35	4.90	2.45	3.00	5.30	2.86	3.15
	A2	10.82	3.00	6.15	11.35	4.08	2.86	16.00	2.85	5.10	7.05	3.70	4.92	1.95	1.00	5.10	2.85	2.95
	A3	9.75	3.00	5.90	10.45	3.60	4.20	18.00	2.70	5.00	7.06	3.68	3.96	1.50	2.00	5.20	2.65	2.90
B	B1	9.16	2.70	4.90	9.00	2.36	1.90	15.00	2.30	2.05	4.00	3.25	3.20	2.60	2.15	4.00	2.85	3.00
	B2	9.04	2.96	4.10	9.00	2.23	1.96	14.90	2.40	2.15	3.50	3.20	3.15	1.50	2.20	4.10	2.90	2.92
	B3	10.00	2.00	4.95	8.85	2.25	2.00	15.05	2.28	2.60	5.55	2.25	3.10	1.80	2.20	4.32	2.60	3.00
C	C1	10.00	2.85	4.90	10.02	3.06	3.80	16.04	3.02	4.36	5.06	2.64	3.00	2.15	2.45	5.12	3.00	2.95
	C2	10.95	3.80	5.00	9.90	3.64	2.25	18.60	3.10	2.26	3.50	3.15	4.95	3.10	3.05	5.82	3.80	2.86
	C3	10.92	3.70	5.80	9.80	3.65	2.15	18.40	3.40	1.86	3.65	3.00	4.80	3.05	3.00	5.45	3.90	3.00
	C4	10.65	3.05	4.10	9.92	3.05	2.10	17.80	3.08	1.85	3.75	3.20	4.74	3.00	2.80	5.55	3.68	3.05
	C5	10.60	3.90	4.10	10.35	3.05	3.85	16.95	2.98	3.95	4.88	2.60	3.88	1.60	2.00	5.86	2.90	3.25
	C6	10.80	4.00	4.00	10.25	3.08	4.00	17.20	3.02	3.96	4.88	2.50	3.90	3.20	2.10	5.78	2.85	3.15
	C7	10.70	3.95	4.20	10.28	3.04	3.95	17.00	3.04	4.00	4.92	2.56	3.80	3.00	2.00	5.76	2.85	3.10
	C8	11.00	4.00	5.85	8.78	3.05	3.80	17.60	2.86	4.00	5.50	3.00	3.05	3.00	2.40	5.90	3.05	2.90
D	D2	11.02	3.10	4.15	9.00	2.87	2.60	15.04	3.05	2.90	4.80	2.25	2.90	3.20	2.00	5.00	2.88	3.00
E	E1	11.80	2.85	6.15	10.24	3.87	4.30	16.23	3.60	5.10	4.90	3.95	5.00	2.50	3.04	5.95	3.05	3.45
	E2	8.44	3.25	4.00	7.50	4.04	5.40	12.70	3.05	6.00	6.00	3.90	4.00	2.40	2.05	6.92	3.90	5.04
	E3	12.60	3.00	5.30	9.94	3.88	4.10	15.30	4.10	4.75	4.92	4.00	5.06	2.66	3.56	6.85	3.10	4.65
	E4	9.83	3.96	3.60	12.36	4.85	3.80	14.70	3.00	4.10	8.00	4.45	5.35	3.20	2.25	6.00	2.20	3.00
F	F1	9.86	2.65	3.80	8.98	2.25	2.00	15.10	2.70	2.80	3.48	2.25	3.10	1.85	2.00	5.15	2.80	3.00
	F2	9.80	3.00	4.00	10.40	3.48	2.10	16.04	3.00	2.35	4.06	3.20	4.05	1.70	2.45	5.00	3.80	2.55
	F4	9.86	2.80	4.00	8.46	3.40	2.00	16.00	3.05	2.65	4.92	3.30	3.00	2.15	2.45	4.92	2.76	2.76
	F5	10.00	3.10	4.15	8.50	3.48	2.20	16.00	3.00	2.00	4.80	3.35	3.10	2.00	2.50	4.90	2.75	2.96
	F6	9.86	3.00	3.85	9.06	2.28	2.08	16.00	3.02	2.15	4.80	3.20	3.08	2.05	2.66	5.00	2.45	2.90
H	H1	9.95	3.00	2.95	8.02	3.02	2.30	15.15	2.90	3.25	4.90	2.60	3.00	3.10	2.10	5.40	3.15	2.45
I	I1	10.12	2.10	4.40	8.30	2.90	1.85	14.85	2.80	2.10	3.95	2.50	3.04	2.10	2.15	4.85	3.98	3.00
	I2	10.15	2.70	3.95	8.39	2.84	1.90	15.16	2.44	2.00	3.86	2.65	3.04	2.08	2.15	5.15	2.85	2.95
J	J1	10.94	3.15	6.00	9.74	4.00	3.95	15.90	4.82	4.40	4.65	2.70	4.35	2.15	3.05	5.80	2.90	3.00
	J2	10.90	2.90	5.65	10.30	3.62	4.10	15.80	3.10	4.85	4.05	3.30	4.90	4.45	2.95	6.00	2.90	3.24
	J3	10.94	2.86	5.14	10.10	3.70	5.00	15.75	3.06	4.95	4.00	3.20	4.95	2.45	3.05	6.00	2.85	3.16
K	K1	12.04	2.18	4.00	9.75	4.00	4.90	18.00	2.91	4.15	4.80	2.50	4.80	2.40	5.90	5.83	2.15	3.10
L	L1	12.40	3.25	4.90	10.30	2.45	5.00	14.24	2.91	2.90	4.88	2.55	3.10	2.00	5.30	6.85	2.00	2.96
	L2	12.02	3.85	3.80	3.95	2.86	4.15	16.00	2.44	2.25	4.85	2.58	3.90	1.90	5.50	6.15	2.45	3.00
M	M1	8.36	2.40	4.75	8.90	3.65	4.00	12.00	3.00	2.32	4.90	2.74	3.00	4.00	5.40	6.75	3.05	5.00
N	N1	11.00	3.65	5.20	11.40	2.45	4.00	12.84	3.00	7.46	8.92	4.00	5.50	2.00	3.05	5.10	2.00	3.00
	N2	10.85	3.20	6.00	11.90	2.60	3.86	14.60	3.10	6.85	8.00	3.60	5.08	2.40	5.00	4.96	3.05	3.25

Appendix 8(a): Amino acid Composition of fresh water fishes from Niger-Benue Confluence (Rainy Season, July-September)

(g/16gN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	10.99	2.96	6.69	10.02	3.66	5.01	15.98	3.09	4.86	3.97	3.34	4.09	2.44	2.96	5.93	2.88	3.67
	A2	10.89	3.19	6.86	11.36	4.06	3.08	16.04	2.86	5.62	7.00	3.68	4.88	1.92	1.04	5.90	2.88	3.60
	A3	9.68	3.18	6.87	10.42	3.58	4.66	18.02	2.75	5.50	7.06	3.66	3.96	1.64	2.06	5.89	2.68	3.58
B	B1	9.90	2.85	5.01	8.79	2.30	2.22	15.02	2.25	2.80	3.49	3.21	3.18	1.60	2.18	4.63	2.89	3.00
	B2	9.08	2.95	5.00	8.89	2.20	2.16	14.97	2.39	2.85	3.51	3.16	3.17	1.56	2.17	4.62	2.59	3.04
	B3	9.18	2.90	5.02	8.80	2.24	2.22	15.00	2.26	2.85	3.50	3.18	3.18	1.60	2.17	4.64	2.60	3.00
C	C1	9.97	4.01	5.26	10.01	3.05	3.97	16.01	2.99	4.56	5.02	2.58	3.04	2.09	2.37	5.89	3.01	3.78
	C2	10.99	3.97	5.34	9.89	3.66	2.75	18.58	3.08	2.86	3.48	3.18	4.96	3.04	2.99	6.00	3.80	3.45
	C3	10.95	3.88	6.23	9.80	3.66	2.63	18.46	3.42	28.5	3.63	3.00	4.80	3.06	2.89	6.08	3.89	3.46
	C4	10.96	3.46	4.94	9.92	3.01	2.48	17.80	3.09	2.85	3.70	3.20	4.74	3.08	2.78	6.09	3.86	3.48
	C5	10.68	4.00	5.00	10.28	3.06	4.00	17.01	3.00	4.60	4.86	2.58	3.86	1.60	1.98	6.66	2.88	3.72
	C6	10.69	4.28	4.89	10.26	3.06	4.01	17.23	3.05	4.60	4.88	2.55	3.88	3.21	1.98	6.50	2.86	3.42
	C7	10.80	4.31	4.89	10.27	3.06	3.99	16.99	3.05	4.61	4.90	2.55	3.86	3.00	2.00	6.48	2.86	3.42
	C8	10.02	4.06	6.20	8.80	3.07	4.01	17.60	2.86	4.44	5.45	2.98	3.02	3.00	2.40	5.98	2.98	3.50
D	D2	10.68	3.85	4.95	8.97	2.89	2.66	14.98	3.01	2.98	4.87	2.24	2.95	3.22	1.96	5.02	2.87	3.15
E	E1	11.01	2.99	6.71	10.22	3.86	4.92	16.25	3.65	5.66	4.88	3.90	5.06	2.54	3.05	6.98	3.04	3.87
	E2	8.69	3.86	4.26	7.48	4.04	6.44	12.690	3.00	8.00	8.02	3.84	4.02	2.38	1.99	8.30	3.92	5.03
	E3	12.43	3.00	5.45	9.98	3.86	4.64	15.30	4.02	5.64	4.96	4.01	5.08	2.62	3.06	7.42	3.01	4.63
	E4	9.78	4.64	3.83	12.38	4.85	4.60	14.68	2.980	7.86	8.00	4.45	5.36	3.32	2.25	6.86	2.26	3.63
F	F1	9.89	3.02	4.82	9.01	2.22	2.06	15.12	2.49	2.92	3.48	3.24	3.11	1.85	2.02	5.18	2.85	3.12
	F2	9.80	3.12	4.78	10.41	3.48	2.34	16.00	3.02	3.00	4.00	3.20	4.03	1.60	2.45	5.40	3.81	3.03
	F4	9.88	3.14	4.80	8.48	3.40	2.08	16.03	3.00	2.96	4.89	3.31	3.04	1.97	2.48	5.00	2.78	3.08
	F5	9.88	3.20	4.18	8.48	3.50	2.40	16.03	3.00	2.96	4.79	3.32	3.05	1.97	2.66	5.00	2.82	3.08
	F6	9.86	3.01	4.90	9.03	2.30	2.08	15.99	2.96	2.68	4.81	3.20	3.06	2.04	2.62	5.08	2.48	3.12
H	H1	9.95	3.97	5.04	8.02	3.01	2.70	15.14	2.90	3.96	4.89	2.56	2.99	3.04	2.06	6.01	3.11	3.42
I	I1	10.12	2.84	4.92	8.32	2.94	2.07	14.85	2.54	2.85	3.97	2.50	3.02	1.97	2.12	5.26	2.95	3.02
	I2	10.14	2.74	5.00	8.45	2.88	2.06	15.20	2.39	2.84	3.90	2.60	3.00	2.00	2.15	5.60	2.82	3.00
J	J1	10.95	3.18	6.41	9.72	3.99	4.27	15.93	3.79	4.38	4.69	2.76	4.35	2.13	2.99	6.87	2.95	3.52
	J2	10.89	3.00	6.00	10.30	3.67	5.00	15.85	3.09	4.86	3.99	3.28	4.91	2.45	2.95	6.00	2.90	3.70
	J3	10.96	2.85	6.68	10.10	3.68	5.00	15.85	3.09	4.87	4.00	3.29	4.88	2.45	2.99	6.01	2.89	3.72
K	K1	12.03	2.64	4.92	9.72	3.98	5.02	18.02	2.90	4.86	4.80	2.52	4.85	2.45	5.90	6.02	2.11	3.44
L	L1	12.42	3.33	5.96	10.28	2.46	5.03	14.22	2.92	2.98	4.86	2.56	3.11	1.77	5.40	7.00	2.00	3.78
	L2	12.04	4.36	4.66	8.96	2.85	4.84	16.00	2.43	2.96	4.89	2.56	3.89	1.89	5.60	6.89	2.45	3.04
M	M1	8.36	2.95	5.02	8.98	3.66	4.29	12.63	2.99	2.86	4.99	2.76	2.99	4.00	5.99	7.42	3.04	5.04
N	N1	10.99	4.02	6.00	11.36	2.46	4.85	12.86	3.04	8.42	8.96	3.97	5.41	1.88	3.07	5.43	2.01	3.42
	N2	10.98	3.96	6.42	11.89	2.58	3.97	14.66	3.12	7.87	8.00	4.00	5.04	2.36	5.02	5.28	3.02	3.68

Appendix 8 (b): Amino acid Composition of fresh water fishes from Niger-Benue Confluence (Dry Season, Dec-March) (g/16gN)

Family	Species	Lys	His	Arg	Asp	Thr	Ser	Glu	Pro	Gly	Ala	Cys	Val	Met	Iso	Leu	Tyr	Phe
A	A1	11.00	2.90	5.08	10.04	3.67	4.63	15.01	3.09	4.33	3.98	3.35	4.89	2.45	2.98	5.99	2.86	3.60
	A2	10.89	3.00	5.80	11.37	4.06	3.00	16.04	2.87	5.03	7.03	3.68	4.88	1.94	1.06	4.94	2.86	3.00
	A3	9.68	3.08	5.80	10.43	3.57	4.00	18.00	2.80	4.84	7.08	3.67	3.99	1.65	2.06	5.89	2.69	2.69
B	B1	10.01	2.06	4.94	8.79	2.40	1.83	15.00	2.30	2.00	3.49	3.20	3.17	2.00	2.00	4.60	2.83	3.06
	B2	9.08	2.64	4.64	8.89	2.22	2.00	15.02	2.38	2.05	3.50	3.16	3.17	1.56	2.18	4.68	2.61	3.04
	B3	9.18	2.90	4.92	8.79	2.25	1.83	15.02	2.28	2.54	3.51	3.16	3.20	1.70	2.18	4.50	2.90	2.98
C	C1	9.96	5.90	4.06	11.00	3.05	3.06	16.02	2.97	4.08	5.04	2.56	3.07	2.09	2.35	5.80	3.09	2.08
	C2	10.99	3.08	4.85	9.89	3.65	2.02	18.60	3.05	2.06	3.49	3.15	4.98	3.05	3.00	5.08	3.90	2.90
	C3	10.91	3.04	5.03	9.82	3.66	2.60	18.44	3.41	2.33	3.65	3.05	4.82	3.06	2.88	6.00	4.00	2.96
	C4	10.95	2.68	4.00	9.93	3.01	2.08	18.00	3.00	2.04	3.69	3.20	4.15	3.01	2.77	5.98	3.86	3.40
	C5	10.68	3.90	4.90	10.30	3.05	3.04	17.01	3.03	4.08	4.90	2.55	3.85	1.63	1.99	5.05	2.88	3.10
	C6	10.70	3.69	4.00	10.24	3.06	4.00	17.23	3.02	3.60	4.89	2.55	3.86	3.22	1.98	6.10	2.89	3.95
	C7	10.82	3.52	4.00	10.27	3.03	3.00	17.00	3.04	3.66	4.90	2.53	3.81	3.00	2.05	6.05	2.84	3.93
	C8	10.02	3.64	5.03	8.90	3.06	3.03	18.00	2.86	4.01	5.43	2.98	3.01	3.00	2.41	5.00	3.00	3.10
D	D2	10.70	3.03	4.06	8.95	2.90	2.06	15.00	3.00	2.00	4.88	2.22	2.94	3.22	1.97	3.00	2.87	3.00
E	E1	11.01	2.09	5.03	10.23	3.85	4.06	16.25	3.66	5.60	4.89	3.89	5.08	2.55	3.08	6.00	3.04	2.80
	E2	8.70	3.05	3.05	7.50	4.03	5.94	12.70	3.05	5.04	8.05	3.82	4.00	2.40	2.00	2.82	3.93	3.02
	E3	12.44	2.90	4.94	10.00	3.84	3.68	15.33	4.04	5.00	5.00	4.00	5.08	2.63	3.07	5.95	3.00	4.00
	E4	9.80	3.60	3.00	12.40	4.83	3.02	14.68	3.00	6.88	8.01	4.45	5.35	3.34	2.23	5.87	2.20	3.03
F	F1	9.89	2.93	4.00	9.00	2.22	2.00	15.12	2.48	2.03	3.48	3.24	3.11	1.85	2.01	4.10	2.86	3.02
	F2	9.81	2.02	4.08	10.40	3.48	1.84	16.01	3.02	3.00	4.02	3.32	4.04	1.60	2.46	4.00	3.80	3.04
	F4	9.87	2.04	3.86	8.48	3.40	2.00	16.02	3.01	2.08	4.89	3.32	3.04	1.97	2.48	4.12	2.78	2.98
	F5	9.88	3.00	4.00	8.48	3.50	2.00	16.03	3.02	2.90	4.79	3.32	3.04	1.97	2.67	4.10	2.83	2.09
	F6	9.87	2.90	4.02	9.04	2.30	1.09	15.96	2.97	2.08	4.80	3.20	3.07	2.05	2.60	4.20	2.38	3.05
H	H1	9.95	3.00	4.06	9.00	3.02	2.22	16.00	2.89	2.94	4.89	2.56	3.00	3.22	1.89	5.08	3.10	2.59
J	J1	11.01	2.90	4.00	7.68	2.94	2.00	15.00	1.99	2.30	3.96	2.51	3.03	1.98	2.14	5.39	2.94	3.00
	J2	10.14	2.03	4.00	8.46	2.89	2.00	15.30	3.00	2.30	3.91	2.62	3.02	2.05	2.11	5.66	2.84	3.60
J	J1	11.02	2.99	6.50	9.69	3.98	4.38	15.89	3.78	4.88	4.69	2.76	4.36	2.13	3.04	6.78	2.90	3.06
	J2	9.99	3.62	5.93	10.30	3.68	5.06	15.90	3.80	4.84	4.81	3.34	4.98	2.46	2.97	6.08	2.94	3.89
	J3	9.99	3.00	6.80	10.14	3.72	5.08	15.90	3.49	4.90	4.08	3.30	4.88	3.46	2.98	6.08	2.89	3.73
	K1	12.03	2.05	3.96	9.75	4.00	4.65	18.03	2.89	4.04	4.82	2.56	4.81	2.45	5.92	6.03	2.00	3.05
L	L1	12.42	2.83	5.08	10.30	2.41	3.94	14.21	2.91	3.00	4.88	2.57	3.12	1.79	5.39	6.03	2.03	3.00
	L2	12.05	3.94	4.04	8.95	2.88	4.03	16.05	2.45	2.25	5.00	2.55	3.90	1.90	5.60	6.00	2.03	3.00
M	M1	8.37	2.05	4.90	9.00	3.68	4.00	12.61	3.00	2.35	4.81	2.76	3.00	4.03	6.00	6.89	3.00	4.08
N	N1	11.00	4.00	5.00	11.34	2.45	4.00	12.86	3.05	6.45	8.99	3.99	5.40	1.90	2.95	4.45	2.02	3.33
	N2	11.00	3.64	5.44	11.90	2.55	3.09	14.66	3.10	6.88	8.05	4.00	5.00	2.37	5.01	2.30	2.09	3.09

APPENDIX 9(a): Minerals elements content of fresh water fishes from Tiga dam (Dry season, Dec-March)

	TIGA DAM DRY SEASON DEC-MARCH)			MINERAL CONTENTS (mg/100G)							
Family	Species	Fish No.	Ash	Ca	K20	Iron	MgO	Na	Cu	P	Zn
A	A1	36	30.0	2892.2	829.2	17.0	217.0	104.0	2.6	20.2	15.8
	A2	14	32.9	2648.0	746.0	18.2	212.2	99.2	2.8	20.0	16.2
	A3	11	8.8	2764.2	812.2	11.0	199.0	199.6	4.0	22.1	16.0
B	B1	25	17.2	1908.0	842.0	18.6	201.2	100.2	6.2	28.6	20.4
	B2	13	13.3	1964.2	690.0	18.0	202.0	199.0	5.8	26.0	21.6
	B3	12	14.3	1982.0	684.0	18.0	212.0	101.0	6.0	26.8	20.4
C	C1	16	16.7	3004.2	588.2	30.2	199.0	206.0	3.8	21.0	12.0
	C2	26	21.2	2906.2	604.2	30.4	204.0	200.2	3.6	21.0	13.0
	C4	13	19.2	2968.2	688.0	30.2	198.0	198.4	2.4	21.8	12.8
	C5	12	26.9	2866.2	484.0	30.0	196.4	200.2	2.2	20.0	13.0
	C6	13	22.6	2808.0	702.0	30.2	204.2	204.2	1.8	19.6	14.0
	C7	14	25.2	2884.2	702.0	29.6	204.6	198.6	2.1	20.8	13.0
D	D1	12	11.5	3262.0	610.0	6.0	130.0	310.0	2.0	19.0	10.0
	D2	12	12.3	3802.0	508.0	5.2	148.0	298.2	3.0	10.0	11.0
E	E1	18	19.2	2000.0	402.2	32.0	136.0	312.0	1.2	11.0	15.0
	E2	11	16.9	2010.0	368.0	27.8	160.0	307.0	1.0	10.0	14.0
	E3	17	14.3	1988.0	304.2	32.0	162.0	299.2	1.0	11.0	15.6
	E4	13	18.1	2070.0	314.2	30.8	161.2	264.2	0.8	9.8	14.0
F	F1	25	19.3	4068.2	812.4	22.6	142.2	422.8	2.0	18.4	20.6
	F2	18	17.1	4808.2	744.2	28.2	142.0	460.2	1.9	17.0	20.9
	F3	14	17.2	4606.2	866.2	30.0	151.2	462.0	1.8	16.0	20.0
	F4	-	-	-	-	-	-	-	-	-	-
	F5	-	-	-	-	-	-	-	-	-	-
	F6	-	-	-	-	-	-	-	-	-	-
G	G1	-	-	-	-	-	-	-	-	-	-
H	H1	11	13.7	3964.2	634.0	30.0	30.0	324.0	1.0	9.0	19.2
I	I1	11	11.7	3862.4	534.6	45.0	30.1	266.2	2.0	11.0	19.2
	I2	13	11.9	4004.2	608.0	46.2	31.0	318.1	1.6	10.0	19.0
	I3	12	9.2	3966.2	638.0	48.2	30.0	306.0	2.0	10.2	18.8
J	J1	10	15.3	4384.0	598.0	11.0	32.2	286.2	2.6	12.0	16.0
	J2	12	8.8	3906.2	700.2	8.0	30.0	304.2	2.2	14.1	14.0
	J3	18	13.3	3961.6	600.0	11.4	31.0	294.1	2.0	11.1	18.2
	J4	14	19.6	4504.0	598.7	10.0	32.0	294.2	3.0	11.2	19.2
K	K1	-	-	-	-	-	-	-	-	-	-
L	L1	-	-	-	-	-	-	-	-	-	-
	L2	-	-	-	-	-	-	-	-	-	-
M	M1	11	14.7	2108.0	1024.0	58.0	40.2	486.2	6.0	11.0	20.4
N	N1	12	31.3	5208.2	808.2	51.4	36.1	362.0	3.0	10.2	16.0
	N2	12	27.2	5306.0	804.0	50.2	35.6	344.0	3.0	9.8	15.9

APPENDIX 9(b): Minerals elements content of freshwater fishes from Tiga dam (Rainy season, July-September)

A DAM RAINY SEASON, JULY - SEPTEMBER)

MINERAL CONTENTS OF FISH (mg/100G)

Family	Species	Fish No.	Ash	Ca	K20	Iron	MgO	Na	Cu	P	Zn
A	A1	40	32.4	3424.0	1044.2	22.0	412	524.0	5.2	24.2	18.6
	A2	35	36.1	3702.2	824.0	20.0	296.4	298.6	3.8	25.0	18.6
	A3	23	9.40	2908.2	808.2	17.2	259.2	320.0	4.0	26.0	17.0
B	B1	26	4.6	2018.0	728.0	22.0	209.0	300.2	7.9	40.2	19.0
	B2	16	11.6	2058.0	770.2	24.0	213.3	278.6	8.0	38.2	22.4
	B3	17	15.2	2098.2	768.0	21.0	248.4	318.0	9.0	32.0	20.0
C	C1	25	6.6	2898.2	635.7	35.8	200.4	308.6	4.0	25.3	17.5
	C2	33	15.8	2942.0	703.1	32.2	210.4	318.2	4.3	25.0	18.2
	C3	20	14.5	2964.0	858.4	35.0	210.0	384.0	5.0	24.0	21.0
	C4	18	15.5	3004.0	729.3	28.0	210.0	358.4	3.0	22.7	18.0
	C5	23	34.4	2906.0	500.0	30.0	216.0	260.8	3.5	24.0	18.5
	C6	40	17.5	2862.0	703.1	36.1	238.2	229.4	4.0	23.9	18.7
	C7	28	23.0	3010.0	732.0	32.0	240.2	278.7	3.2	25.0	19.0
D	D1	20	8.8	3290.0	616.2	10.0	132.6	314.7	2.0	20.0	10.1
	D2	17	11.4	3782.0	517.5	9.6	140.4	280.6	2.6	11.0	12.0
E	E1	10	16.0	2098.5	582.0	33.0	136.2	314.6	1.8	12.0	18.7
	E2	13	14.4	2080.0	494.0	30.2	158.6	289.7	1.0	12.0	15.0
	E3	10	16.0	2006.0	482.0	31.0	150.7	298.7	1.6	11.8	16.0
	E4	18	17.8	2110.0	455.0	30.8	162.0	278.6	1.0	11.0	15.2
F	F1	15	11.0	4004.2	815.2	23.8	142.0	400.9	3.0	19.0	21.0
	F2	13	14.6	4823.0	740.0	28.6	144.2	404.2	1.8	18.2	22.2
	F3	13	15.9	4564.0	844.0	26.8	150.0	457.5	2.0	16.0	20.6
	F4	12	21.1	4022.0	787.0	30.4	151.0	372.0	3.0	17.0	22.0
	F5	13	19.7	3898.0	880.0	30.2	150.0	409.7	3.4	18.0	21.0
	F6	13	8.5	4098.2	820.0	29.0	151.0	379.7	2.8	16.7	21.2
G	G1	12	7.1	-	-	-	-	-	-	-	-
H	H1	47	13.4	3978.0	632.0	27.0	24.7	335.7	1.2	10.0	17.8
I	I1	56	8.1	3910.2	638.7	42.7	31.3	260.0	2.4	12.2	18.9
	I2	14	5.7	4112.3	589.7	46.2	32.0	308.0	2.1	11.0	17.8
	I3	13	5.4	4000.0	648.4	47.6	31.2	317.0	2.0	12.0	18.7
J	J1	47	14.5	4289.2	638.4	11.0	32.0	300.0	2.4	13.7	16.0
	J2	48	17.4	3862.2	706.2	9.0	31.0	300.7	3.0	14.0	14.3
	J3	62	16.5	3956.4	608.6	11.7	32.6	296.7	2.9	12.0	18.0
	J4	16	24.0	4525.0	600.7	11.0	32.0	300.2	3.0	13.2	20.7
K	K1	11	11.0	2100.0	832.8	50.0	42.7	476.6	5.8	13.6	23.8
L	L1	16	12.1	1982.0	729.4	34.2	41.0	309.7	5.0	13.0	23.0
	L2	15	13.5	1987.7	735.0	34.0	40.1	318.7	4.0	13.0	22.0
M	M1	11	10.9	2672.0	935.0	56.0	43.0	458.2	6.0	12.0	27.0
N	N1	13	13.1	5186.0	768.0	54.0	40.0	360.0	3.0	11.0	17.0
	N2	12	13.7	5242.0	780.0	54.0	37.8	350.0	4.0	11.2	16.0

APPENDIX 10(a): **Mineral element Content of fresh water fishes from Zaria dam (Rainy Season, July-September)**

ZARIA DAM RAINY SEASON, JULY-SEPTEMBER)			MINERAL CONTENTS (mg/100G)							
Fam	Spe	Fish	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
A	A1	36	32.1	3410.0	104.0	22.2	410.0	530.1	4.8	22.4	18.8
	A2	28	39.7	3220.0	825.9	21.0	308.2	308.2	4.2	25.0	18.0
	A3	22	11.5	2910.0	800.7	16.0	260.0	322.1	4.4	26.0	17.0
B	B1	24	15.2	2020.4	735.2	22.0	212.0	300.0	8.1	42.0	19.8
	B2	20	15.0	2050.7	768.0	23.6	217.2	285.0	8.5	32.0	22.4
	B3	10	14.0	2102.2	770.2	21.9	260.0	328.2	8.7	32.4	20.0
C	C1	32	10.6	3000.0	640.4	36.7	205.8	310.0	4.0	26.0	18.0
	C2	22	13.4	2950.0	700.4	32.8	211.2	320.2	4.5	24.7	19.0
	C3	30	15.4	2950.0	864.5	38.0	210.0	390.0	4.8	24.0	20.9
	C4	13	16.7	3006.2	728.0	30.0	212.6	361.0	3.0	23.0	18.3
	C5	44	34.4	2900.0	503.2	30.1	216.0	264.2	3.8	24.0	19.2
	C6	47	20.0	2850.6	702.1	35.1	240.7	228.7	4.0	23.8	18.4
	C7	32	33.5	3004.4	731.4	30.6	240.0	280.0	3.2	23.7	20.0
D	D1	24	10.4	3300.5	615.7	9.8	132.7	315.8	2.0	20.0	10.4
	D2	21	12.0	3778.7	510.4	9.0	140.2	282.0	2.2	11.5	12.2
E	E1	28	16.4	2090.0	580.5	30.8	140.0	317.2	2.0	12.6	18.4
	E2	18	14.0	2066.0	485.0	31.0	160.2	302.0	1.0	11.8	15.5
	E3	12	16.0	2004.0	475.0	30.4	158.2	302.2	1.3	12.0	16.4
	E4	14	16.7	2115.0	450.0	32.1	166.0	280.4	1.5	11.0	15.0
F	F1	37	11.7	4000.0	810.0	23.4	140.4	412.2	2.4	19.2	20.7
	F2	20	15.6	4830.2	740.0	28.0	150.1	382.6	1.9	17.0	22.1
	F3	22	22.2	4550.7	840.0	27.7	148.2	466.2	2.0	16.4	20.0
	F4	14	25.8	4020.0	770.7	30.8	152.0	368.0	3.2	16.2	20.8
	F5	16	24.0	3900.0	860.0	29.1	146.4	412.8	3.0	17.4	21.0
	F6	9	17.7	4100.8	814.0	29.2	151.3	380.4	4.0	16.2	20.6
G	G1	6	5.4	3990.0	630.0	31.4	30.0	342.0	1.8	10.0	17.8
H	H1	52	26.0	3990.0	630.0	31.4	30.0	342.0	1.8	10.0	17.8
I	I1	53	10.0	3910.0	640.0	42.0	30.4	260.0	2.0	12.4	19.2
	I2	16	10.0	4100.0	608.2	46.0	32.0	314.4	1.5	10.9	17.8
	I3	16	9.6	3990.0	650.8	48.2	31.0	317.0	1.6	12.0	18.2
J	J1	67	16.0	4310.0	642.0	11.2	32.0	300.0	2.8	13.2	16.0
	J2	90	18.4	3870.0	710.0	9.4	31.4	300.8	2.4	14.0	14.0
	J3	58	17.6	3965.0	610.8	11.2	31.0	300.0	3.1	12.0	18.8
	J4	26	22.2	4510.0	600.0	11.0	32.2	298.8	3.1	12.0	18.2
K	K1	8	14.4	2100.8	840.2	50.0	41.9	480.0	4.8	13.2	23.0
L	L1	22	15.4	1988.0	732.0	34.0	41.0	312.8	4.6	13.0	22.0
	L2	24	16.2	2000.0	740.0	34.8	42.6	318.2	4.2	13.1	22.6
M	M1	10	13.0	2700.0	950.0	60.2	42.0	462.4	6.0	12.0	22.4
N	N1	18	14.6	5212.8	788.2	54.0	39.0	560.8	3.0	11.0	18.0
	N2	12	12.8	5255.0	802.0	54.0	40.1	350.0	3.8	10.8	15.8

APPENDIX 10(b): Mineral element Content of fresh water fishes from Zaria dam (Dry Season, Dec-March)

	ZARIA DAM DRY SEASON, DEC-MARCH)						MINERAL CONTENTS (mg/100G)				
	Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P Zn
A	A1	45	29.7	2848.0	822.8	17.4	215.0	100.0	2.7	19.2	16.2
	A2	22	33.0	2680.8	744.0	18.2	214.2	104.2	3.2	20.0	16.0
	A3	9	11.6	2710.0	800.2	11.0	200.2	200.0	4.0	22.2	15.8
B	B1	47	17.2	1904.0	644.4	17.2	198.8	102.2	6.2	31.2	20.2
	B2	18	13.0	1965.5	681.8	17.8	298.0	199.0	6.1	28.0	22.0
	B3	20	14.0	1970.0	684.2	18.0	212.2	101.2	6.0	30.0	20.0
C	C1	16	16.8	3005.8	584.2	30.4	200.0	204.2	3.3	20.1	12.4
	C2	14	20.0	2904.0	602.0	30.2	200.8	200.4	3.0	20.6	13.0
	C3	21	19.6	2960.8	800.0	30.0	206.0	196.8	2.9	20.6	11.8
	C4	19	19.8	3021.0	676.5	27.2	196.2	202.1	2.2	21.2	13.0
	C5	22	23.9	2860.8	488.5	30.0	194.2	200.8	2.2	22.0	14.0
	C6	18	22.7	2810.0	702.8	31.2	202.2	206.0	1.9	20.4	14.2
	C7	18	23.8	2860.0	700.0	28.4	204.0	200.0	1.8	20.9	13.2
D	D1	26	13.8	3270.0	610.0	6.0	130.0	317.0	1.6	19.0	10.0
	D2	28	12.9	3820.0	510.2	5.2	141.2	304.0	2.6	10.4	11.4
E	E1	25	21.1	200.0	408.2	32.6	136.4	312.2	1.0	11.0	15.0
	E2	8	20.8	2010.0	361.2	27.9	160.9	307.0	0.8	10.0	14.2
	E3	22	15.4	1988.0	300.8	32.0	164.0	300.0	1.4	9.6	14.8
	E4	9	19.1	2068.0	310.0	30.8	162.1	262.0	0.9	9.2	14.0
F	F1	28	19.5	4068.0	812.0	22.6	140.1	422.0	2.1	18.2	20.0
	F2	13	17.1	4808.0	742.0	28.4	146.0	464.0	1.6	17.0	20.6
	F3	17	17.2	4608.0	860.8	27.2	152.8	462.0	2.1	15.6	20.0
	F4	2	19.7	4002.0	781.0	31.2	147.0	400.2	2.8	15.6	20.4
	F5	4	21.4	3808.8	880.0	30.0	149.6	420.0	3.0	18.0	21.0
	F6	5	20.3	4090.8	812.0	29.1	150.8	414.0	2.8	16.0	20.6
H	H1	81	13.8	3980.0	632.0	30.2	30.0	322.0	1.0	9.6	20.2
I	I1	9	13.7	3866.0	532.0	42.4	30.1	264.0	2.0	11.0	19.6
	I2	10	13.6	4004.0	608.8	46.8	31.0	320.2	1.8	10.0	20.0
	I3	8	13.0	3980.0	642.4	48.8	30.0	316.0	2.0	9.9	20.0

APPENDIX 10(b cont'd): Mineral element Content of fresh water fishes from Zaria dam (Dry Season, Dec-March)

ZARIA DAM DRY SEASON, DEC-MARCH)									MINERAL CONTENTS (mg/100G)		
Family	Species	Fish No	Ash	Ca	K20	Iron	MgO	Na	Cu	P	Zn
J	J1	28	15.4	4400.0	604.2	10.8	32.6	286.0	2.6	12.0	16.0
	J2	86	9.8	3904.0	708.0	8.6	30.4	302.7	2.2	14.0	14.3
	J3	30	14.0	3966.0	604.0	11.2	31.0	294.2	2.0	11.2	18.2
	J4	22	19.6	4521.0	600.2	11.0	30.2	294.2	2.8	11.2	19.2
M	M1	8	15.0	2112.0	1022.0	58.2	42.0	488.2	6.4	11.6	22.0
N	N1	6	32.0	5214.0	806.2	56.2	38.6	364.2	3.0	10.4	16.4
	N2	5	29.8	5302.0	802.4	50.0	39.2	350.0	3.0	9.8	16.0

APPENDIX 11(a): *Mineral element Content of fresh water fishes from* Shiroro dam (Dry Season, Dec-March)

SHIRORO DAM DRY SEASON, DEC-MARCH)			MINERALCONTENTS (mg/100g dry weight)							
Family	Species	Fish No	Ash	Ca	K20	Iron	MgO	Na	Cu	P	Zn
A	A1	21	29.0	2840.0	820.0	16.8	215.0	102.0	2.5	20.4	16.0
	A2	10	33.0	2680.0	740.0	18.0	210.0	100.0	3.0	20.2	15.8
	A3	6	12.8	2700.0	810.0	10.6	198.8	198.0	3.8	21.0	15.8
B	B1	30	17.0	1900.0	640.0	18.4	200.0	100.0	6.4	30.0	20.0
	B2	21	13.2	1960.0	680.0	17.8	200.0	198.6	6.0	26.0	21.0
	B3	13	14.0	1980.0	680.0	18.2	210.0	100.8	6.2	28.0	20.2
C	C1	12	16.6	3000.0	580.0	30.2	198.6	206.0	3.6	21.4	12.4
	C2	32	20.3	2900.0	600.0	30.0	200.2	198.0	3.3	20.6	12.8
	C3	14	19.4	2960.0	802.0	28.8	204.0	196.0	3.0	20.6	12.0
	C4	20	19.8	300.0	680.0	28.6	196.6	198.0	2.4	22.0	13.0
	C5	10	23.8	2860.0	480.0	29.0	196.4	200.0	2.0	22.4	13.6
	C6	15	22.0	2800.0	700.0	30.0	200.0	206.0	2.0	20.6	13.8
	C7	19	23.6	2840.0	700.0	29.0	200.0	200.0	2.0	21.0	12.8
D	D1	15	13.8	3260.0	608.0	5.8	128.0	315.0	1.8	18.6	9.8
	D2	12	13.0	3800.0	506.0	5.0	140.0	300.0	2.8	10.2	10.6
E	E1	28	21.2	2000.0	400.0	32.4	134.0	310.0	1.0	10.8	14.6
	E2	9	21.0	2008.4	360.0	28.0	158.0	305.0	0.8	9.6	14.2
	E3	21	15.4	1980.0	300.0	31.8	160.0	298.6	1.2	9.8	15.0
	E4	12	19.0	2060.0	312.0	30.6	160.0	260.0	1.0	9.0	13.8
F	F1	46	19.5	4060.0	810.4	22.4	140.1	420.0	2.3	18.0	20.3
	F2	24	17.1	4800.0	740.0	28.0	144.0	460.4	1.8	16.4	20.7
	F3	24	17.3	4600.0	860.4	26.6	150.2	460.8	2.0	15.6	19.8
	F4	8	19.7	4000.0	780.8	30.0	146.1	400.0	2.8	15.4	20.4
	F5	12	21.4	3800.0	880.4	30.4	148.3	418.0	2.8	17.7	20.6
	F6	9	20.0	4080.0	810.6	28.4	150.7	412.6	2.6	16.3	20.4
H	H1	6	13.8	3960.0	630.0	32.3	29.6	320.0	1.3	9.3	18.4
I	I1	16	13.8	3860.0	530.7	44.8	30.1	260.0	1.8	10.9	19.0
	I2	12	13.6	4000.0	600.2	46.0	30.8	316.1	1.6	9.8	18.9
	I3	12	13.0	3960.0	640.1	48.0	29.6	300.0	1.8	9.7	18.6

APPENDIX 11(a) cont'd: Mineral element Content of fresh water fishes from Shiroro dam (Dry Season, Dec-March)

SHIRORO DAM DRY SEASON, DEC-MARCH)				MINERAL CONTENTS (mg/100g dry weight)							
Family	Species	Fish No	Ash	Ca	K20	Iron	MgO	Na	Cu	P	Zn
J	J1	30	15.4	4380.0	600.3	10.6	32.0	284.1	2.4	12.3	15.8
	J2	24	10.0	3900.0	706.1	8.4	30.4	300.7	2.2	13.6	14.3
	J3	32	14.0	3960.0	602.0	11.0	30.6	290.3	2.2	10.9	18.0
	J4	26	19.6	4500.0	598.7	10.3	31.8	292.4	2.6	11.0	18.4
L	L1	3	13.8	1860.0	940.0	58.0	40.4	450.0	4.6	12.8	20.6
M	M1	4	15.0	2100.0	1020.0	60.0	42.3	480.0	6.2	11.4	20.0
N	N1	3	32.0	5210.0	804.0	54.0	38.2	362.0	2.8	10.0	16.4
	N2	2	30.0	5300.0	800.0	52.0	37.6	348.0	3.2	10.0	15.8

APPENDIX 11(b): Mineral element Content of fresh water fishes from Shiroro dam (Rainy Season, July-September)

Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
	SHIRORO DAM RAINY SEASON, JULY-SEPTEMBER)						*MINERAL CONTENTS (mg/100g)*				
A	A1	50	32.1	3420.0	1040.0	20.6	410.0	520.0	5.0	24.2	18.2
	A2	40	38.6	3200.0	820.8	21.2	300.0	300.0	4.0	25.3	18.4
	A3	34	11.8	2920.2	900.0	18.4	260.0	320.0	4.2	26.1	17.3
B	B1	41	15.8	2020.8	730.0	22.3	210.0	300.0	8.0	42.4	20.0
	B2	13	15.0	2060.0	770.2	23.2	215.0	280.6	8.2	31.1	22.2
	B3	12	14.0	2100.2	722.4	22.0	250.0	320.2	8.6	32.2	20.3
C	C1	33	13.8	2900.0	640.0	36.0	204.1	310.0	4.2	26.0	18.0
	C2	32	14.1	2940.0	700.0	32.4	210.2	320.0	4.3	24.7	19.2
	C3	14	15.3	2960.0	860.0	34.7	208.0	386.0	4.8	23.5	20.7
	C4	10	17.0	3000.0	730.8	28.4	212.3	360.0	2.9	23.0	18.3
	C5	23	33.9	2900.0	503.2	29.6	215.9	268.8	3.7	24.5	19.0
	C6	20	20.0	2860.0	700.0	34.3	240.0	230.1	3.8	23.9	18.7
	C7	34	23.5	3006.2	730.0	31.6	241.0	280.3	3.2	24.7	18.6
D	D1	20	11.2	3300.5	610.5	10.2	130.0	315.0	1.8	18.8	10.1
	D2	12	13.0	3780.0	515.7	9.3	143.4	280.0	2.4	11.0	12.0
E	E1	22	17.2	2100.0	480.0	32.8	138.0	315.0	1.8	12.4	18.4
	E2	14	14.0	2088.0	490.0	30.0	160.0	300.0	1.2	11.6	15.3
	E3	18	16.0	2008.0	480.0	30.6	160.0	300.0	1.3	12.0	16.2
	E4	10	16.0	2112.0	450.0	31.0	164.0	280.0	1.4	11.2	14.8
F	F1	32	11.7	4000.0	815.0	24.0	142.0	410.0	2.6	18.6	21.0
	F2	28	15.5	4820.0	738.0	28.4	146.0	400.0	2.0	17.2	22.0
	F3	39	26.6	4560.0	840.0	27.2	150.0	460.6	2.2	16.4	20.3
	F4	11	25.4	4020.0	780.0	30.0	150.2	370.2	3.1	16.6	21.6
	F5	8	24.0	3900.0	882.0	30.2	148.6	410.0	3.2	17.6	20.8
	F6	12	17.6	4100.0	816.0	29.0	151.3	380.4	3.0	16.4	20.8
G	G1	44	25.9	3980.0	640.8	30.0	28.4	340.0	1.6	10.2	18.0
I	I1	53	10.3	3908.0	638.4	42.6	31.3	258.0	1.8	12.4	19.0
	I2	16	9.9	4100.0	600.0	46.2	31.6	310.0	1.7	10.8	18.00
	I3	21	9.4	3980.0	650.0	45.0	30.8	315.0	1.6	11.6	18.4

APPENDIX 11(b cont'd): Mineral element Content of fresh water fishes from Shiroro dam (Rainy Season, July-September)

SHIRORO DAM RAINY SEASON, JULY-SEPTEMBER)				MINERAL CONTENTS (mg/100g)						
Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
J	J1	78	15.9	4300.0	640.8	10.8	32.0	302.0	2.4	13.0	15.6
	J2	90	18.6	3880.0	708.0	9.2	31.2	302.4	2.6	13.8	14.3
	J3	82	17.8	3960.0	610.0	11.1	32.0	294.3	3.0	11.6	18.0
	J4	33	22.0	4500.0	602.0	10.8	31.9	296.0	3.1	12.0	19.2
K	K1	6	14.6	2112.0	480.0	49.8	42.1	480.0	4.8	13.2	22.8
L	L1	32	15.6	1980.0	730.0	34.2	40.6	310.0	4.6	13.2	22.3
	L2	30	15.8	2000.0	740.0	35.0	42.1	320.0	4.4	13.1	22.4
M	M1	6	13.2	2680.0	940.0	60.0	42.6	460.4	6.2	12.4	22.0
N	N1	19	14.8	5200.0	780.0	54.6	38.4	362.0	3.2	11.2	16.4
	N2	22	13.0	5250.0	800.0	53.8	37.4	348.0	3.6	10.8	15.8

APPENDIX 12(a): Mineral element Content of fresh water fishes from Niger-Benue Confluence (Dry Season, Dec-March)

NIGER-BENUNE CONFLUENCE DRY SEASON, DEC-MARCH)									MINERAL CONTENTS (mg/100g dry weight)		
Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
A	A1	I4	29.0	2900.0	900	58.2	265.0	150.1	7.0	40.8	32.1
	A2	5	33.0	2720.0	790	52.7	260.0	147.2	9.2	40.4	30.2
	A3	6	12.7	2740.0	870.7	48.3	238.8	234.4	9.6	41.2	20.7
B	B1	13	17.0	1955.0	700.2	52.0	245.0	150.6	10.1	52.2	36.8
	B2	5	13.4	2005.7	740.7	52.	265.0	242.4	10.	46.0	37.0
	B3	5	14.0	2007.6	760.0	52.4	270.7	165.8	11.0	46.2	36.9
C	C1	8	16.6	3070.0	600.0	70.2	238.6	246.3	9.0	40.1	32.4
	C2	13	20.2	2980.7	640.0	71.0	254.2	254.4	9.1	40.7	32.6
	C3	12	19.6	3025.0	862.0	61.0	252.0	234.0	9.7	40.7	32.0
	C4	6	19.8	3046.0	720.0	60.2	267.6	242.0	6.7	44.2	33.0
	C5	8	23.8	2940.4	560.7	62.2	263.2	234.2	6.4	44.2	33.2
	C6	10	21.8	2870.0	780.0	7103	243.4	256.7	6.2	40.7	33.4
	C7	11	13.6	2880.0	780.0	70.1	272.1	252.0	6.2	41.4	32.4
D	D1	16	13.8	3320.7	678.0	35.2	168.0	365.7	4.8	40.2	21.4
	D2	12	13.0	3840.0	556.7	30.0	200.0	345.0	6.2	30.0	05.2
E	E1	16	21.4	2060.2	440.0	72.4	194.0	360.0	3.0	30.2	34.2
	E2	10	21.0	2058.6	410.0	78.0	198.0	352.1	2.8	28.1	34.0
	E3	11	15.4	2068.3	384.4	81.6	205.0	354.2	3.4	29.1	30.0
	E4	8	19.0	2130.4	342.0	72.0	208.0	300.7	3.0	27.0	28.7
F	F1	24	19.4	4090.4	870.2	62.0	240.0	480.0	6.8	40.1	40.0
	F2	17	17.2	4870.0	814.2	08.7	204.3	410.2	4.8	38.2	40.1
	F3	12	17.0	4672.0	920.0	60.2	190.0	500.0	6.0	35.0	39.6
	F4	6	19.7	4092.3	840.2	70.0	196.0	440.0	6.8	32.8	40.8
	F5	5	21.5	3872.0	960.8	69.2	197.0	458.0	6.8	34.8	40.6
	F6	7	20.0	4160.0	870.8	64.2	190.7	452.6	6.6	36.6	40.2
H	H1	3	14.0	4020.0	700.7	52.6	49.2	360.0	4.2	27.6	48.0
I	I1	5	13.9	3920.0	590.0	74.6	56.2	300.0	4.6	33.0	39.7
	I2	6	13.6	4075.7	660.0	72.0	56.4	356.0	4.4	27.9	38.9
	I3	8	13.0	4025.7	700.0	76.0	49.2	354.1	4.6	27.7	38.6
J	J1	22	15.6	4420.7	650.3	30.7	57.0	324.1	6.2	36.2	34.8
	J2	19	10.0	3940.0	748.6	24.2	56.0	360.0	6.0	36.9	34.4
	J3	29	14.0	4000.0	662.0	33.0	56.2	350.0	5.9	31.0	36.0
	J4	18	19.6	4565.0	658.6	30.9	56.4	352.4	6.4	33.0	40.4
L	L1	6	15.8	1920.0	100.0	98.0	60.2	490.0	9.2	36.4	42.6
	L2	12	16.4	1942.0	930.0	84.6	58.7	395.7	9.4	35.9	41.0
M	M1	2	15.0	2140.0	1060.0	90.0	64.2	520.2	12.0	33.2	42.0
N	N1	6	32.0	5250.0	854.0	84.0	59.4	402.0	6.8	30.1	36.0
	N2	3	28.0	5340.0	850.0	82.7	59.2	388.0	7.0	30.0	37.8

APPENDIX 12(b): Mineral element Content of fresh water fishes from Niger-Benue Confluence (Rainy Season, July-September)

Niger-Benue confluence (Rainy season, July-September)

Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
						MINERAL CONTENTS (mg/100g dry weight)					
A	A1	64	31.7	3540.0	1140.0	60.7	502.0	570.0	15.0	54.2	36.0
	A2	48	32.4	3400.0	887.2	61.7	352.2	352.0	8.6	58.1	36.2
	A3	24	31.2	3020.7	102.2	54.4	300.4	372.4	8.7	60.2	32.4
B	B1	28	12.7	2140.0	800.7	64.0	290.7	349.0	12.0	62.8	40.0
	B2	14	15.2	2160.0	830.2	72.4	285.4	321.3	12.2	56.0	41.0
	B3	9	15.4	2200.0	872.4	68.4	300.7	360.4	12.4	58.2	40.6
C	C1	24	9.6	3008.0	700.6	92.3	275.0	352.1	9.0	52.1	36.0
	C2	34	14.0	3040.0	780.4	94.1	287.0	359.2	9.2	54.2	38.2
	C3	25	14.5	3000.0	940.0	87.3	284.0	432.4	9.4	50.1	40.4
	C4	11	14.4	3100.7	800.2	91.0	290.2	420.4	6.4	49.2	36.7
	C5	14	34.0	3007.4	598.7	67.5	294.0	304.2	6.7	49.7	37.3
	C6	20	17.7	2890.0	790.7	97.2	314.1	294.0	9.4	50.2	37.2
	C7	21	22.5	3104.2	800.0	90.1	304.2	330.6	9.6	52.4	37.0
D	D1	20	10.0	3392.0	710.5	50.2	172.4	355.0	6.2	51.0	25.2
	D2	22	11.6	3875.2	595.7	42.4	187.4	320.0	7.2	41.0	27.4
E	E1	20	14.4	2205.7	640.0	96.4	190.7	360.0	3.4	40.0	36.2
	E2	10	17.4	2188.0	580.7	90.7	222.4	340.0	3.6	42.4	30.1
	E3	9	15.2	2096.2	570.0	87.6	220.4	342.0	3.9	41.0	32.2
	E4	14	16.0	2190.0	520.0	89.6	224.4	320.0	3.8	41.4	30.0
F	F1	14	11.7	4079.7	875.0	67.2	192.7	460.7	7.2	52.1	43.0
	F2	17	15.4	4892.0	840.0	72.8	194.2	457.2	6.0	50.2	44.2
	F3	14	21.8	4650.0	930.0	70.2	201.0	506.2	6.4	49.7	40.7
	F4	7	25.0	4120.7	880.7	90.1	200.4	410.2	7.2	48.2	43.2
	F5	8	24.0	3990.0	942.0	90.6	198.7	460.2	7.4	52.6	42.6
	F6	6	17.9	4220.7	896.0	82.4	201.6	420.2	7.0	48.4	42.6
G	G1	10	5.8	1840.0	280.0	30.8	100.0	160.4	3.3	6.8	18.0
H	H1	22	25.5	4020.0	694.0	82.0	70.2	392.0	4.2	40.0	46.0
I	I1	33	10.5	4028.0	698.4	82.4	55.4	305.7	3.4	36.0	29.0
	I2	8	7.8	4160.0	660.2	86.2	50.2	370.7	3.2	40.2	30.0
	I3	6	9.4	4020.5	710.0	88.2	50.0	360.0	3.0	37.6	31.0
J	J1	52	15.9	4355.1	700.8	50.0	55.7	340.0	6.2	41.0	24.0
	J2	62	18.8	3920.4	768.0	49.2	54.0	342.0	7.0	42.0	27.2
	J3	75	17.2	4000.0	650.0	57.2	54.2	354.0	9.0	37.6	31.4
	J4	10	23.8	4562.1	642.7	50.8	55.6	356.0	9.1	38.7	32.1
K	K1	3	24.0	2172.3	900.2	89.7	74.2	520.0	12.2	42.0	36.2

APPENDIX 12(b) cont'd: Mineral element Content of fresh water fishes from Niger-Benue Confluence (Rainy Season, July-September)

Niger-Benue confluence (Rainy season, July-September)

Family	Species	Fish No	Ash	Ca	K20	Iron	Mg0	Na	Cu	P	Zn
						MINERAL CONTENTS (mg/100g dry weight)					
L	L1	30	15.4	2030.7	790.0	74.3	80.4	354.7	12.0	42.4	35.2
	L2	28	16.0	2080.2	800.0	85.0	80.7	368.0	11.7	42.2	35.4
N	N1	16	14.8	5260.7	820.7	97.4	52.4	412.0	9.4	41.7	26.2
	N2	12	13.0	5310.0	860.3	96.8	52.7	401.7	9.6	40.2	24.1

APPENDIX: 13 ORGANIC MATTER CONTENT OF ALL FRESH WATER FISH FAMILIES COMBINED

FAMILY	MEAN ORGANIC MATTER	ST.DEV	S.E.
Cyprinidae	72.40	10.23	0.42
Mormyridae	85.16	1.69	0.08
Bagridae	80.49	6.67	0.19
Schilbeidae	87.56	1.71	0.10
Characidae	82.67	2.39	0.11
Mochokidae	81.84	3.98	0.15
Centropomidae	79.81	8.44	2.05
Clariidae	89.05	3.88	2.28
Cichlidae	83.05	3.45	0.17
Citharinidae	84.87	1.07	0.03
Gymnarchidae	75.62	7.82	1.50
Distichodontidae	86.23	7.81	0.53
Malapteruridae	89.81	8.44	1.16
Osteoglossidae	84.06	1.08	0.08

* The figures represent mean values of organic matter.
* ST. DEV - Standard deviations.
* S.E. - Standard error.

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APPENDIX 14: CARBOHYDRADE CONTENT OF ALL FRESH WATER FISH FAMILIES FROM FOUR LOCATIONS COMBINED

FAMILY	CARBOHYDRATE(g/100g)	ST.DEV	S.E.
Cyprinidae	11.46	6.05	0.25
Mormyridae	8.97	1.80	0.09
Bagridae	11.27	2.31	0.07
Schilbeidae	10.13	3.75	0.22
Characidae	9.98	0.83	0.04
Mochokidae	9.70	1.86	0.07
Centropomidae	9.79	2.00	0.49
Clariidae	9.96	1.16	0.08
Cichlidae	24.88	2.55	0.13
Citharinidae	16.98	2.70	0.08
Gymnarchidae	10.61	2.03	0.39
Distichodontidae	10.22	1.40	0.09
Malapteruridae	18.53	1.64	0.23
Osteoglossidae	21.01	2.22	0.17

* The figures represent mean value of carbohydrate
* ST. DEV. - Standard deviation.
* S.E. - Standard errors.

APPENDIX 15: LIPID CONTENT OF ALL FRESH WATER FISH FAMILIES FROM FOUR LOCATIONS COMBINED

FAMILY	MEAN LIPID (g/100g)	ST.DEV	S.E.
Cyprinidae	23.32	5.94	0.25
Mormyridae	38.70	3.53	0.17
Bagridae	29.21	5.20	0.15
Schilbeidae	38.03	6.57	0.39
Characidae	41.84	2.54	0.12
Mochokidae	30.37	4.30	0.16
Centropomidae	23.21	4.23	1.03
Clariidae	27.63	2.83	0.20
Cichlidae	22.22	2.44	0.12
Citharinidae	26.40	4.42	0.13
Gymnarchidae	26.10	6.54	1.26
Distichodontidae	26.70	2.96	0.20
Malapteruridae	40.13	6.88	0.95
Osteoglossidae	22.13	5.21	0.40

* The figures represent mean values of lipid content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 16: PROTEIN CONTENT OF ALL FRESH WATER FISH FAMILIES FROM FOUR LOCATIONS COMBINED

FAMILY	MEAN PROTEIN CONTENT (g/100g)	ST.DEV	S.E.
Cyprinidae	36.22	6.71	0.28
Mormyridae	52.46	2.01	0.10
Bagridae	39.82	2.48	0.07
Schilbeidae	38.86	4.65	0.27
Characidae	32.15	1.91	0.09
Mochokidae	41.52	5.46	0.20
Centropomidae	46.86	7.67	1.86
Clariidae	52.76	3.86	0.27
Cichlidae	35.76	1.84	0.09
Citharinidae	40.99	2.12	0.06
Gymnarchidae	37.91	2.54	0.49
Distichodontidae	42.17	5.07	0.34
Malapteruridae	37.63	1.93	0.27
Osteoglossidae	40.15	2.31	0.18

* The figures represent mean values of Protein content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 17: CALORIFIC VALUE OF FRESH WATER FISH FAMILIES FROM FOUR LOCATIONS COMBINED

FAMILY	MEAN CALORIC VALUE (Kcal/100g)	ST.DEV.	S.E.
Cyprinidae	490.60	69.06	2.85
Mormyridae	551.81	25.80	1.23
Bagridae	540.87	54.04	1.57
Schilbeidae	608.68	19.52	1.15
Characidae	601.19	43.96	2.10
Mochokidae	554.55	40.81	1.50
Centropomidae	535.96	54.51	13.2
Clariidae	595.37	24.58	1.75
Cichlidae	511.32	39.46	1.94
Citharinidae	545.81	24.22	0.70
Gymnarchidae	585.70	23.41	4.50
Distichodontidae	527.51	56.85	3.83
Malapteruridae	588.825	23.68	3.25
Osteoglossidae	520.090	23.41	1.79

* The figures represent mean values of caloric content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 18: CALCIUM CONTENT OF ALL FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED

FAMILY	CALCIUM CONTENT (mg/100g)	ST.DEV	S.E.
Cyprinidae	2984.30	288.80	11.9
Mormyridae	2722.10	80.70	3.84
Bagridae	2944.60	75.30	2.19
Schilbeidae	3554.60	266.10	15.7
Characidae	2664.30	61.60	2.82
Mochokidae	4269.50	352.50	12.92
Centropomidae	3986.50	22.70	5.51
Clariidae	3988.10	78.90	5.61
Cichlidae	4186.80	266.50	13.10
Citharinidae	1997.10	73.40	2.11
Gymnarchidae	2330.6	335.8	64.58
Distichodontidae	5252.9	46.70	3.15
Malapteruridae	2430.20	72.40	9.95
Osteoglossidae	2550.10	86.40	6.59

* The figures represent mean values of calcium content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 19: POTASSIUM CONTENT OF ALL FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED

FAMILY	POTASSIUM CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	875.70	107.90	4.45
Mormyridae	737.20	60.80	2.90
Bagridae	687.40	106.10	3.09
Schilbeidae	979.90	64.30	3.79
Characidae	438.50	97.90	4.48
Mochokidae	831.50	56.20	2.06
Centropomidae	649.20	30.00	7.28
Clariidae	625.70	48.5	3.45
Cichlidae	646.20	50.60	2.49
Citharinidae	817.90	122.40	3.52
Gymnarchidae	974.40	44.90	8.63
Distichodontidae	808.00	26.50	1.79
Malapteruridae	516.50	48.20	6.62
Osteoglossidae	770.30	140.10	10.69

* The figures represent mean values of potassium content.

* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 20: IRON CONTENT OF ALL FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED.

FAMILY	IRON CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	27.20	17.43	0.72
Mormyridae	30.21	18.32	0.87
Bagridae	43.07	21.52	0.63
Schilbeidae	15.56	14.90	0.88
Characidae	44.08	23.56	1.08
Mochokidae	39.74	20.61	0.76
Centropomidae	39.44	18.97	4.60
Clariidae	54.38	15.48	1.10
Cichlidae	17.99	14.61	0.72
Citharinidae	55.59	26.28	0.76
Gymnarchidae	62.43	9.89	1.90
Distichodontidae	62.44	17.02	1.15
Malapteruridae	37.63	8.60	1.18
Osteoglossidae	54.93	12.06	0.92

* The figures represent mean values of iron content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIS 21: MAGNESIUM CONTENT OF FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED.

FAMILY	MAGNESIUM CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	249.82	82.60	3.41
Mormyridae	230.28	32.82	1.56
Bagridae	226.15	32.76	0.95
Schilbeidae	147.77	22.13	1.30
Characidae	168.08	25.92	1.19
Mochokidae	162.72	25.02	0.92
Centropomidae	36.51	15.47	3.75
Clariidae	36.32	9.93	0.17
Cichlidae	37.55	10.64	0.52
Citharinidae	52.12	16.37	0.42
Gymnarchidae	44.40	6.37	1.23
Distichodontidae	42.63	8.21	0.55
Malapteruridae	53.54	11.22	1.54
Osteoglossidae	52.12	8.64	0.66

* The figures represent mean values of magnesium content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 22: SODIUM CONTENT OF FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED

FAMILY	SODIUM CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	269.84	151.63	6.26
Mormyridae	229.26	93.52	4.45
Bagridae	226.98	68.12	1.98
Schilbeidae	313.63	24.79	1.46
Characidae	307.64	26.45	1.21
Mochokidae	427.55	35.01	1.28
Centropomidae	341.96	24.13	5.86
Clariidae	307.19	32.91	2.33
Cichlidae	306.05	30.35	1.49
Citharinidae	370.21	78.69	2.27
Gymnarchidae	461.59	31.64	6.08
Distichodontidae	366.54	21.88	1.48
Malapteruridae	270.14	56.70	7.79
Osteoglossidae	498.32	43.20	3.30

* The figures represent mean values of sodium content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 23: COPPER CONTENT OF FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED.

FAMILY	COPPER CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	6.27	5.30	0.22
Mormyridae	8.24	2.13	0.10
Bagridae	4.52	2.47	0.07
Schilbeidae	3.20	1.82	0.11
Characidae	1.75	1.01	0.05
Mochokidae	3.60	1.92	0.07
Centropomidae	2.04	1.36	0.33
Clariidae	2.35	0.98	0.07
Cichlidae	3.70	2.05	0.10
Citharinidae	6.94	3.49	0.10
Gymnarchidae	6.60	1.24	0.24
Distichodontidae	4.46	2.35	0.16
Malapteruridae	2.40	1.09	0.15
Osteoglossidae	6.96	2.94	0.22

* The figures represent mean values of copper content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 24: PHOSPHORUS CONTENT OF ALL FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED

FAMILY	PHOSPHORUS CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	29.35	12.64	0.52
Mormyridae	37.10	11.08	0.53
Bagridae	28.73	10.85	0.32
Schilbeidae	21.36	12.67	0.75
Characidae	16.93	11.09	0.51
Mochokidae	23.96	12.32	0.45
Centropomidae	15.71	11.65	2.83
Clariidae	16.67	10.37	0.74
Cichlidae	18.61	11.00	0.54
Citharinidae	22.31	13.11	0.38
Gymnarchidae	15.19	9.15	1.76
Distichodontidae	16.76	11.53	0.78
Malapteruridae	11.65	10.46	1.44
Osteoglossidae	10.06	9.48	0.72

* The figures represent mean values of phosphorus content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

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APPENDIX 25: ZINC CONTENT OF ALL FISH FAMILIES FROM FOUR LOCATIONS AND SEASONS COMBINED

FAMILY	ZINC CONTENT (mg/100g)	ST.DEV.	S.E.
Cyprinidae	17.03	1.28	0.05
Mormyridae	20.63	1.20	0.56
Bagridae	16.10	3.06	0.09
Schilbeidae	10.78	0.93	0.05
Characidae	15.44	1.49	0.07
Mochokidae	21.06	0.68	0.02
Centropomidae	18.50	0.99	0.24
Clariidae	18.74	0.49	0.03
Cichlidae	16.98	2.26	0.11
Citharinidae	22.50	0.71	0.02
Gymnarchidae	21.20	1.13	0.22
Distichodontidae	16.23	0.52	0.04
Malapteruridae	16.99	0.64	0.09
Osteoglossidae	26.00	1.85	0.14

* The figures represent mean values of zinc content.
* S.E. - Standard errors.
* ST. DEV. - Standard deviations.

APPENDIX 26: EFFECTS OF LOCATION ON AMINO ACID CONTENT OF FRESH WATER FISHES.

AMINO ACIDS	LOCATIONS			
Lysine	1	2	3	4
Mean	10.51	10.48	10.50	10.45
Standard deviation	0.98	0.96	0.87	0.94
Significant "r"	P = 0.06 n.s			
Histidine				
Mean	3.27	3.08	3.23	3.23
Standard deviation	0.57	0.65	0.63	0.63
"r"	P = 1.34 n.s			
Arginine				
Mean	5.06	4.93	5.06	5.03
Standard deviation	0.91	0.96	1.15	0.89
"r"	P = 0.32 n.s			
Serine				
Mean	3.47	3.27	3.41	3.40
Standard deviation	1.18	1.19	1.18	1.19
"r"	P = 0.36 n.s			
Glutamic acid				
Mean	15.80	15.81	15.80	15.93
Standard deviation	1.46	1.46	1.48	1.49
"r"	P = 0.13 n.s			
Proline				
Mean	3.00	2.96	2.97	2.97
Standard deviation	0.45	0.37	0.40	0.40
"r"	P = 0.13 n.s			
Glycine				
Mean	3.90	4.15	4.23	3.96
Standard deviation	1.54	1.73	1.78	1.62
Significant "r"	P = 0.67 n.s			

APPENDIX 26: EFFECTS OF LOCATION ON AMINO ACID CONTENT OF FRESH WATER FISHES.

AMINO ACIDS	LOCATIONS			
Cystine				
Mean	3.08	3.19	3.28	3.14
Standard deviation	0.57	0.61	0.65	0.54
"r"	P = 1.49 n.s			
Methionine				
Mean	2.42	2.36	2.38	2.38
Standard deviation	0.65	0.62	0.62	0.62
"r"	P = 1.0 n.s			
Isoleucine				
Mean	2.85	2.83	2.90	2.92
Standard deviation	1.14	1.18	1.19	1.29
"r"	P = 0.09 n.s			
Leucine				
Mean	5.73	5.55	5.49	5.64
Standard deviation	0.82	1.02	1.06	1.06
"r"	P = 0.81 n.s			
Tyrosine				
Mean	2.94	2.96	2.95	2.89
Standard deviation	0.51	0.53	0.47	0.50
"r"	P = 0.26 n.s			

Significant at < 0.05
n.s. = not significant
1 = Tiga dam
2 = Zaria dam
3 = Shiroro dam
4 = Niger - Benue Confluence.

APPENDIX 27: ROXIMATE COMPOSITION OF FISH SPECIES (g/100g)

FAMILY	Species	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory
1	Labeo Coubie	32.4±3.5	71.6±1.61	12.6±2.60	26.3±1.87	36.1±3.16	500.06
	Labeo Senegalensis	36.1±4.3	73.2±1.82	12.8±2.45	23.7±1.30	34.7± 1.89	468.48
	Barbus Occidentalis	16.4± 4.2	82.7± 4.60	13.6± 3.60	27.2± 0.80	40.3± 1.66	535.81
2	Mormyrus rume	14.6± 0.4	85.4± 1.33	9.0± 1.20	40.1± 0.34	50.6±0.73	696.15
	Mormyrops deliciosus	11.6± 1.7	86.0± 2.30	9.2± 0.64	38.7± 2.53	51.3± 2.04	687.52
	Hyperopsus bebe	15.2± 0.5	84.2± 1.00	8.4± 1.86	36.0± 0.81	51.1± 1.00	657.49
3	Auchenoglanis Occidentalis	6.9± 1.3	92.0± 1.2	10.1± 1.01	30.1± 3.01	42.6± 2.73	561.66
	Chrysichthys nigrodicltatus	15.7± 1.6	85.0± 1.00	9.6± 1.23	31.3± 1.08	41.3± 2.03	563.86
	C Furcatus	15.8± 1.9	84.5± 1.61	9.6± 1.24	31.6± 2.11	42.1± 0.63	571.11
	C. auratus	14.3± 2.1	83.6± 1.32	9.8± 1.01	31.4± 2.12	40.0± 0.04	555.48
	Porcus bayad	15.5± 1.8	65.6± 2.12	13.2± 0.30	29.6± 1.09	27.1± 0.01	484.37
	P. docmac	28.4± 3.7	79.0± 2.22	13.2± 0.40	29.1± 1.06	27.7± 3.14	482.92
	P. Filamatosus	17.5± 1.4	77.0± 1.80	13.2± 0.32	30.3± 1.08	28.3± 2.17	497.62
	Clarites katuceos	23.0± 1.3	64.7± 2.60	8.7± 1.12	30.1± 1.12	28.0± 0.11	475.62
4	Eutropius niloticus	13.4± 0.9	87.6± 1.60	12.8± 1.40	40.3± 2.31	38.9± 0.08	649.28
	Schilbe mystus	10.7± 1.3	88.3± 1.30	11.4± 1.30	36.5± 2.1	32.± 3.11	570.04
5	Alestes nurse	16.0± 1.3	84.0± 1.92	9.8± 0.83	40.7± 2.60	32.1± 1.91	603.38
	Hydrocynus brevis	14.4± 0.7	82.3± 2.10	9.1± 0.33	40.3± 1.78	31.5± 1.67	593.41
	A. macrolepidotus	16.0± 0.8	82.9± 1.72	9.6± 0.40	40.8± 0.80	32.4± 1.15	605.16
	Hepsetus Odoe	17.8± 1.9	80.4± 1.80	10.8± 1.12	40.0± 0.34	30.3± 0.47	570.93
6	Synodontis schall	11.0± 1.4	84.7± 1.00	9.5± 1.12	33.3± 0.6	43.3± 1.04	593.45
	S. Clarias	14.6± 1.3	82.3± 1.33	9.6± 0.80	31.3± 1.32	43.7± 1.88	577.06
	S. budgetti	15.9± 1.5	81.0± 1.87	9.4± 0.62	33.4± 0.31	40.9± 1.31	580.78
	S. membranaceus	23.1± 1.1	78.2± 1.63	9.4± 1.30	30.7± 1.22	39.5± 1.01	547.44
	S melanopterus	19.7± 0.3	76.1± 1.30	9.3± 1.12	30.1± 1.67	36.1± 3.21	522.63
	S filamentosus	9.5± 1.7	86.0± 1.20	9.4± 1.70	29.6± 1.70	45.7± 0.81	571.09
7	Malapterurus electricus	12.1± 3.2	89.0± 0.23	18.5± 1.30	45.3± 1.00	37.6± 5.30	713.00
8	Lates niloticus	17.4± 0.7	78.0± 1.44	11.8± 0.97	25.4± 1.70	46.7± 3.21	546.53
9	Clarias gariepinus	10.5± 0.2	89.0± 1.40	10.2± 1.00	27.6± 1.30	52.4± 0.49	592.22
		8.9± 0.3	89.6± 1.86	10.3± 0.81	28.1± 0.91	52.3± 0.37	596.63
	C. anguillaris	9.3± 0.7	92.1± 1.32	10.1± 0.80	26.3± 1.45	55.7± 0.83	597.61
10	Orechromis niloticus	14.5± 1.3	85.3± 1.22	25.1± 1.80	24.1± 0.33	34.8± 1.03	523.26
	Tilapia zilli	17.4± 1.1	83.0± 1.16	23.7± 1.11	20.3± 1.67	34.3± 1.01	478.67
	Sarotherodon galilaeus	16.5± 1.3	84.5± 1.34	26.3± 1.00	21.4± 1.34	34.9± 0.34	503.08
	Hemichromis fasciatus	24.0± 0.7	76.7± 2.78	23.7± 1.33	22.7± 1.03	32.0± 1.41	488.82

APPENDIX 27 (cont'd): ROXIM ATE COMPOSITION OF FISH SPECIES (g/100g)

	FAMILY	Species	Ash	Organic matter	Carbohydrate	Lipid	Protein	Calory
11.		Heterotis niloticus	15.7± 0.9	84.06± 1.08	22.8± 1.03	25.1± 1.90	36.3± 1.11	540.12
12		Citharinus citharus	12.1± 0.8	84.3± 1.08	16.3± 1.70	27.7± 1.60	39.3± 1.46	576.13
		C. latus	14.5± 1.3	85.1± 1.06	16.7± 0.97	30.1± 0.31	40.8± 0.88	578.82
13		Gymnarchus niloticus	12.7± 1.2	80.0± 2.06	11.5± 1.30	30.0± 3.10	38.1± 2.15	541.70
14		Distichodus rostratus	19.9± 1.6	86.3± 3.20	10.6± 2.00	26.7± 2.30	40.8± 2.01	521.51
		D. engycephalus	20.7± 1.7	87.4± 1.87	11.3± 1.40	25.3± 1.71	41.1± 1.66	512.73

* Figures represent mean and standard deviations of proximate contents.

APPENDIX 28: **Mineral Contents of Fish Species (mg/100g)**

FAMILIES	SPECIES	Calcium		Potassium		Iron		magnesium		Sodium		Copper		Phosphorus		Zinc	
Cyprinidae	Labeo Coubie	3424.0	84.1	1044.2	202.6	22.0	17.4	312.2	63.2	324.4	54.7	6.4	1.8	227.2	4.1	18.6	0.8
	Labeo Senegalensis	3202.2	96.7	824.0	87.1	20.3	13.3	246.4	23.6	270.8	8.6	3.3	1.2	28.0	6.2	18.6	0.7
	Barbus occidentalis	2908.3	148.8	808.2	103.5	17.2	11.0	259.2	43.7	220.3	50.2	5.8	1.9	29.3	3.4	17.0	0.5
Mormyridae	Mormyrus tume	2018.0	99.8	728.2	27.9	26.8	3.8	209.0	16.7	300.2	83.5	7.9	0.9	40.2	3.7	19.0	1.0
	Mormyrops deliciosus	2358.0	86.9	770.3	34.1	32.4	3.6	213.3	28.4	278.6	18.7	8.0	1.1	30.2	1.6	22.4	1.6
	Hyperopisus bebe	2698.7	1008.3	768.7	28.4	25.1	4.2	248.4	32.8	318.0	80.1	9.4	1.2	32.3	1.8	20.0	1.1
Bagridae	Auchenoglanis occidentalis	2898.2	148.6	635.7	36.4	35.8	6.3	200.4	32.7	308.6	22.7	4.1	1.1	25.3	2.6	17.5	1.3
	Chrysichthys nigrodigitatus	2942.0	107.3	703.1	106.1	32.2	9.1	210.5	22.4	318.2	23.3	4.3	1.3	25.0	3.9	18.2	1.0
	C. furcatus	2964.0	240.3	858.4	114.8	38.0	6.3	210.0	20.2	384.0	41.0	5.0	1.1	24.8	3.8	21.0	1.2
	C. auratus	3004.0	186.1	729.3	89.5	28.1	12.0	210.0	20.3	358.3	40.4	3.0	0.5	22.7	4.3	17.0	1.7
	P. bayad	2906.9	188.3	500.0	63.1	30.8	10.2	216.3	21.4	260.8	30.3	3.5	0.6	24.3	4.1	16.5	1.6
	P. docmac	2862.7	169.8	703.1	55.6	36.1	8.3	238.2	23.3	229.4	18.7	4.0	1.0	23.9	5.2	18.7	2.1
	P. filamentosus	3010.0	278.7	732.0	11.3	42.3	5.8	240.6	28.7	278.7	21.1	3.2	0.8	25.1	3.4	19.0	8.4
	Clarotes laticeps	2572.3	326.4	515.4	18.1	28.6	8.5	230.9	15.3	210.3	19.7	3.6	1.0	28.7	6.3	16.3	1.1
Schilbeidae	Eutropius niloticus	3290.0	233.8	616.3	73.2	12.2	2.3	132.6	32.1	313.7	18.2	3.0	0.6	23.3	2.1	10.1	0.7
	Schilbe mystus	3782.0	266.1	517.5	23.7	9.6	1.4	145.4	28.3	280.6	24.7	3.6	0.6	19.7	3.3	12.0	1.3
Characidae	Alestes nurse	2198.6	210.0	582.0	55.7	43.0	3.6	136.2	27.5	314.6	16.5	1.8	0.3	15.0	4.2	18.7	2.4
	Hydrocynus brevis	2080.6	189.3	494.0	62.0	30.2	6.4	158.6	26.4	289.7	21.2	1.0	0.2	15.0	3.1	15.0	0.6
	H. Macrolepidotus	2334.7	553.1	482.9	44.3	31.0	8.7	158.7	18.8	298.7	23.9	1.6	0.5	13.4	2.3	16.0	1.3
	Hepsetus Odoe	2410.3	689.3	455.1	28.7	33.8	6.5	162.0	23.1	278.6	19.8	1.0	0.4	13.3	1.6	15.2	0.8
Mochokidae	Synodontis schall	4004.2	196.6	815.2	32.6	33.8	3.2	142.3	28.4	408.9	20.6	3.6	1.0	23.6	4.2	21.0	1.1
	S. clarias	4822.1	188.3	740.0	88.7	38.6	3.3	144.0	22.2	404.2	27.5	1.8	0.8	22.2	5.1	22.2	1.3
	S bugarti	4564.6	168.7	844.3	29.9	36.8	4.2	150.1	20.3	457.5	21.1	2.3	0.7	20.0	6.2	20.6	0.7
	S. Membranaceus	4022.0	164.0	784.1	103.2	40.4	3.6	151.0	18.9	372.0	32.7	3.0	0.7	21.0	5.1	22.0	0.9
	S. Melaropterus	3898.0	244.6	880.3	53.4	40.2	2.5	150.6	19.3	408.7	19.9	3.4	0.6	22.1	4.8	21.3	1.0

APPENDIX 28 (cont'd): **Mineral Contents of Fish Species (mg/100g)**

FAMILIES	SPECIES	Calcium	Potassium	Iron	magnesium	Sodium	Copper	Phosphorus	Zinc
	S. filamentosus	4098.2 198.3	820.0 22.3	39.0 1.4	162.7 16.2	379.7 42.3	2.8 0.5	20.7 3.4	21.2 0.5
Malapteruridae									
	Malapterurus electricus	2490.2 208.4	445.5 90.6	28.6 3.7	68.1 9.3	270.1 25.2	2.1 0.4	13.2 1.3	17.5 1.3
	Centropomidae								
	Lates niloticus	3978.2 107.9	632.0 28.8	97.0 8.3	24.7 10.3	353.7 24.1	1.8 0.4	16.7 2.7	17.8 1.3
Claridae									
	Clarias mariepinus	3910.2 102.9	638.7 22.6	52.7 5.6	31.3 6.4	260.6 16.7	2.4 0.4	16.2 1.7	18.9 1.6
	C.	4112.3 160.3	589.7 36.2	56.2 6.4	36.3 7.1	308.3 9.8	3.0 0.6	15.6 1.4	17.8 1.4
	C. Anguillaris	4000.6 100.4	648.4 20.8	57.6 9.3	31.2 5.6	317.0 20.3	2.0 0.3	16.0 1.3	18.7 1.8
	Cichlidae								
	Orechromis niloticus	4289.2 110.9	638.4 28.1	13.0 3.2	32.7 3.1	300.3 11.7	3.0 0.6	16.7 2.4	16.0 1.3
	Tilapia zilli	3862.5 204.7	706.2 102.3	9.0 1.8	31.0 2.3	300.7 10.3	3.0 0.5	17.0 2.1	14.3 1.1
	Sarotherodon galilaeus	3956.4 266.5	608.6 57.4	18.7 2.4	37.5 5.6	296.7 11.5	2.9 0.2	15.0 1.8	18.0 1.6
	Hemichromis fasciatus	4525.0 189.3	600.7 38.9	13.0 2.3	32.3 5.4	300.2 10.6	3.6 0.2	18.2 2.3	20.2 2.7
	Osteoglosidae								
	Heterotis niloticus	2100.8 115.6	782.4 57.7	55.6 16.6	42.7 5.2	476.6 26.4	6.8 1.3	9.6 1.0	25.8 2.3
Citharinidae									
	Citharinus citharus	1982.0 110.2	729.4 34.9	54.2 17.0	41.0 13.7	309.7 60.3	6.5 0.9	23.0 1.4	23.6 1.3
	Citharinus latus	1987.7 146.3	795.0 36.3	44.0 22.7	40.1 9.9	318.7 66.1	7.2 1.3	23.0 1.4	22.6 1.2
Gymnarchidae									
	Gymnarchus niloticus	2672.0 177.5	955.4 44.9	56.7 11.5	44.6 6.4	358.2 17.9	6.5 0.8	13.2 1.5	22.0 1.2
Distichodontidae									
	Distechodus rostratus	5186.0 118.3	768.0 26.5	54.9 20.3	40.3 6.8	360.2 18.1	5.3 0.8	14.9 1.1	17.1 1.0
	Distechodus engycephalus	5242.0 107.7	780.2 25.3	54.9 21.6	37.8 8.2	350.7 11.3	4.5 0.3	14.8 1.2	16.2 0.8

The figures represent the mean of values and standard deviations of mineral contents.

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THE E:N, E:T, E:P RATIOS, EAAI AND C.S/P.S OF FISH SPECIES

Species	E:N[a]	E:T[b]	EAAI[c]	C.S/P.S[d]	E:P	E	NE	Total
A1	0.74	42.72	136.07	62.64	1.20	43.46	58.27	101.73
A2	0.80	44.49	130.94	59.80	1.20	41.82	52.16	93.98
A3	0.73	42.35	124.99	57.54	0.99	39.92	54.33	94.25
B1	0.89	47.35	112.56	51.81	0.71	35.95	40.02	75.97
B2	0.90	47.50	109.62	50.55	0.63	35.07	38.76	73.83
B3	0.84	45.66	109.30	50.36	0.68	34.91	41.54	76.45
C1	0.82	45.21	124.49	57.31	0.95	39.76	48.18	87.94
C2	0.98	49.65	141.02	64.92	1.08	45.04	45.67	90.71
C3	0.97	49.46	142.99	65.83	1.08	45.67	46.66	92.33
C4	1.01	50.25	139.33	64.14	1.12	44.50	44.05	88.55
C5	0.81	45.04	128.40	59.11	1.51	41.01	50.04	91.05
C6	0.87	46.64	131.60	60.58	1.51	42.03	48.07	90.10
C7	0.88	46.83	132.41	60.95	1.49	42.29	48.01	90.30
C8	0.83	45.55	128.59	59.20	1.46	41.07	49.08	90.15
D1	1.05	51.26	137.26	63.19	1.12	43.84	41.67	85.51
D2	1.08	51.99	119.73	55.12	1.18	38.24	35.31	73.55
E1	0.88	46.88	143.27	65.96	1.42	45.76	51.85	97.61
E2	0.89	47.24	139.49	64.21	1.42	44.55	49.75	94.30
E3	0.95	48.33	149.54	68.84	1.47	47.76	49.83	97.59
E4	0.85	46.16	137.23	63.17	1.44	43.83	51.12	94.95
F1	1.00	50.18	122.58	56.43	1.29	39.15	38.95	78.01
F2	1.04	51.12	125.24	57.65	0.91	40.00	38.10	78.01
F3	0.94	48.71	129.44	59.85	0.94	41.34	43.52	84.86
F4	0.92	48.11	120.54	55.49	0.85	38.50	41.52	80.02
F5	0.88	46.84	116.28	53.53	0.94	37.14	42.14	79.28
F6	0.85	45.98	116.38	53.57	1.02	37.17	43.66	80.83
H	0.96	49.09	122.08	56.20	1.03	38.99	40.42	79.41

I_1	0.85	46.07	122.83	56.54	0.84	39.23	45.92	85.15
I_2	1.03	50.94	126.40	58.19	0.77	40.37	38.87	79.24
I_3	0.99	49.83	124.71	57.41	0.71	39.83	40.10	79.93
J1	0.88	46.96	133.72	61.56	0.81	42.71	48.23	90.94
J2	0.89	49.23	140.27	64.57	0.85	44.8	50.05	94.85
J3	0.90	47.53	136.67	62.91	0.79	43.65	48.07	91.82
J4	0.87	46.79	118.76	54.67	1.18	37.93	43.12	81.05
K	0.91	47.73	138.70	64.85	1.15	44.30	48.50	92.80
L1	1.02	54.95	153.73	70.77	1.24	49.1	40.25	89.33
L2	1.08	52.04	149.19	68.68	1.16	47.65	43.91	91.56
M	1.03	51.10	140.33	64.60	1.17	44.82	43.00	87.82
N1	0.82	45.33	141.93	65.34	1.11	45.33	54.65	99.98
N2	0.81	49.44	140.83	64.83	1.09	44.98	55.00	99.98

a - Essential to non-essential amino acid ratio

b - Essential amino acid to toal nitrogen ratio

c - Essential amino acid index

d - Chemical score/protein score

e - Essential amino acid to protein ratio

E - Essential amino acids

NE - Non-essential amino acids

Egg total essential amino acid = 319.375

Egg total amino acid = 693.75

Duggal and Eggum, 1977)

Appendix 30 Effects of Location on Physical Parameters and Proximate Components

Parameter	Locations 1	2	3	4
Standard length				
mean	39.60	39.90	39.90	40.3
Standard deviation	102.3	102.4	104.2	108.5
Significance "r"		P = 0.000[s]		
Fresh weight				
mean	617.80	625.60	612.1	610.6
Standard deviation	695.9	741.1	694.0	732.1
Significance "r"		P = 0.01[s]		
Organic matter				
mean	81.35	81.43	82.54	81.13
Standard deviation	7.39	7.32	7.22	7.04
Significance "r"		P = 0.83[ns]		
Carbohydrate				
mean	12.72	12.83	12.51	12.75
Standard deviation	5.92	5.82	6.14	5.95
Significance "r"		P = 0.06[ns]		
Lipids				
mean	28.16	27.87	28.59	28.00
Standard deviation	6.76	6.46	6.87	6.62
Significance "r"		P = 0.24[ns]		
Protein				
mean	40.67	40.67	41.60	40.42
Standard deviation	7.10	6.70	8.19	7.05
Significance "r"		P = 0.55[ns]		
Calory				
mean	542.59	543.41	548.63	540.37
Standard deviation	61.60	57.13	59.65	55.83
Significance "r"		P = 0.39[ns]		

* Significant at ≤ 0.05
ns = Not significant
s = Significant
1 = Tiga dam
2 = Zaria dam
3 = Shiroro dam
4 = Niger-Benue confluence

Appendix 31 **Test of Significance in Amino Acid Contents of Fish Families for the Seasons**

Amino acid (g/100g)	Mean value (±SE) Rainy season	Dry season	Significance "r"
Lysine	10.49±0.077	10.48±0.079	P=0.930^{ns}
Histidine	3.431±0.046	2.972±0.050	P=0.000^{s}
Arginine	5.407±0.069	4.634±0.081	P=0.000^{s}
Aspartic acid	9.690±0.090	9.71±0.092	P=0.87^{ns}
Threonine	3.225±0.054	3.233±0.053	P=0.910^{ns}
Serine	3.630±0.100	3.140±0.092	P=0.004^{s}
Glutamic acid	15.860±0.120	15.870±0.120	P=0.820^{ns}
Proline	2.973±0.033	2.983±0.035	P=0.840^{ns}
Glycine	4.350±0.140	3.780±0.130	P=0.035^{s}
Alanine	4.940±0.120	5.01±0.120	P=0.660^{ns}
Cystine	3.177±0.051	3.164±0.048	P=0.850^{ns}
Valine	3.967±0.071	3.964±0.964	P=0.980^{ns}
Methionine	2.365±0.051	2.407±0.053	P=0.570^{ns}
Isoleucine	2.850±1.170	2.900±0.100	P=0.730^{ns}
Leucine	5.98±0.532	5.225±0.621	P=0.630^{ns}
Tryosine	2.949±0.035	2.926±0.030	P=0.900^{ns}
Phenylalanine	3.546±0.520	3.113±0.322	P=0.025^{s}

SE = Standard error of mean
ns = Not significant
s = Significant at ≤ 0.05

Appendix 32 - Effect of Location on Mineral Contents of Fish Families

Mineral contents (mg/100g)	Locations 1	2	3	4
Calcium				
Mean	3375.2	3314.9	3340.9	3315.6
Standard deviation	985.6	987.6	971.4	978.0
Significance "r"		P= 0.06	n.s.	
Potassium				
Mean	754.6	682.5	687.1	689.0
Standard deviation	153.9	150.0	148.6	150.7
Significance "r"		P= 0.84	n.s.	
Iron				
Mean	69.46	28.18	28.42	28.72
Standard deviation	18.49	13.06	12.99	13.39
Significance "r"		P= 0.97	n.s.	
Magnesium				
Mean	182.17	136.13	138.95	136.03
Standard deviation	100.14	85.35	83.97	83.36
Significance "r"		P= 0.85	n.s.	
Sodium				
Mean	353.43	303.43	309.32	309.37
Standard deviation	85.38	87.94	88.64	89.03
Significance "r"		P= 0.15	n.s.	
Copper				
Mean	7.29	3.12	3.43	3.10
Standard deviation	2.72	1.73	3.27	1.69
Significance "r"		P= 0.62	n.s	

Appendix 32 CONT'D

Phosphorus				
Mean	41.64	17.15	17.21	17.08
Standard deviation	8.63	6.71	6.85	6.79
Significance "r"			P= 0.78 n.s.	
Zinc				
Mean	22.34	24.10	22.11	23.24
Standard deviation	3.44	2.83	3.00	3.10
Significance "r"			P= 0.07 n.s.	

* n.s. = Not significant
s = Significant

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