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Proximate Composition and Mineral Contents of Cultured and Wild Tilapia (*Oreochromis niloticus*) (Pisces: Cichlidae) (Linnaeus, 1758)

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Abstract: Studies were conducted on the proximate composition and mineral contents of wild and cultured tilapia (*Oreochromis niloticus*) bought from Aqua Vista Fish Farm and artisanal fishermen at Nsidung beach, Calabar, Cross River State, Nigeria. The internationally accepted methods of AOAC were used for the analysis. Results obtained were as follows: Moisture (wild individuals: 80.90%, cultured: 80.80%), crude protein (wild individuals: 17.40%, cultured: 17.10%), crude fat (wild individuals: 0.57%, cultured: 0.30%), ash (wild individuals: 1.20%, cultured: 1.31%), Carbohydrate (wild individuals: 0.22%, cultured: 0.20%); Calcium(wild individuals: 28.3 mg/100 g, cultured: 27.0 mg/100 g), Magnesium (wild individuals: 11.9 mg/100 g, cultured: 2.70 mg/100 g), Potassium (wild individuals: 17.1 mg/100 g, cultured: 11.90 mg/100 g), Iron (wild individuals: 151.0 mg/100 g, cultured: 146.0 mg/100 g), Zinc (wild individuals: 67.10 mg/100 g, cultured: 66.9 mg/100 g and Sodium (wild individuals: 13.0 mg/100 g, cultured: 12.7 mg/100 g).

Key words: Proximate composition, mineral contents, wild and cultured tilapia, *Oreochromis niloticus*, Aqua Vista Fish Farm and Nsidung beach

INTRODUCTION

Fish and shell fish are important animal protein and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body (Adeniyi *et al*., 2012). Fin and shell fishes have significant role in nutrient, income generation, employment and foreign exchange earnings of the country (FAO, 2009, 2010).

Oreochromis niloticus, generally feeds in shallow waters, as harmful gases (such as carbon dioxide, hydrogen sulfide and ammonia) and temperature fluctuations found in deep waters create problems for the physiology of the fish (Pfenning *et al*., 2011). The species thrives on the warmer temperatures commonly found in shallow waters compared to the colder environment of the deep lake. In general, tilapias are macrophyte-feeders, feeding on a diverse range of filamentous algae and plankton (Toguyeni *et al*., 1997). The *Oreochromis niloticus* typically feeds during daytime hours. Due to their fast reproductive rate, however, overpopulation often results within groups of Nile tilapia. To obtain the necessary nutrients, night feeding may also occur due to competition for food during the daylight hours. A recent study found evidence that, contrary to popular belief, size dimorphism between the sexes results from differential food conversion efficiency rather than differential amounts of food consumed. Hence, although males and females eat equal amounts of food, males tend to grow larger due to a higher efficiency of converting food to energy.

The biochemical composition of several cultured and wild temperate and tropical fin and shell fishes are reported in literature (Anthony *et al*., 2003; Ogibona *et al*., 2009; Udo, 2012). The health implications associated with their consumption are also reported elaborately (Ackman, 1989; FAO, 2005; Udo, 2012). Researchers affirm that fish and fisheries products and extracts when consumed properly can assist to alleviate or even cure arthritis, blood pressure and weight problem and even heart diseases (Udo, 2012; Udo and Vivian, 2011).

Literature on biochemical analysis of *Oreochromis niloticus* include those of Abdullahi (2000), El-Serafy *et al*. (2005), Job and Ekanem (2010), Udo and Vivian (2011), Udo (2012), Alemu *et al*. (2013) and Ayeloja *et al*. (2013). None of these studies however reports on the biochemical analysis of the species under culture and on those from the wild which the present study is designed.

MATERIALS AND METHODS

Sources of fish samples: Twenty adult *Oreochromis niloticus* (total length 58.0-60.0 cm) and weight between 400.0-430.0 g were bought from Aqua Vista Fish Farm Calabar, (4°6N and 8°5) and artisanal fishmen at Nsidung beach, (5°30 and 8°18) all located within the Calabar and Great Qua Rivers flood plain, Calabar, Nigeria (Fig. 1).

Proximate composition determination: Proximate compositions of fish were determined by conventional method of (AOAC, 2000).

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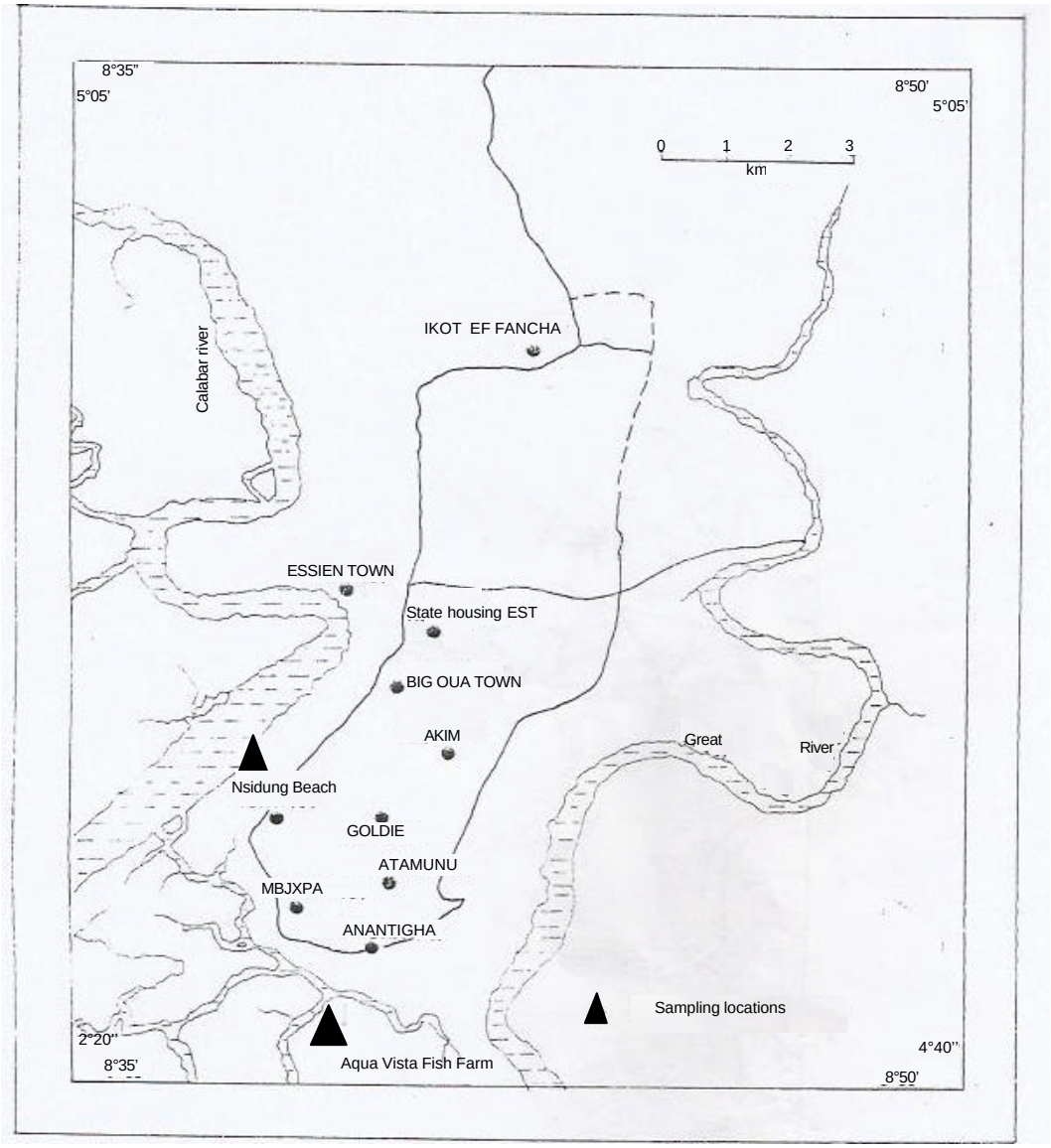

Fig. 1: Map of Calabar and great qua rivers flood plain calabar, Nigeria, showing sampling locations ▲

Estimate of moisture: At first, the initial weight (g) of the samples was taken. Then samples were dried in an oven at about 105°C for about 8 to 10 h until a constant weight was obtained and cooled in a desiccators and weighed again. Then, the samples were the percentage of moisture content was calculated following equation:

Moisture of (%) = weight loses/Original weight of sample) x 100

Estimation of fat: For the estimation of fat content, the dried samples left after moisture determination were finely grinded and the fat was extracted with a non polar solvent, ethyl ether. After extraction, the solvent was evaporated and the extracted materials were weighed. The percentage of fat content was calculated as:

Fat of (%) = (weight of extract/weight of sample) x 100

Estimation of protein: The protein content of the fish was determined by micro-kjeldahl method. It involves conversion of organic nitrogen to ammonium sulphate by digestion with concentrated tetraoxosulphate (vi) acid in a micro-kjeldahl flask. The digest was diluted, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and was determined titrimetrically. The percentage of protein in the sample was calculated by the following equation:

Protein of (%) = (c-b) x 4 x d x 6.25/a x 1000 x 100

Where,

a = sample weight (g)
b = volume of NaOH required for back titration and neutralize 25 mL of 0.1NH_2SO_4 (for sample)
c = volume of NaOH required for back titration and neutralize 25 mL of 0.1NH_2SO_4 (for blank)
d = normality of NaOH used for titration
6.25 = conversion factor of N to protein
14 = atomic weight of N

Estimation ash: The ash content of a sample is the residue left after ashing in a muffle furnace at about 550-660°C till the residue becomes white. The per cent of ash was calculated as follows:

Percentage (%) of ash-(weight of ash/weight of sample) x 100

Crude fiber: Crude fiber was also analyzed following the procedure of AOAC 2.00 g of each sample were weighed into separate round bottom flasks. 100 mL of 0.25M tetraoxosulphate (vi) acid solutions was added to each ample in the flask and the mixtures were boiled under reflux for 30 min. The hot solutions were quickly filtered under suction. The residues were thoroughly washed with hot water until acid-free. Each residue was transferred into the round bottom flasks and 100 mL of hot 0.3M of sodium hydroxide solution was added and the mixtures were boiled again under reflux for 30 min and filtered quickly under section. Each insoluble residue was washed with hot water until it was base-free.

They were dried to a constant weight in an oven at 100°C for 2 h, cooled in a desiccators and weighed (C_1). The weighed samples were then incinerated and reweighed (C_2). Percentage crude fiber content was determined by subtracting the initial weight C_1 from the final weight C_2 and multiplied 100.

Total carbohydrate: The total carbohydrate content was determined by subtracting the sum of the percentage moisture, ash, crude lipid, crude protein and crude fiber from 100%, that is:

Carbohydrate (%) = 100-(moisture+ash+protein+lipids+fiber %)

Mineral analysis: The following elements Calcium, Magnesium, Sodium, Potassium, Iron and Zinc were determined by the methods recommended by AOAC (2000). The ground samples were sieved with a 2 mm rubber sieve and 2 g of each of the samples were weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550°C in a muffle furnace. The resultant ash was dissolved in 5ml of HNO_3/HCl/H_2O (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5 mL of deionized water was added and heated. The solution in each crucible was transferred into a 100 mL volumetric flask by filtration through a Whatman No. 42 filter paper and the volume was made to the mark with deionized water. The solution was used for elemental analysis in an Atomic Absorption Spectrophometer following AOAC (2000) at appropriate wave lengths.

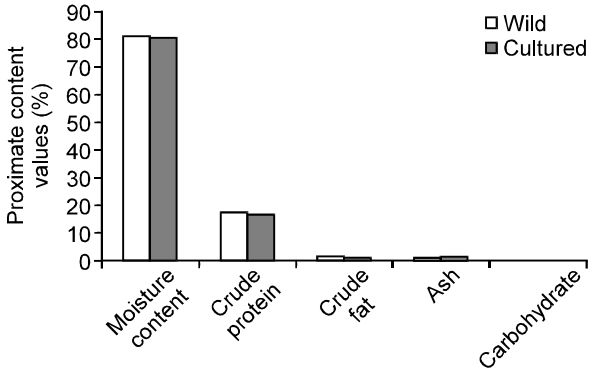

Fig. 2: Distribution of proximate composition (%) in the wild and cultured tilapia (*Oreochromis niloticus*)

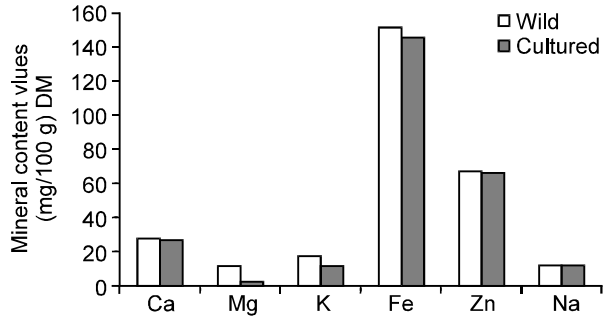

Fig. 3: Distribution of mineral contents (mg/100 g) in the wild and cultured tilapia (*Oreochromis niloticus*)

Data analysis: Data obtained were subjected to analysis of variance (ANOVA) (Shoal and Rohlf, 1968; Ogbeibu, 2005) to establish the difference in the proximate and material composition of the species from each of the culture system. The proximate composition and mineral content values were also compared with international permissible limits of FAO (2010) and USDA (2010).

RESULTS

proximate composition: The proximate composition of the cultured and wild tilapia *(Oreochromi niloticus)* are shown in Table 1. Moisture content was 80.8% in the cultured species and 80.90% in the wild groups, crude protein was 17.6% in the wild species with 17.10% in the cultured species. Ash content had a percentage composition of 1.20% in the wild species and 1.31% in the cultured. The proximate composition of

Table 1: Proximate and mineral composition of wild and cultured Tilapia (*Oreochrimis niloticus*) used for the study

Proximate Composition (%)	Wild	Cultured	FAO (2010) and USDA (2010) Limits (%)
Moisture content	80.90	80.80	78-90
Crude protein	17.40	17.10	15-28
Crude fat	0.57	0.30	15-18
Ash	1.20	1.31	*
Carbohydrate	0.22	0.20	2-5
Mineral contents (mg/100 g) Dm	**Wild**	**Cultured**	**FAO (2010) and USDA (2010) Limits (mg/100 g) Dm**
Calcium, Ca	28.3	27.0	19-881
Magnesium, Mg	11.9	2.7	4.5-452
Potassium, K	17.1	11.9	19-502
Iron, Fe	151.0	146.0	1-5.6
Zinc, Zn	67.1	66.9	0.23-2.1
Sodium, Na	13.0	12.7	30-134

carbohydrate in the wild species was 0.22% in the cultured individuals, while crude protein was 0.57% in the wild with 0.30% in the cultured individuals. The variations in the proximate composition in the wild and cultured *Oreochromis noloticus* are shown in Fig. 2. The proximate composition of the wild *O. niloticus* was significantly higher ($p<0.05$) than those of the caltuned.

Mineral composition: The mineral composition of the two groups of *Oreochromis niloticus* is presented in Table 1. In the wild individuals, 28.3 mg/100 g of calcium was recorded, while the cultured group had 27.0 mg/100 g of calcium. 2.7 mg/100 g of magnesium was recorded in the wild species with 11.9 mg/100 g in the species. 151.0 mg/100 g of iron was detected in the wild with *Oreochromis niloticus* with 146.0 mg/100 g in the cultured species. Total of 67.1 mg/100 g of zinc was recorded with 66.9 mg/100 g in the cultured; while 13 mg/100 g of sodium was detected individuals with in the wild 12.7 mg/100 g in the cultured individuals.

The mineral contents in the *Oreochromis niloticus* was significantly higher ($p<0.05$).

DISCUSSION

Data obtained from the present study revealed that the proximate composition and mineral contents of wild *Oreochromis niloticus* were higher than those of the cultured individuals. The term fish quality is all encompassing and its study difficult owing to the fact that specific parameters that are recognized as being a virtue in one part of the world are judged to be less important elsewhere (Rasmassen, 2001).

The ranges of values of the proximate composition and mineral contents of the *Oreochromis niloticus* from the artisanal fishermen of the Calabar River used in this study are within the ranges of values recorded for the species from the wild by El-zaeem *et al.* (2012) from Manzalah Lake, Nile River and Eku Lake and for those under culture in Egypt. Similar ranges of both the proximate and mineral contents reported in this study have been reported by Violer and Zoher (1984) from individuals from Bangladesh and FAO (2010) and USDA (2010) permissible limits for fish and fisheries product. *Oreochromis niloticus* is an omnivore that feeds on both plankton and aquatic plants. The chemical concept from differences between wild and farmed fish species and groups may be attributed to some environmental factors. In general, tilapias are macrophyte-feeders, feeding on a diverse range of filamentous algae and plankton (Toguyeni *et al.*, 1997).

In the wild, there is wide diversity of microscopic organisms and macrophytes which fish species generally feed on (Toguyeni *et al.*, 1997; Job and Udo 2002; Olojo *et al.*, 2003; Pfenning *et al.*, 2011). These may be lacking in controlled systems like ponds (Abdullahi, 2000; El-zaeem *et al.*, 2012). In this connection, Favalora *et al.* (2002), Flos *et al.* (2002) and El-zaeem *et al.* (2012) reported that the quality of fish is affected by parameters such as feed type, level of dietary intake and growth. Feed composition is also a major factor influencing the proximate composition and mineral content of fishes (El-zaeem *et al.*, 2012). Fish body composition, as well, is largely influenced by feed composition (Adewoyei and Omotosho, 1997; Adewoyei *et al.*, 2003; Fawole *et al.*, 2007; Adeniyi *et al.*, 2012; Favalora *et al.*, 2002).

An increase in other parameters such as feeding rate and fish size also result in enhanced adipose deposition and decrease water moisture content in the fish body (El-zaeem *et al.*, 2012). The protein content however, remained less stable. An increase in body fat content is generally accompanied by reduction in slaughter yield owing to an increase in the weight of viscera in relation to body weight (Abdullahi, 2000; El-zaeem *et al.*, 2012). The levels of proximate constituents of the whole body as well as the fillets of fishes are readily manipulated by feed composition and feeding strategies, whereas sensory parameters are less affected by these variables (Favalora *et al.*, 2012; El-zaeem *et al.*, 2012).

The interplay of the aforementioned factors have been previously advanced as reasons responsible for the usually observe differences in wild and cultured fish species (Ackman, 1989; Hossain, 1996; Toguyeni *et al.*, 1997).

Conclusion: From the results of the study, wild *Oreochromis niloticus* has higher values of proximate composition and mineral contents than the cultured. This shows nutritive superiority of the wild *Oreochromis niloticus* over the cultured individuals. The two cichlid groups are however good sources of protein, calcium, potassium, iron, zinc and sodium as they are known good nutrient sources for enhanced growth and repairs of worn-out tissues in children and older adults.

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