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The Proximate Composition and Mineral Contents of Two Economically Important West African Cichlids: *Heterotis niloticus* and *Oreochromis niloticus* (Pisces: Cichlidae)

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Abstract: This study investigated the proximate composition and mineral contents of two commercially important cichlids, *Heterotis niloticus* and *Oreochromis niloticus*, reared in fish ponds in Nigeria. The method of study followed internationally accepted procedures after AOAC. Crude proteins in both species were 18.92±0.11 gm/100 gm and 21.86±0.02 gm/100 gm for *H. niloticus* and *O. niloticus* respectively. Carbohydrate was 5 times more in *H. niloticus* than in *O. niloticus*. Ash, moisture, crude fat and NFE were similar in both species ($p>0.05$). Similarly, the concentration of calcium, iron, copper and phosphorus were not significant in the species ($p>0.05$). However, sodium and potassium were 3 and 2 times higher in *H. niloticus* when compared to that measured in *O. niloticus*. The significance of these results are discussed on the basis of their economic, social and health uses.

Key words: Cichlids, fish meal, animal feeds

INTRODUCTION

The prominence of fish meal (imported or local) in the production of animal feeds can not be disputed. Adeyeye *et al.* (2008) reported on the quality of the shell and flesh of *Penaeus notabilis* and stated that they are good in the production of sausages, soup and cakes. Olomu and Nwachukwu (1972) emphasized on the use of fish meal for the production of feeds for broiler chicken.

Recently, Scientists have sort after other possible sources of cheap and easily available protein that can substitute the expensive fish meal used in animal feed production. For example, Ojewole *et al.* (2003) tested grasshopper meal for broiler chicken feed; Agunbiade *et al.* (2004) used shrimp meal and cassava products as supplement for diet of broiler chicken. Fasakin and Merce (1992); Fasakin (2002) also tested some aquatic plants as possible replacement of fish meal in animal feeds. The possibility of using shrimp head (discard) meal as source of protein in feeds was tested by Meyer (1986) and Nwanna (2003). These authors asserted that shrimp head meal contained high level of excellent profile of amino acid which compared favorably with artificial fish meal. Most other authors have equally tested and recommended the use of cheaper protein sources such as maggots, snails, periwinkles, etc, to replace fish meals with measurable success. However, most of these substitutes are expensive and their usage will result in great competition with man who also needs them as food and supplements.

Heterotis niloticus and *Oreochromis niloticus* are fish species that provides cheap and affordable protein to the populace (rich and poor) and are easily available in Nigeria in most fresh waters. Most *Tilapia* species are stunted in their natural habitats and in poorly managed fish ponds. These stunted individuals attract low prices and patronage from most consumers in Nigeria. *Heterotis niloticus* usually grows very large but due to its taste it is also not attractive and commands low patronage. An alternative use therefore for these species is to convert them to other uses, particularly into fish meals.

This study presents data on the nutritive value and chemical/mineral composition of *H. niloticus* and *O. niloticus*. This preliminary study will provide information that could be useful clues to the adoption of these species in the production of fish meal for animal feeds. Most fish meals contain protein levels approximating 60%. For example *Pellonula* species meal (Ojewole and Udom (2005) contain 56.12%, *Tilapia zillii* of Lagos Lagoon has a protein content of 47% (Osibona *et al.*, 2009) and *Clarias gariepinus* fed with different diets prepared by Nwanna (2003) gave protein contents of between 69% and 70% respectively. When the proximate food value of wild and cultured *Hypophthalmicthys molitrix* (Silver carp) and *Ctenopharyngodon idella* (Grass carp) were investigated by Ashraf *et al.* (2011), crude protein level of 20.00±0.15% and 19.46±0.2% were reported for farmed and wild fish respectively. In the same study, wild Grass carp contain more protein (19.73±0.15%) than Silver carp also caught from the wild, which showed protein of 15.80±0.12%. In the blue mackerel, Vlieg (1988) reported 49.7% for protein and gave data for protein in marine fin-fishes in Australia to ranged between 14% and 50% respectively.

The gross energy (Kj/kg) value of an organism indicate the nutritive excellence of that organism; the lower the gross energy of an organism the better it nutritive value and vice versa. Several authors have linked the energy value measured in an organism to the calories that could be absorbed from that organism (Anthony *et al.*, 2003).

The mineral component of organisms are necessary factors that assist in the choice of species for use as food supplements or additives. The benefits of these minerals derivable from fish to their consumes are numerous. Valuable minerals in organisms are two classes namely; the macro- minerals and micro-minerals. Macro-mineral elements are those whose daily bodily requirements can be measured and vice-versa for the micro minerals (Satter, 2007). Fawole *et al.* (2007) listed calcium, sodium, potassium, phosphorus and iron as the most important macro minerals whose deficiency could lead to malfunctioning of body systems and could equally cause disease conditions and affect reproduction in species. These mineral elements are important components of the structure of bones and other body tissues (NRC, 1989, 2001). For example, 99% of body calcium of organisms is in the bones (Satter, 2007). Generally, sea foods are prominent sources of minerals and fish are among the most important source for excellent supply. Minerals are reported to contribute to bone formation, participate in metabolic activities, in the formation of hemoglobin, myoglobin and hemenzyme in animals. They also participate in blood clotting, muscle contraction, bone and teeth formation/repairs and in some enzymatic metabolic processes. Some are also known as agents in the regulation of pH, osmotic pressure, water balance, nerve impulse transmission and active transport of glucose/amino acids (Mercer, 1992; Lee *et al.*, 1993; Abulude *et al.*, 2006). However, when these mineral elements are accumulated in body systems beyond threshold limits they become hazardous to health. For example, copper at high concentrations and with its carcinogenic influence are dangerous to human health. Udo and Arazu (2011) measured high concentrations of copper in some fishes imported into Nigeria while most local fish species contain copper below threshold limits (Asuquo *et al.*, 2004).

MATERIALS AND METHODS

Specimens of *H. niloticus* and *O. niloticus* were harvested from the fish ponds of the Department of Fisheries and Aquaculture, Institute of Oceanography, University of Calabar, Calabar, Nigeria. Only matured adults specimens measuring 400 gm each (*H. niloticus* and *O. niloticus*) were selected for the study. From each species, ten whole individual specimens were used for the study; fins, internal organs, head and scales were not removed. Specimens were washed, dried with towel and weighed. They were further dried in oven for 24 hrs at 75°C. The difference in weight before and after this extensive drying was considered as the quantity of moisture in the specimen.

The dried specimens were powdered and stored in labeled containers for further determinations. Methods extant in AOAC (2000) were used for the determinations of the proximate composition and mineral contents of the homogenized specimens. Crude protein was determined with Micro-Kjeldahl method, fat by Soxhlet extraction, ash by furnace ashing at 600°C for 12 hrs while NFE was by difference.

The mineral composition of the samples were measured with the Spectrophometer at different wavelengths as follows: Iron at wavelength 420 nm, Calcium at 48 nm, Sodium at 380 nm and Nitrate 320 nm while Phosphates, Magnesium and Copper were read at 420 nm, 568 nm and 62 nm respectively. The results obtained from these measurements were expressed in mg/100 gm. Student t-test was applied to compare the results (Sokal and Rohlf, 1968) in order to ascertain significant differences in the concentration of the elements in these organisms.

RESULTS

Ash, fat and NFE in *Heterotis niloticus* and *Oreochromis niloticus* were not significantly different ($p>0.05$) (Table 1). Carbohydrate in both species were significantly different from each other ($p>0.05$). Calories (energy) was higher in *H. niloticus* giving 339.99±0.05 kj/kg and 263.30±0.1 kj/kg in the other species (Table 1). Also *H. niloticus* contain more crude protein than *O. niloticus* of the same size (Table 1).

Similarly, the concentration of sodium (381.10 mg/100 gm) in the fishes was high in *H. niloticus* than in *O. niloticus* giving 104.50 mg/100 gm. Except iron, phosphate, nitrate/nitrogen and phosphorus whose concentrations are similar ($p>0.050$), the concentrations of calcium and potassium in both species were significantly different (Table 2) ($p>0.05$). Copper was not detected in any of the species.

DISCUSSION

Fish has high food potential and could be expected to give relief to humans from malnutrition especially in countries with low income earners and with high protein demand (FAO, 2005; Ashraf *et al.*, 2011). The quality of fish protein is superior to that which could be obtained from milk, meat and eggs. It this reported in literature that fish has well balanced amino acid profile, needed minerals as well as fatty acids (Ashraf *et al.*, 2011). In this study, *H. niloticus* showed significantly lower moisture and low protein contents (18.92 gm/100 gm Vs 21.86 gm/100 gm) than that measured in *O. niloticus* ($p>0.050$) (Table 1). Also, the ash content of *O. niloticus* was significantly higher (16.5 gm/100 gm Vs 5.0 gn/100 gm) than that measured in *H. niloticus* (Table 1). The moisture content measured in *O. niloticus* of this study

Table 1: The proximate composition of *H. niloticus* and *O. niloticus* from fish ponds in Nigeria

Fish species	Proximate composition (gm/100 gm)						
	Protein	Carbohydrate	Moisture	Ash	Fat	NFE	Energy (kj/kg)
H. niloticus	18.92±0.11	30.00±0.02	51.00±0.12	5.0±0.00	16.02±0.20	3.00	339.00±0.05
O. niloticus	21.86±0.02	06.13±0.02	59.30±0.15	5.5±0.10	16.50±0.30	3.60	263.30±0.15

Table 2: Some trace and major elements in *H. niloticus* and *O. niloticus* obtained from fish ponds in Nigeria

Fish species	Mineral components (mg/100 gm)							
	Na	Ca	Cu	Fe	K	PO_4	NO_3 + N	P%
H. niloticus	381.10	14.32	0.00	119.01	34.30	1.11	34.60	33.30
O. niloticus	104.50	17.10	0.00	120.60	16.80	1.34	32.90	33.33

is different from that reported for *Tilapia zillii* (80.4±3.7%) of Lagos lagoon, Nigeria. The protein content of *O. niloticus* of this study is 21.86% (Table 1) and that reported for *T. zillii* was given as 19.0±1.9% (Osibona *et al*., 2009). These authors and Kleimenov (1971) stated that *T. zillii* belongs to the high protein-low fat with high moisture content category of fish. In this study, it was discovered that *O. niloticus* of Calabar fish ponds and *Tilapia zillii* caught in Lagos, Nigeria are both high protein-low fat and high moisture fishes. The fat content of 4% and 6% are reported in this study for *H. niloticus* and *O. niloticus* respectively (Table 1).

The proximate food value reported for Grass carp and Silver carp indicate high moisture/high protein with significantly higher lipid concentration in cultured individuals (Ashraf *et al*., 2011). This result is similar to the findings of the current study on *O. niloticus* and *H. niloticus*. These results also tend to collaborate with that of Asraf *et al.* (2011) in establishing a pattern that higher lipid contents is always associated with high moisture and protein in farmed fish species. For example, cultured perch showed higher protein and fat while these were lower in wild perch (Jankowska *et al*., 2007); water contents in cultured catfish *Pagellus bogaraveo* (Black sea bream), European sea bass, (*Dicentrachus labras)* and yellow perch (*Perca flavescens*) was lower than the moisture in wild individuals (Boujard *et al*., 2004; Gonzales *et al*., 2007 and Alvarez *et al*., 2009). It also seem to be generally accepted that moisture, protein and lipid contents of fish increased with size. But in this study the moisture content of *H. niloticus* and *O. niloticus* of the same size were significantly different from each other with that of *O. niloticus* being higher than that determined in *H. niloticus*. This observation may have originated from the fact that *O. niloticus* and *H. niloticus* being different species living within the same ecological environment probably are able to exhibit some similarity in physiological adjustments to the habitat. Oduor-Odote and Kazungu (2008) reported that fat and other food constituents in fish also vary as a result of feed intake, migratory swimming or sexual change related to spawning among other factors in the environments.

Minerals: In this study, copper was not detected in any of the species; calcium and potassium were low in concentration. Literature reports that calcium, (a macro mineral) is responsible for blood clotting, muscle contraction, the formation of bones, muscles and teeth in animals (Mercer, 1992). Satter (2007) reported that about 99% of calcium is found in the bones and by implication; the low concentration of calcium in the species of this study may be linked to the mineral being completely utilized for body tissue formation. Both species has high concentration of sodium and iron (Table 2). Sodium is needed for the regulation of pH, osmotic pressure, water balance, nerve impulse transmission and the active transport of amino acids *(*NRC, 1989; 2001*)*. Iron takes part in the formation of hemoglobin, myoglobin and hemenzyme *(*Lee *et al*., 1993).

Potassium is a micro element in *H. niloticus* and *O. niloticus* respectively. This element is always bonded to protein molecules and also is known to contribute to the stabilization of body pH of animals (Abulude *et al*., 2006). The concentration of the minerals in the specimen of this study have not exceeded WHO (1998) recommended/permissible levels in aquatic species. This probably shows that, the mineral elements found in these species are at levels that are safe for human consumption. It also indirectly shows that the ponds from where the animals of this study originated receive water supply from chemically clean sources which are probably free from pollution.

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