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Nutritive Value of *Ethmalosa fimbraita* (Clupeidae), *Mugil cephalus*, (Mugilidae) and *Cynoglosuss senegalensis* (Cynoglossidae) of the Cross River Estuary, Nigeria, West Africa

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Abstract: The nutritive value and the content of some minerals were investigated in three commercially important marine fish species of the Cross River estuary, Nigeria. The fishes studied using standard procedures as recommended by AOAC were *Ethmalosa fimbraita*, *Mugil cephalus* and *Cynoglosuss senegalensis*. The protein, carbohydrate, fat and moisture contents were 18.50%, 9.63%, 8.70% and 66.50% in *E. fimbraita* while these results in *M. cephalus* were 19.75%, 11.75%, 8.60% and 63.66% respectively. Data obtained for *C. senegalensis* were 19.76% for protein, 9.22% as carbohydrate, 9.02% for fat and 65.02% for moisture. Trace elements, e.g. iron and manganese were high in concentration in these species than the major elements. The concentration of most of the studied elements were significantly similar in the species except Copper (Cu^{2+}), which was more concentrated in *C. senegalensis* than in the other two species. The ash content was higher in *C. senegalensis* and *M. cephalus* ($p>0.05$) while that in *E. fimbraita* was significantly lower in concentration ($p>0.05$). These probably underscore the importance of the other two species being richer sources of minerals than *E. fimbraita* in the Cross river estuary.

Key words: *Ethmalosa fimbraita*, *Mugil cephalus*, *Cynoglosuss senegalensis*

INTRODUCTION

A number of studies have been carried out on the chemical, proximate composition and caloric energy value of several fish species from the fresh and salt waters (Vlieg, 1988; Ackman and McLeod, 1989; Saadettin *et al*., 1999; Abdullahi, 2001; Muhammad Ashraf *et al*., 2011). Fish in diets can be very nutritious to man; it is rich in most of the needed vitamins, it contains a good selection of minerals and its protein contains all the essential amino acid in the right proportions (Kinsella *et al*., 1978; FDA, 2009; Kalay *et al*., 2008; Tremblay, 2011).

The principal components of the fish include water, (about 70-80% of body weight), protein, low calorie fat and fiber. The minor constituents are carbohydrate, minerals (in usable form), vitamins and Nitrogen Free Extracts (NFE).These biochemical qualities vary from one species to another depending on food composition, food and feeding habit, feeding rate, habitats, sex, age, size, genetic traits and season/migration (Dawson and Griman, 1980; Abdullahi, 2001; Ajah, 2009).

Literature reports that *Mugil cephalus* and *Cynoglussus* sp of the Brazilian Coast has the fat contents of between 2.0-8.7% and 1.0-5.4% respectively (Menon and Wataneba, 1971) while the fat in *M. cephalus* of New Zealand marine waters is between 3.86-14.6% (Vlieg, 1988). It has also been observed that the oil content of these species vary with their sizes, larger fish with about 1% fat more than smaller ones. Carbohydrate in the fish muscles of fishes that feed on leaves is generally within the range of 18-40% but values as low as 2-4% in white muscles and fatty fishes are rare.

Fish seem to be the only source of essential and balanced minerals in usable form to man (Marvin and Shaw, 1996). The mineral contents in fishes vary remarkably from species to species (Austreng and Refstie, 1979; Kalay *et al*., 2008). Whole fish, muscles and fillets, however, contained low levels of copper (Cu^{2+}) and zinc (Zn) within the range of 0.1-4.0 mg/100 g. There are not much significant differences between this concentration in the above mentioned parts and other anatomical parts as regards sodium (Na^{+}). Manganese (Mn^{2+}) and iron (Fe^{2+}) (Saadettin *et al*., 1999; Kalay *et al*., 2008). Magnesium and potassium levels in the muscle of sea fishes range from 5.0-6.0 mg/100 gm. These fishes are also reported to contain more iron (Fe^{2+}) compared to the other minerals (Okoye, 1998; Tremblay, 2011).

Ethmalosa fimbraita, *Mugil cephalus* and *Cynoglosuss senegalensis* are marine water fishes; the first and the second being pelagic/benthopelagic and the later demersal. *E. fimbraita* feeds on phytoplankton, plant materials and algae. It can attain a final total length of approximately 14.5 cm and 17.2 cm in the Chinese

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brackish waters and the Cross River estuary respectively (Menon and Walsh, 1971; Moses, 1980). *Mugil cephalus* inhabits estuarine intertidal, freshwater and coastal marine environments. They are also found in lagoons as juvenile fish and are most common in impounded areas around mangroves in sea grass beds and offshore. *M. cephalus* attains an adult size of 46 cm (Aperkin and Vilenskaya, 1978; Greeley *et al*., 1987; Isangedidhi, 2010). Their fingerlings feeds on copepods and other zooplanktons but as adults they feed on detritus and algae. The habitats, food and feeding habits, food values, migrating/ swimming and sexual changes in *Cynoglosuss senegalensis* is equivalents to that of *Mugil cephalus*.

In this study, we provide first hand data on the proximate composition and value of some important mineral constituent of *Ethmalosa fimbriata*, *Mugil cephalus* and *Cynoglosuss senegalensis* of the Cross River estuary, Nigeria. These fishes are important marine fish species caught regularly by artisanal fishermen in this estuary and its surroundings. They are highly consumed by the low income earners and cherished as a delicacy in the fish consuming communities of Nigeria.

MATERIALS AND METHODS

Six specimens each of *Ethmalosa fimbraita*, *Mugil cephalus* and *Cynoglosuss senegalensis* weighing approximately 98.7 gm used for this study were bought fresh from the fishermen. In the laboratory, each specimen was filleted and dried in an oven at 75°C for 24 hrs. The specimens were re-weighed after drying to determine their moisture contents.

The dried fillets were powdered and stored in an air tight container for analysis Methods extant in AOAC (2000) were used for the determinations of the proximate composition and mineral contents of the homogenized fillets. Crude protein was determined using the Macro-kjeldhal method, fat by Soxhlet extraction, ash by furnace ashing at 600°C for 12 hrs while NFE was by difference (AOAC, 2000). The mineral content of the animals were determined from the solution obtained after dissolving the ash (residues left after burning in furnace) in distilled water containing a few drops of concentrated HCL. Sodium and potassium were measured with flame photometer (AOAC, 2000). Iron, Manganese, calcium was determined with the Spectrophometer at different wavelengths.

Single classification One Way Classification Analysis of Variance (ANOVA) (Sokal and Rohlf, 1969) was used to establish differences in the proximate and mineral composition of the species. Further comparison of the concentration of the minerals to determine threshold limits was by matching of data obtained from this study with standard values of permissible limits for metals in aquatics species (GESAMP/IMO/FAO/UNESCO/WMO/WHO/IAESA/UN/UNEP, 1977; FAO/WHO, 1984; WHO, 1998).

RESULTS

Proximate composition: The food value of *M. cephalus* and *E. fimbraita* ($p>0.05$) were similar to each other but were significantly different from that of *C. senegalensis* of the Cross River estuary. Moisture content was significantly lower in *M. cephalus* than in both *E. fimbraita* and *C. senegalensis* (Table 1). Fat in *C. senegalensis* was equally low with high ash content when it is compared to that measured in the other two species (Table 1) The crude protein level of *E. fimbraita* was lower than that measured in *C. senegalensis* and *M. cephalus* respectively. The energy value measured in *E. fimbraita* and *M. cephalus* were statistically similar ($p>0.05$) giving 449.55 Kj/kg and 450.83 Kj/kg respectively; but were significantly different from 384.45 Kj/kg measured in *C. senegalensis*. The ash level of the three species were different from each other (Table 1).

Mineral concentration: The concentration of trace and major elements in *E. fimbraita*, *M. cephalus* and *C. senegalensis* were high although with significant differences in some of the elements.

The concentration of magnesium, phosphorus, manganese and lead were similar in these three species ($p>0.05$). There were drastic differences in the concentration of potassium, zinc and copper in *M. cephalus* compared to the other species (Table 2). The lowest value of 0.83 mg/100 gm was recorded as

Table 1: The proximate composition of *Ethmalosa fimbraita*, *Mugil cephalus* and *Cynoglosuss senegalensis* of the Cross River estuary (Mean weight = 98.7 gm; Mean Total Length h = 20.5 cm)

	Moisture	NFE	Protein	Crude fiber	Ash	Fat	Carbohydrate	Energy
Specimen	Proximate composition (%)							(Kj/kg)
E. fimbriata	66.50	2.96	18.50	0.01	1.90	8.70	9.63	449.55
M. cephalus	63.66	3.15	19.75	0.03	2.20	8.60	11.75	450.83
C. senegalensis	65.02	3.16	19.76	0.02	4.50	9.02	9.22	384.45

Table 2: The mineral composition of *E. fimbraita*, *M. cephalus* and *C. senegalensis* of Cross River estuary, Nigeria (mg/100 gm)

Specimen	Na^+	K^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Zn	Cu	P	Mn	Pb
E. fimbraita	307.76	11.40	92.80	7.32	114.50	1.19	3.44	6.90	33.50	4.23
M. cephalus	246.60	9.12	74.30	7.22	27.70	0.29	0.83	6.50	32.70	4.60
C. senegalensis	308.10	11.00	93.30	7.37	92.20	0.96	2.77	6.20	35.20	4.51

Table 3: Data on the proximate components of some marine fin fishes of New Zealand closely related to the specimens of this study

Fish species	Protein (%)	Oil (%)	Moisture (%)	Ash (%)
Mugil cephalus	18-21.1 (19.5)	3.8-14.6 (10.7)	61.0-70.2 (64.4)	4.2-7.1 (5.9)
Pelotretis flavibitus	18.4-19.5 (18.0)	2.0-3.2 (2.5)	74.5-76.3 (75.2)	3.0-4.2 (3.5)
Aldrichetta forsteri	17.2-19.1 (18.20)	3.6-5.6 (4.6)	72.8-75.2 (73.9)	2.7-3.5 (3.3)
Chrysophrys auratus	17.4-18.9 (18.2)	2.2-5.1 (4.1)	70.8-73.7 (72.1)	4.5-5.7 (5.0)
Peltorhamphus novaezeelandiae	18.0-18.6 (18.3)	3.7-4.6 (4.2)	74.5-75.3 (74.7)	2.6-2.9 (2.8)

• Data in brackets are mean values (Vlieg, 1988)

copper in *M. cephalus* while its concentration in *C. senegalensis* and *E. fimbraita* were similar ($p>0.05$). In like manner, the concentration of sodium, potassium calcium, copper and zinc were significantly lower in *M. cephalus* than in the other two species.

DISCUSSION

Data obtained from the current study revealed that the proximate composition and mineral contents of the species are similar to those reported for most marine fin fish species throughout the world (Vlieg, 1988; Ayalogu, 1980; NRC, 1989; Udo and Arazu, 2011) (Table 3). This study show that the proximate composition of *E. fimbraita*, *M. cephalus* and *C. senegalensis* of the Cross River estuary validates international data reported for other species (Table 2); in terms of crude protein and moisture content. However, the species of the Cross River estuary showed slightly lower levels of moisture than their New Zealand counterparts. This slight difference in moisture could relate to the environments of the species; New Zealand is a temperate region while the Cross River estuary is in the tropics. Literature reports that weather or seasonal changes influence the food value of fish species (Kinsella *et al*., 1978; Kalay *et al*., 2008). The fat/oil content of the species from New Zealand are also lower except in *M. cephalus* whose fat content closely resembles that of *M. cephalus* of the Cross River estuary. This result differs from the 2.0-8.7% reported for *M. cephalus* and 1.0-5.4% for *Cynoglossus* of the Brazilian coast. It appears that these species in the Cross river estuary are more oily than their counterparts from Brazil. *E. fimbraita* showed lower ash content than *M. cephalus* and *C. senegalensis* in the Cross River estuary. A comparison of the ash content measured in other marine species indicates that the value of ash in *E. fimbraita* is not unusual. Udo and Arazu (2011) reporting on the proximate composition of frozen *Scomber scombrus*, *Sardina pilchardus* and *Trachurus trachurus* reported similar high values as in this study. Vlieg (1988) recorded the values of ash in *M. cephalus* and two species of New Zealand sole to range between 2.8-5.5% (Table 3). These values are similar to the values determined in this study for *M. cephalus* and *C. senegalensis* (Table 1).

Energy (calories) values determined in this study were similar in *E. fimbraita* and *M. cephalus* but different in *C. senegalensis*. These differences could probably be linked to the niche and feeding habits of the three species; *C. senegalensis* is a demersal species relying on detritus and other benthic substances for food. It is not a very active fish while the other two are active swimmers and pelagic/benthopelagic species.

It seems that *C. senegalensis* and *M. cephalus* has more carbohydrate than *E. fimbraita*; higher than what it should be in marine species. Low values of carbohydrates are often reported in literature for marine fish species, USDA (2010) reported. Udo and Arazu (2011) measured carbohydrate values of between 0-11.6% in threes species of frozen fishes imported into Nigeria and 60% carbohydrate for the shell of a local crab species, *Callinectes amnicola* of the Cross River, Nigeria (Udo and Arazu, 2011).

Mineral composition: The mineral contents of fishes vary from species to species based on factors such as sex, age and ecological makeup of fish environment (FDA, 2009; Tremblay, 2011). There are generally a few of them which are common in all saltwater fish including calcium, iron, potassium, magnesium; some fish muscles and fillets contain low levels of copper and zinc. The most important minerals in fish are calcium and phosphorus. Calcium is the most abundant mineral in humans existing as hydroxyapatite (hard mineral which provides strength to the bone and teeth); very important to humans for it role in blood clotting, muscle contraction, bone and teeth formation/repairs and also an important factor in enzymatic metabolic processes (NRC, 1989, Tremblay, 2011). In this study the concentration of calcium was high in all the specimens studied for this report (Table 2). This probably implies that these three fish species are excellent sources of calcium in the order of their concentration as follows: *C. senegalensis* > *E. fimbraita* > *M. cephalus*. Further comparison of the calcium in the species of this study with other results from literature on other marine species show that Mackerel and some catfishes exhibit lower calcium levels in the range of 13.20 mg/100 gm and 12.87 mg/100 gm (USDA, 2010). Udo and Arazu (2011) reported calcium values of 2.80 mg/100 gm, 2.08mg 100/gm and 2.11 gm/100 gm for *Scomber scombrus*, *Trachurus trachurus* and *Sardina pilchard* respectively. In this study the calcium content of *E. fimbraita* was similar to that measured in *C. senegalensis* and significantly different from the value obtained from *M. cephalus*. Generally these two species with similar calcium concentration are very bony and have tiny scales tightly assembled together on the skin. These body areas probably constituted the major origin of the high calcium in their body. Phosphorus in conjunction with calcium, contribute to strengthening the bones and teeth especially in children and lactating mothers. The concentration of phosphorus in the three species is similar implying that all are excellent sources of the mineral and are possibly are of equal quality to serve the phosphorus needs of humans. In this study too, *M. cephalus* showed lower concentration in most of the investigated mineral elements compared to the other two animals of this study. In like manner, the concentration of sodium, potassium, calcium, copper and zinc were significantly lower in *M. cephalus* than in *C. senegalensis* and *E. fimbraita* of the Cross River estuary (Table 2). These values are high compared to the recommended limits (WHO, 1998; FAO, 2010). Iron plays the role of assisting to deliver oxygen to cells and regulate cell growth in the body of humans. It is rated by experts as low in most sea water fin fishes. This is not true in *E. fimbraita*, *Mugil cephalus* and *C. senegalensis* of the Cross River estuary (Table 2). This contradiction probably shows that the sea water species found in the estuaries in the tropics are probably better sources of iron than their temperate water counterparts. USDA (2010) and Udo and Arazu (2011) reported iron values within the range of 0.03 mg/100 gm-1.38 mg/gm for frozen *S. scombrus*, *T. trachurus* and *S. pilchardus* imported into Nigeria and for mackerel and temperate catfishes respectively Potassium concentration was similar in *C. senegalensis* and *E. fimbraita* but lower in *M. cephalus* of this study (Table 2). Potassium is also reported to vary in concentration in salt water fishes. It is important in humans because of its role in maintaining body electrolytic balance and in the regulation of muscle contraction and nerve transmission (FDA, 2009). Magnesium is reported as another essential mineral in fish. In the human body it works together with calcium to form minerals that compose the bones, aids in proper muscle functioning maintaining some of which have exceeded the recommended limits for metals in fish (FAO/WHO, 1984; FAO, 2010). It seems to point to the fact that the species are potential health hazards and their consumption should be controlled. However, at present these values are approaching international limits though they are still within national limits. It is suspected that the frequent oil spills in the Niger Delta of Nigeria has contributed to the high levels of some of these minerals in water which have eventually entered the into the organisms pointing to these species as near hazards to health. Asuquo *et al.* (2004) in a closely related study asserted that some fish species in the Niger Delta are already loaded with heavy metals increasing in concentration at the following magnitude: iron > zinc > manganese > lead > copper within the system of the species they studied.

Conclusion: It could therefore be concluded that the studied species and their environment should be further monitored chemically and biologically with indices of physical parameters examined for further and stronger conclusion to be made as regards their food quality; presently they seem contaminated.

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