

Nutritive and microbial composition of some fresh marine fish species

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ABSTRACT

Nutritive and microbial composition of some fresh marine fishes (*Ethmalosa fimbriata*- Bonga; *Pseudotolithus enlongatus* - Croaker; *Mugil cephalus* – Mullet and *Lutjanus goreensis* – Red Snapper) were investigated. The fishes were purchased from Creek Road Market in Port Harcourt. Two kilograms of each of the fish species were obtained for the analysis. Fish samples were analysed for proximate composition such as moisture content, crude protein, crude fat, and total ash using standard methods. At the same time, mineral contents such as Potassium, Sodium, Calcium, and Phosphorus were determined by the dry ash extraction method. Fish samples were also examined for microbiological analysis including total bacterial count (TBC), total Enterobacteriaceae count (TEC), and total mould count (TMC). Data obtained were subjected to analysis of variance. In all the species, the mean moisture content of fresh fish samples ranged from 71.27% – 75.94%. The mean protein content of fresh fish samples ranged from 18.05% - 22.18%). The lipid content of the fish muscle shows wide variation from as low as 3.0% to as high as 9.10% in some species. The fish samples contained appreciable mean concentrations of potassium (1430.03-1843.87mg/100g), sodium (372.14-427.13mg/100g), calcium (794.11-2100.13mg/100g), and phosphorus (910.04-1350.00mg/100g). For the microbiological composition, the mean value range of TBC was 0.67 - 2.33CFU/g, TEC was 0.33 - 2.67CFU/g, and TMC 0.00 - 3.33CFU/g which varied significantly ($P < 0.05$) among the species under consideration. The present observations were in accordance with similar results recorded in seafood samples like shrimps, crabs, salmon, prawns, etc. collected from retail markets with similar bacteria counts to those sampled from Creek Road markets.

Keywords: Nutritive value, microbial composition, mineral contents, marine fishes, proximate composition

INTRODUCTION

Fish generally has a high nutritional value for humans. It is majorly composed of water, with protein values ranging between 15 and 20%, but values lower than 15% or as high as 28% are occasionally reported in some species (Andres *et al.*, 2000). Fish is rich in mineral salts such as potassium phosphorous, iron, and vitamins A and C, but, above all, the quantity and the composition of fats present in fish differ from other food (Miller and Atanda, 2004). Fish demand is increasing as a result of the increasing world population, higher standards of living,

good perception and high acceptance of fish, and fishery products among its consumers (Akinrotimi *et al.*, 2011). Nigerians have been regarded to have a huge appetite for fish with an annual demand of 1.50 million metric tonnes (Ovie and Raji, 2006). The demand for fish is therefore on the increase and this is due to the health benefits associated with fish consumption and the impact of fish in enhancing food security among the expanding Nigerian populace living in rural and urban areas. Despite the fact that fish has a high nutritional value, it also has a great risk for pathogens (Ogur, 2022). Fish

caught in contaminated waters or by people not maintaining proper hygienic rules during transportation and storage of the fish may allow the presence of pathogens that cause foodborne diseases in fish (Feldhusen, 2000).

Fresh fish and other sea-foods generally undergo many chemical and biological changes immediately after capture, which can ultimately result in spoilage. The three main categories of food spoilage that can occur are physical spoilage, chemical spoilage, and microbiological spoilage. Action by microorganisms is a common means of food spoilage and food-borne illness (Teutscher, 2010). Potential food spoilage microorganisms include bacteria, fungi (mold and yeast), viruses, and parasites. Food spoilage refers to damaging the original nutritional value, texture, and flavour of the food to the extent that it becomes unsuitable to eat (Sveinsdottir, 2008). Fresh, frozen, and cold smoked fish are considered unacceptable when the total bacterial count is beyond 107 CFU/g (Yanar, 2007). This study is designed to evaluate the nutritive value and microbial load of some fresh marine fish species.

MATERIALS AND METHODS

Experimental location

The experiment was conducted at the Fish Processing Unit, in African Regional Aquaculture Centre, Aluu in Port Harcourt. Fresh samples of Red snapper (*Lutjanus goreensis*); Croaker (*Pseudotolithus elongatus*); Mullet (*Mugil cephalus*) and Bonga (*Ethmalosa fimbriata*) were purchased from creek road market, Port Harcourt, and identified with the keys of Ames *et al.* (1999) on marine and brackish water fishes.

Experimental procedure

Samples, 200g of each of the fish species were properly packed in an ice chest and taken to the laboratory. They were assessed for proximate, mineral, and microbial compositions in triplicates.

Proximate Analysis

Proximate chemical composition analysis including determination of moisture content, crude protein, crude fat, and total ash of the fresh fish were performed according to AOAC official methods (1998).

Mineral Analysis

The mineral contents of the samples were determined by the dry ash extraction method. Following the method described by George and Maynard (1989), 2.0 g of each sample was burnt to ashes in a muffle (as in ash determination) the resulting ash was dissolved in 100 mL of dilute hydrochloric acid (1M HCl), and was then diluted to 100 mL in a volumetric flask using distilled water. The digest so obtained was used for the various analyses. (i.e analysing for Ca, P, K, Na).

Microbial Analysis

Microbial contamination was determined by the methods described by FAO (1992). One parameter, the total plate count was analyzed. The plate count agar (Tryptone Glucose Yeast Agar CM0325) manufactured by OXOID Ltd, UK was used as the growth medium.

Statistical Analysis

The data were collated and subjected to analysis of variance ANOVA in a completely randomized design. Tukey's multiple comparison tests were applied to identify differences between the means at a 5% probability level.

RESULTS

The proximate compositions of some fresh marine fishes from the creek road market are presented in Table 1. The results indicated that the values of moisture content between *E. fimbriata* and *P. elongatus* on one hand and between *M. cephalus* and *L. goreensis* on the other hand were not significant. However, there was a significant difference between the two groups. The crude protein values in *E. fimbriata* and *L. goreensis* were not significantly different. While those of *P. elongatus* and *M. cephalus* were within the same range, there was a significant difference between the two groups. Higher values of crude fat were recorded in *E. fimbriata* and *P. elongatus* when compared to the other species. The values of ash in *E. fimbriata* and *M. cephalus* were within the same range and were significantly different from those obtained from *P. elongatus* and *L. goreensis* which were within the same range. However, zero values were recorded in crude fiber and carbohydrates in all species under consideration.

Table 1: Proximate composition of fresh marine fish species (Mean \pm SD)

Proximate Composition (%)	Experimental Species			
	<i>E. fimbriata</i>	<i>P. elongatus</i>	<i>M. cephalus</i>	<i>L. goreensis</i>
Moisture Content	71.67 \pm 0.02 ^a	72.50 \pm 0.20 ^a	73.38 \pm 0.031 ^b	75.27 \pm 0.03 ^b
Crude Protein	18.05 \pm 0.01 ^a	20.14 \pm 0.04 ^a	22.18 \pm 0.04 ^a	18.62 \pm 0.03 ^a
Crude Fat	9.10 \pm 0.35 ^c	5.15 \pm 0.005 ^b	3.15 \pm 0.02 ^a	3.27 \pm 0.01 ^a
Crude Fibre	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a
Ash	1.16 \pm 0.005 ^a	2.21 \pm 0.02 ^b	1.29 \pm 0.02 ^a	2.83 \pm 0.03 ^b
CHO	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a	0.00 \pm 0.00 ^a

Means with different superscript within the same row are significantly different ($P < 0.05$)

Key: CHO - Carbohydrate

Table 2: Mineral composition of some fresh marine fish species (Mean \pm SD)

Mineral Composition (mg/100g)	Experimental Species			
	<i>E. fimbriata</i>	<i>P. elongatus</i>	<i>M. cephalus</i>	<i>L. goreensis</i>
Calcium (Ca)	794.11 \pm 1.25 ^a	1333.14 \pm 2.50 ^a	1210.05 \pm 1.26 ^a	2100.13 \pm 1.25 ^b
Phosphorus (P)	910.04 \pm 0.20 ^a	1111.03 \pm 1.15 ^b	1100.12 \pm 0.20 ^b	1350 \pm 2.00 ^b
Potassium (K)	1430.03 \pm 1.25 ^a	1760.16 \pm 1.25 ^b	1730.16 \pm 2.50 ^b	1843.87 \pm 6.25 ^c
Sodium (Na)	404.11 \pm 1.26 ^b	373.06 \pm 0.50 ^a	427.13 \pm 1.00 ^b	372.14 \pm 0.76 ^a

Means with different superscript within the same row are significantly different ($P < 0.05$)

Table 3: Microbiological composition of fresh marine fish species (Mean \pm SD)

Microbiological Composition ($\times 10^1$ CFU/g)	Experimental Species			
	<i>E. fimbriata</i>	<i>P. elongates</i>	<i>M. cephalus</i>	<i>L. goreensis</i>
TBC	1.67 \pm 0.58 ^b	0.67 \pm 0.58 ^a	1.68 \pm 0.48 ^b	2.33 \pm 0.58 ^c
TEC	1.67 \pm 0.58 ^b	2.67 \pm 1.15 ^c	1.00 \pm 0.00 ^b	0.33 \pm 0.58 ^a
TMC	0.00 \pm 0.00 ^a	1.67 \pm 0.58 ^b	3.33 \pm 0.58 ^c	1.00 \pm 0.00 ^b

Means with different superscript within the same row are significantly different ($P < 0.05$)

Key: TBC – Total Bacterial Count; TEC – Total Enterobacteriaceae Count; TMC – Total Mould Count

The mineral composition of the marine fishes under consideration from the creek road market is presented in Table 2. The results indicated that lower values of Calcium (794.11 \pm 1.25 mg/100g), Phosphorus (910.04 \pm 0.20 mg/100g), and Potassium (1430.03 \pm 1.25 mg/100g) were recorded in *E. fimbriata* when compared to other species that are within the same range. However, the values of Sodium in *E. fimbriata* and *M. cephalus* were not significantly different but were significantly different from those of *P. elongatus* and *L. goreensis* which were within the same range.

The microbiological composition of the marine fishes under consideration from the creek road market is presented in Table 3. The results indicated that the values of TBC, TEC, and TMC varied significantly ($P < 0.05$) among the species under consideration. The highest value of TBC (2.33 \pm 0.58 $\times 10^1$ CFU/g) was observed in

the specie *L. goreensis*, while the lowest (0.67 \pm 0.58 $\times 10^1$ CFU/g) was in *P. elongates*. For TEC, The highest value of TEC (2.67 \pm 1.15 $\times 10^1$ CFU/g) was observed in the specie *P. elongatus*, while the lowest (0.33 \pm 0.58 $\times 10^1$ CFU/g) was in *L. goreensis*. For TMC, the highest value of TMC (3.33 \pm 0.58 $\times 10^1$ CFU/g) was observed in the specie *M. cephalus*, while the lowest (0.00 \pm 0.00 $\times 10^1$ CFU/g) was in *E. fimbriata*.

DISCUSSION

The nutritional compositions of fresh marine fishes are known to vary with species, sex, size, season and geographical location (Sarkar, 2005). Additional factors that influence nutritional composition include feed intake and sexual changes associated with spawning (Hossain, 2010). The species investigated were the popular market fishes in Rivers State, and

economically belong to the different traditional grades, according to consumer and fishermen preferences in Nigeria. The nutritional elements showed variable values in the species analysed.

Moisture is the principal constituent of fish, quantity-wise. Moisture content in many fish varies between 60-80%. Moisture content is also found to vary considerably within the same species of fish depending on the age, fat content, feeding condition, spawning etc. Fatty fish exhibit an inverse relationship between fat and moisture contents (Emikpe *et al.*, 2011). In this study, moisture contents were very high in these species. The percentage of moisture in fish muscles was within the acceptable level in all the samples without any significant difference due to the stable water levels in the environmental location from where the fish were collected. The moisture content did not differ among all the marine fishes and the values were close to each other, the slight differences present may be attributed to the difference in fish species. A similar result was found in some marine fishes evaluated for their proximate composition in coastal areas of India by Ashraf *et al.* (2011).

Generally, proteins are important for normal function, growth, and maintenance of body tissue and hence protein content is considered to be an essential tool for the evaluation of the biochemical and physiological standards of a given organism (Belton *et al.*, 2014). They are critical to the structure of cells, proper functioning of antibodies resisting infections, regulation of enzymes and hormones, and growth and repair of body tissues (Koffi-Nevry *et al.*, 2011). From a nutritional point of view, protein is the most important constituent of fish. Protein content in most fish averages 18-20%, though the general variation is in the range of 15-24%. Variations in protein content occur in relation to age, fat content, spawning, starvation etc. (Hossain, 2011). In this study, protein content was slightly higher in the muscle of *M. cephalus* than in the other three species. Although, slight variations were observed for the protein levels and statistically with no significant difference ($P>0.05$), indicating that protein levels were within the same range in the species. The results of the range of protein content were within the range of variations reported by Fawole *et al.* (2007) in some marine species from Lagos Lagoon. The fish species

examined are highly proteinous. The high tissue protein content of the fish species in this study may be related to the high protein contents of their common diets as they fed mostly on fish items, crustaceans, molluscs, algae and diatoms (ARL, 2012). The relatively average percentage of protein obtained in this work may be attributed to the fact that marine fishes are good sources of protein, but the differences observed in values obtained, could also be a result of fish consumption or absorption capability and conversion potentials of essential nutrients from their diets or effect of their local environment into such biochemical attributes needed by organisms' body (Agbabiaka *et al.*, 2012).

A factor showing a wide variation in the fish is the lipid content (Ackman, 2009). Lipid serves as a source of energy during starvation and fasting (Azim *et al.*, 2012). The lipid level in the fish tissues is under the direct influence of their food and feeding habits (Hardy and Keay, 2015). All lipids are hydrophobic (Azrina *et al.*, 2011). According to Eyo (2001), fish are often classified on the basis of their fat contents i.e. lean fish (fat less than 5%), medium fat fish (fat 5 –10%) and fatty fish (fat more than 10% by weight). Based on this classification, fish species in this study were classified as lean fish, except *M. cephalus* and *E. fimbriata* which could be classified as medium-fat fish. In this study, the lipid content of the fish muscle shows wide variation from as low as 3.0% to as high as 9.10% in some species. The low concentrations of lipids in the muscles of the marine species in this study could be due to poor storage mechanisms and the use of fat reserves during spawning activities (Dewi *et al.*, 2011). Also, the low level of fat in this study could be due to their feeding habit, as a lesser amount of lipids are stored in fat depots. The lower concentrations of lipids in the muscles of these species could be due to the utilisation of fat reserves during normal body activities and the ecology as well (Saito *et al.*, 1999). Moreover, the low concentrations of lipid in the muscles of the marine fishes in this study could be due to poor storage and moisture content. There is a disadvantage in that it increases the fish's susceptibility to microbial spoilage, and oxidative degradation of polyunsaturated fatty acids and consequently decreases the quality of the fish for a longer preservation time (Babiker *et al.*, 2014).

Ash is a measure of the mineral content of a food item. It is the inorganic residue that remains after the organic matter has been burnt off (Omogwu, 2014). Ash is constituted by the minerals present in the flesh. The ash content gives a measure of the total mineral content in the tissue (Oluborode *et al.*, 2010). The variability of ash in the body tissue composition of the fish has been attributed to several factors such as environment, age, size, diet and species (Saha *et al.*, 2000). In the present study, the percentage of ash content in the fishes analysed was very low, this is comparable to the study of Emikpe *et al.*, (2011) who reported the same trend in some marine fishes from Lagos Lagoon. However, the ash levels were found less in all the selected marine fishes in this study, when compared to the results of other workers including Hardy and Keay (2015) in marine fish from Lake Geriyo. This is also in line with the observation of Mesomya *et al.* (2002) in some marine fishes from India. The lesser amount of ash contents found in these fishes may be due to less amount of skeletons.

Carbohydrate in a living cell is a good source of energy. It also helps in the development and growth of the body. The carbohydrate content in fish is generally very low and practically considered zero in most marine fishes (Bala and Mondol, 2001). In this study, zero values were recorded in all the species. These zero values of carbohydrates could be due to higher values of moisture and a relatively high value of protein content. The low carbohydrate values could also be due to the fact that glycogen does not contribute much to the reserves in the fish body tissue (Balachandran, 2001; Oladipo and Bankole, 2013). The major carbohydrate present in fish is glycogen which is a polymer of glucose and is stored mainly in the liver. The muscle of the live fish generally contains between 0.1-1% glycogen (Bilgin *et al.*, 2008). Moreover, Burgess *et al.*, (1965) reported zero values of carbohydrates in some marine fishes found in Arabian Gulf. A similar result was equally reported by Chukwu and Shaba (2009) in some fishes from the West Coast of the Peninsular in Malaysia.

The fish samples in this study contained appreciable concentrations of potassium, sodium, calcium and phosphorus suggesting that these fishes could be used as good sources of minerals. The main role of these minerals can be described as structural and functional. Structurally, they stand out for their role as integrators of organic compounds in the body, while functionally, they are important in controlling biological functions (Shamima *et al.*, 2011). The variations recorded in the concentration of the different mineral components in the fish examined could have been a result of the rate at which these components are available in the water body (Rayhan, 2010), and the ability of the fish to absorb and convert the essential nutrients from the diet or the water bodies where they live. This is supported by the findings of Mansur *et al.* (2013) in the proximate assessment of some marine fishes. The richness in phosphorus levels in the four species can also be attributed to the fact that phosphorous is a component of protein. Calcium content was observed to be higher in all the samples and it is an important mineral essential for the growth, and maintenance of bones, teeth and muscles (Connell, 1990). There was also great variability in the amounts of calcium and phosphorus, due to the size of the fishes used. The tendency is for bigger species to be totally filleted as compared to smaller species that retain more bone due to the difficulty of removing all the bony tissue during the fillet process (Eyo, 2001). Sodium content was high in the different species of marine fish during this study which may have resulted from the environment where the fishes were caught from.

Today, fish has become a major food item and seafood constitutes an important food component with a large percentage of dietary protein globally for a large section of the world population. They come after meat and poultry as staple animal protein foods, where fish forms a cheap source of protein. (Viji *et al.*, 2014). Sea foods are prone to bacterial contamination, especially the experimental study species, which concentrate these bacteria in their systems and therefore, are ideally suited to trap all bacteria

and viruses, pathogenic or otherwise, that live in the water. From the result of the microbial analysis, it has revealed that total bacteria count, Enterobacteriaceae and mould count were obtained from these marine fishes collected from the Creek road market.

Fish is also susceptible to microbial contamination as millions of bacteria are present in the surface slime, gills and in intestines of live fish. Bacterial growth and invasion of fish are prevented by the body's natural defence system during life but after death, the defence system breaks down and the bacteria multiply and invade the flesh (Eyo, 2001). During the present study, the variation in the microbial counts of fresh samples collected from the market may be due to the lack of improper handling procedures adopted by fish sellers and buyers. The diversity of microorganisms in the selected fish species may be attributed to exposure at the market and also due to the capability of fish in reabsorbing moisture from the atmosphere to support the growth of microorganisms. The present observations were in accordance with similar results recorded in seafood samples like shrimps, crabs, salmon, prawns etc. collected from retail markets which also had similar bacteria counts to those sampled from Creek Road markets. The bacterial load and varieties of bacterial isolates from the fish samples were an indication of the method of fishing adopted by fishermen which must have exposed the fish sample to the high bacterial load of the disturbed bottom sediment where fish nets were trawled along the bottom sediment for long periods

CONCLUSIONS

The percentage of moisture in fish muscles was high and within the acceptable level in all the samples without any significant difference which indicates that the moisture contents of fish are of great importance, as most of the biochemical reactions and physiological changes in fish depend on moisture content. The protein content was slightly higher in the muscle of *M. cephalus* than in the other three species. Although statistically, there was no significant difference ($P > 0.05$). This indicates that protein levels were within the same range in the species. The lipid content of the fish muscle shows wide variation from as low as 3.0% to as high as 9.10% in some species. The fish samples in this study contained appreciable

concentrations of potassium, sodium, calcium, and phosphorus suggesting that these fishes could be used as good sources of minerals. The variation observed in the microbial counts of fresh samples collected from the market may be due to the lack of improper handling procedures adopted by fish sellers and buyers.

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