Comparative Study of the Nutritional Composition of Selected Freshwater and Marine (Frozen) Scaled Fish Species in Zaria

[1]YASHIM, E. Y., [1]Kassim, F. M. and [2]Dambo, A.
[1]Department of Zoology, Ahmadu Bello University, Zaria-Nigeria
[2]Department of Biology, Ahmadu Bello University, Zaria-Nigeria

Correspondence: nmana2007@yahoo.com

Abstract
The study was carried out to compare the proximate composition and mineral contents of Labeo senegalensis, Brycinus macropedotus (Freshwater fish) and Trachuus trachurus, Merluccius merluccius (frozen Marine fish) in Zaria which are rich source of food and meat to mitigate the nutritional problems of man. Proximate composition (crude protein, dry matter, ash, lipid and carbohydrates) were determined using standard methods of Association Officials of Analytical Chemists (AOAC) and selected macro elements (calcium, potassium, phosphorus) and micro elements (zinc, iron and copper) were also determined using Atomic Absorption Spectroscopy (ASS), potassium and phosphorus were determined using Flame Photometer. The finding showed that the Dry matter (moisture content) of T. trachurus (36.3%) varied significantly ($p<0.05$) from that of other species and the total moisture content of T. trachurus and M. merluccius (32.13%) was higher than L. senegalensis and B. macrolepedotus (25.77%). The protein content of freshwater fishes showed significantly high ($p<0.05$) protein content (60.15%) compared to marine (frozen) fishes (56.61%). The nitrogen free extract (carbohydrates), T. trachurus and M. merluccius showed a high level of carbohydrates (24.33%) of compared to L. senegalensis and B. macrolepidotus which could be as a result of food and feeding habitat, habitat or geographical location. The proximate composition of freshwater fishes and marine (frozen) fishes varied significantly ($P<0.05$). The mineral components of Calcium, Potassium, Phosphorus, Zinc, Iron and Copper did not differ significantly ($P>0.05$) between the freshwater fishes and marine (frozen) water fishes and are within the dietary requirements of human nutrition.

Keywords: Proximate; Macro, Microelement; Fish Species

Introduction

Fish is an important group of vertebrates influencing every niche of human life in many ways as a rich source of food; they also provide several by-products such as fishmeal, fish chum, fish oil, fish glue, etc. Fish supply proteins, fats, vitamins A, D and E, and other macronutrients (Brasky *et al.,* 2010). It also consists of a great number of principal minerals like calcium, iron, sodium, iodine, while many others are important in trace amounts (Melanson *et al.,* 2005). Fish as a rich source of protein, presents the form of simple proteins with different essential amino acids, fats and traces of vitamin B Complex and the form of other non-protein nitrogenous forms (Brasky *et al.,* 2010). Fish consumption is linked to the reduction of risks of various types of diseases and improvement of neurological development (Hellberg *et al*., 2012).

The proximate of fish species varies among fish species, estimation of some proximate profiles of fish such as protein, lipid, and moisture contents is often necessary to ensure that they meet the requirements of food regulations and commercial specifications. Proximate composition is a good indicator of physiology which is needed for routine analysis of fishes (Tsegay *et al*., 2016).

Most developing countries are facing enormous nutritional deficiency problems due to low levels of some essential nutrients in their diet. The deficiency in principal nutritional mineral elements induces a lot of malfunctioning as it reduces productivity and causes diseases (Heady *et al.,* 2018).

In recent years, fish has become the favourite foodstuff for the majority of societies because of several health reasons (Ali and Kiumars, 2010). It is a cheap source of high protein, as such there is a need to produce it as an alternative way of fulfilling animal protein requirements for the poor rural communities. Fish has received increased attention from time to time as a potential source of Animal and some minerals for human diets (Sutharshiny and Sivasshanthini, 2011). Nigeria imports 900,000 tons of fish for 800 million each year to bridge the gap although Nigeria needs 2.1

million tons of fish, it only produces 650, 000 tonnes per year (SARNISA, 2009).

All living organisms require these mineral elements and some of these biochemical attributes at moderate levels, but when they exceed metabolic demand or requirements, they tend to become accumulated in tissues of organisms such as fish which can metabolize it to lesser extents because most of these heavy metals are non-biodegradable (Lenntech, 2006).

Among the modern fish species, marine contained 58% while 41% are freshwater fish and the remaining 1.0% is diadromous (Ullah and Ahmad, 2014). The price of freshwater fishes available is out of reach of some Nigerians, making room for alternative frozen fishes like Hake, horse mackerel, etc. The study of mineral elements present in living organisms is of biological importance, many of such elements take part in some metabolic processes and are known to be indispensable to all living things.

Labeo senegalensis (Valenciennnes, 1842) is a highly fecund fresh water fish that presents a seasonal cycle of reproduction while *Brycinus macrolepidotus* (Valenciennes, 1850) is also a common freshwater species, especially water bodies of low salinity, which thrives both in riverine and lacustrine conditions. *Trachurus trachurus* (Linnaecus, 1758) is a migratory species of Marine water fish commonly called Atlantic horse mackerel or common scad while *Merluccius merluccius* (Linnaeus, 1758) is also a marine water fish species which is commonly known as European Hake or Panla in Nigeria with very long spawning period which differs between populations ((Olurin *et al.*, 2006; Froese *et al*., 2018).

Human nutrition deals with the provision of essential nutrients in foods, which are necessary to sustain human life, promote optimal health and reduce the risk of chronic diseases such as cardiovascular disease and cancer as well as to prevent classic nutritional deficiency diseases such as kwashiorkor and marasmus (Mohanty *et al.*, 2019).

The increasing consumer awareness of nutritional issues and appropriate composition of meals contribute to the growing interest in health-enhancing food. Determination of some nutritional

composition is often necessary to ensure that they are within the range of dietary requirements and commercial specifications, therefore this study tends to determine the nutritional composition presented in some selected scaly fishes in the river Galma Zaria.

Materials and Methods

Sample collection*:* The sample of freshwater fishes were obtained from River Galma, comprising of *Labeo senegalensis (*African Carp*)* and *Brycinus macrolepidotus* (African Characidae) while the marine water (frozen) fishes were obtained from Sabon Gari market Zaria, comprising of *Trachurus_trachurus* (Horse mackerel*)* and *Merluccius merluccius* (European hake). Samples (10 fish each) were transferred into an icebox to prevent further post mortem changes and avoid spoilage and transported to the Institute of Agricultural Research (IAR) Laboratory, Zaria, Kaduna State for biochemical analysis. Samples were washed, weigh and lengths of samples taken.

Proximate Composition

Determination of moisture content: The moisture content of the samples was determined following AOAC (1995) standard method.
Determination of Crude protein (Kjeldahl method): Crude protein content was determined using Standard methods (AOAC. 2000).
Determination of Ash: Ash content was determined based on the standard methods (AOAC, 1995).
Determination of Crude lipid: This was determined by the Soxhlet method (AOAC, 1995).

Mineral Analysis

Mineral elements analysis followed the method described by (AOAC, 2000). Samples were analyzed for minerals contents of iron (Fe), copper (Cu), zinc (Zn), potassium (K), calcium (Ca) using the Atomic Absorption Spectrophotometric (Shimadzu AAS, AA-6300), phosphorus was determined using Flame Photometer (Spectronic 20).

Data Analysis

The result of the comparative study was analysed using Two Way analysis of variance (ANOVA) with significance level at $P \leq 0.05$

while T-test was used to compare freshwater and marine water fish composition.

Results

The proximate composition (Table 1) showed *Trachurus trachurus* had the highest Dry matter and *Labeo senegalansis* had the least. *Labeo senegalensis* has a significantly high level of protein, Crude lipid and Ash compared to other fish species. Nitrogen free Extract (carbohydrates) of *Merluccius merluccius* has the highest value while *Laboe senegalensis* had the least.

The Dry matter of marine fishes and crude lipid was significantly higher than that of freshwater fishes, while crude protein and Ash content of freshwater fishes was higher than marine fishes. Also the Nitrogen free extract of (frozen) fishes was higher in marine (frozen) fishes than freshwater fishes (Table 2).

Table1: Proximate composition of Freshwater and Marine (frozen) fishes obtained in River Galma and Sabon Gari fish market

	Labeo senegalensis	*Brycinus macrolepidotus*	*Trachurus trachurus*	*Merluccius merluccius*	P-value
Dry Matter (%)	23.03±0.00b	28.51±0.00b	36.53±0.00a	27.72±0.00b	0.001
Crude Protein (%)	61.23±0.53a	59.06±0.08b	60.00±0.13a	53.21±0.06c	0.000
Crude lipid (%)	7.48±0.07ab	7.15±0.10b	7.70±0.21a	6.26±0.08c	0.000
Ash (%)	13.25±0.24a	13.12±0.24a	11.46±0.09b	12.71±0.14a	0.001
Nitrogen Free Extract (%)	18.05±0.83c	20.67±0.30b	20.84±0.41b	27.81±0.15a	0.000

Mean value ± standard deviation

The values represent the mean of Triplicate determinants and standard deviations, mean values with different letters in the same column were significantly different ($P<0.05$)

Table 2: Comparison of Proximate Composition between Freshwater and Marine (frozen) fishes obtained in River Galma and Sabon gari fish market Zaria.

	Freshwater fishes	Marine (frozen) fishes

			P-value
Dry Matter (%)	25.77±1.23	32.13±1.97	0.103
Crude Protein (%)	60.15±0.54	56.61±1.52	0.020
Crude lipid (%)	7.32±0.09	6.98±0.34	0.246
Ash content (%)	13.18±0.15	12.09±0.29	0.019
Nitrogen Free Extract (%)	19.36±0.71	24.33±1.57	0.004

Values are means ± standard deviations P<0.05 is significant

Table 3: Mineral composition of Freshwater and Marine fishes obtained in River Galma and Sabon Gari fish market

	Elements (mg/kg)					
Fish species	K	P	Ca	Cu	Zn	Fe
Labeo senegalensis	7125	26679	9880.5	25.25	248.75	1025.75
Trachurus trachurus	3725	22357	10243.25	22.75	162.5	774
Meluccius merluccius	75025	15650	4437.25	31.5	162.75	962.75
Brycinus macrolepidotus	4400	25263	9016.5	27.75	173.5	815.75
T-test	6.896	9.177	6.246	14.367	8.991	15.013
P-value	0.006	0.003	0.008	0.001	0.003	0.001

P<0.05 is significant

Table 4: Comparison between mineral composition of freshwater and marine (frozen) fishes obtained in River Galma and Sabon Gari fish market

Minerals	Freshwater fishes	Marine fishes	P-value
K	5425.00±1700.00	4712.50±312.50	0.698
P	24.517.70±2161.14	20456.26±4806.67	0.664
Ca	10061.88±181.38	6726.88±2289.63	0.359
Cu	24.00±1.25	29.63±1.88	0.070
Zn	205.63±43.13	168.13±5.38	0.581

Fe	899.88±125.88	889.25±73.50	0.873

Values of mean ± standard deviations $P < 0.05$ significant

Labeo senegalensis has a higher value of phosphorus (P), Zinc (Zn) and Iron (Fe) while *Merluccius merluccius* has the highest value of Potassium (K) and Copper (Cu) and *Trachurus trachurus* has the highest value for calcium (Ca) (Table 3). T-test showed significant difference in all element except K and Ca ($P<0.005$).

The comparison of mineral contents (Table 4) did not show significant difference ($P>0.05$) in all the six elements analysed, Phosphorus (P), Potassium (K), Calcium (Ca), Copper (Cu), Zinc (Zn) and Iron (Fe).

Discussion

The study revealed Dry matter (moisture content) content in *Trachurus trachurus* (36.5%) was the highest which differed significantly from *Labeo senegalensis (*23.03%*), Merluccius merluccius (*27.72%*)* and *Brycinus macrolepidotus (*28.51%*)* this could be as a result of geographical location and processing of T**.** *trachurus* (Suhenden *et al*., 2008). The proximate analysis of *L. senegalensis* is similar to that recorded in *Labeo pengusia* with 65.08% of crude protein and 7.98% of lipid (Hei and Sarojnalini, 2012). Eyo (2001) reported that insufficient protein is one of the most widespread nutritional deficiency in many tropical fishes but *L. senegalensis*, *T. trachurus* and *B. Macrolepidotus* had significantly higher proteins content (61.23%, 60.0%, 59.06%) respectively than *Merluccius merluccius* (27.8%) in this study thus making it a good source of animal protein. The crude protein was significantly higher in freshwater fishes than some marine (frozen) fishes which could be due to denaturation of protein in some marine (frozen) fishes as a result of freezing and variability in temperature (Careche *et al*., 2001). The crude Lipid of *Labeo senegalensis* was the highest with a value of (7.48%) and the least was in *Merluccius merluccius* (6.26%) these difference could have resulted during thawing in *Merluccius merluccius* where water crystals cut the fish

tissue and facilitate the extraction of lipid. Ash content was higher in *Labeo senegalensis* (13.2%) and *Brycinus macrolepidotus* (13.72%) than *Trachurus trachurus* (11.4%) which is high compared to that reported by Udo and Azarus (2011). Fish is reported to show low levels of Carbohydrates (USDA, 2010) although high level of nitrogen free extract (carbohydrates) was recorded in this study in the marine fish species *M. merluccius* and *T. trachurus* (24.33%) compared to the freshwater fish species L. *Senegalensis* and *Brycinus macrolepidotus* (19.36%*)* which could as a result of the food and feeding habit, habitat and geographical location of the fish. Ash Content was higher in *L. senegalensis* (13.25%) and *B. macrolepidotus* (13.72%) than *Trachurus trachurus* (11.4%) which was high compared to that of Udo and Azarus (2011) findings. Total Ash content represents the content of inorganic elements and mineral salts on the analysed edible portion of the fish which greatly depends on the size, weight, food source and external environment.

Other studies showed that the moisture content in marine fishes is low with a high value for protein and fat content (Arannilewa *et a*l., 2005), but this study showed a high value of moisture (32.13%) and lower value of lipid (6.98%) in marine fishes. The Calcium (Ca) and potassium (k) values were higher than other macro elements analyzed for the four species of fish, Observations agrees with the similar work of Ali and Kiumars (2010). Calcium provides rigidity to the skeleton and play an important role in many if not most metabolic processes while potassium assist in a range of essential body functions including blood pressure, digestion and normal water balance. *Labeo senegalensis* and *Brycinus macrolepidotus* showed a high level of Potassium and Calcium compared with *Trachurus trachurus* and *Merluccius merluccius*, similar findings was attributed to the dominance of the elements in the water body where the fish is found.

Conclusion

Studies revealed that the species of *L.* sene*galensis, B. macrolepidotus, M. Merluccius and T. trachurus* are all good sources of nutrients especially protein though they varied significantly among the four species, these fishes could be exploited as they constitute a living source of dietary protein to humans and other animals, it could also be used in the preparation of fishmeal.

The whole fish body is rich in mineral elements, significant variation occurred within the mineral components in the four species, hence the dietary mineral intake of these fishes will differ greatly among the freshwater and marine (frozen) fishes, and one species will suffice in place of the other species for minerals.

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