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The Biochemical Composition of Three Exotic Fish Delicacies: *Scomber scombrus*, (Linnaeus, 1758), *Trachurus trachurus* (Linnaeus, 1758) and *Sardina pilchard* (Walbaum, 1792) Frozen and Imported into Nigeria

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Abstract: Three species of exotic fish imported into Nigeria namely; *Sardina pilchardus* (Walbaum, 1792) *Trachurus trachurus* (Linnaeus, 1758) and *Scomber scombrus* (Linnaeus, 1758) were analyzed to determine the proximate composition of its nutrients and the contents of some of its macro- and micro - minerals using the methods recommended by AOAC. These fishes were bought from a major cool storage facility in Calabar, Nigeria. This cool storage facility is one of the major outlets for the distribution of imported frozen foods in the Cross River State of Nigeria. From this facility, the fish and other frozen and imported foods are distributed to retailers for sale in open market while still frozen. Results showed that the moisture content of these species were not significant ($p>0.05$). The crude protein ranged from 14.02-19.5% while the fat values were 9.9, 7.4 and 9.5% in *S. scombrus*, *T. trachurus* and *S. pilchardus* respectively, measured values for ash in the species were low between 1.30-1.53%. The mineral content of the three species were equally not significantly different from each other ($p>0.05$). Some macro-elements were high with calcium measuring 2.60 mg/100 gm in *S. pilchardus* while the value of iron ranged from 0.03-0.05 mg/100 gm in the species. We observed that the concentration of copper was high exceeding the WHO recommended safety limits for metals in seas foods.

Key words: Frozen fish, imported, food value, Nigeria

INTRODUCTION

The Atlantic mackerel, *Scomber scombrus* is a pelagic schooling fish found on both sides of the North Atlantic, Horse mackerel (*Trachurus trachurus)* is believed to originate off the coast Portugal (Nadcisa *et al*., 2001). This fish is pelagic in nature and an important commercial fish. The Sardine, *Sardina pilchardus* originate from off Mexico and Cornwell in England. These exotics are imported, iced, from Japan, Norway, Thailand and Brazil into Nigeria. They are highly cherished as fish food especially by the low income.

Frozen food loose their nutrient value when preserved for a long time (Waters,1988; Arannilewa *et al*., 2005; Omotosho and Olu, 1995; Saliu, 2008 Sengon *et al*., 2000; Suhenden *et al*., 2008). Many factors are reported to be responsible for the deterioration of nutrient qualities of organisms namely; food habit (Omotosho and Olu, 1995; Ayinla and Akande, 1988), type of fish species a (Audrey *et al*., 2006; Suhenden *et al*., 2008) claimed that 98% of the total mass of sea food flesh consists of water, protein and fat. It is also reported that moisture, protein and fat in frozen fishes decreased after freezing (Mills, 1975; Omotosho and Olu, 1995; Saliu, 2008). Other researchers also accept that methods of processing and storage and its duration generally causes depletion in essential nutrients and minerals in frozen and stored fin fishes (Judith and Jenny, 1987; Saliu, 2008; Hardy and Smith, 1976; Botta *et al*., 1978; Ryder *et al*., 1993; Arannilewa *et al*., 2005; Castrillion *et al*., 1996). The fat content of sardine (*Clupea pilchardus*) is reported to be 15.41% while its protein content was given as 39.25% when frozen (Castrillion *et al*., 1996). In Table 1 the proximate and mineral composition of Mackerel and catfishes are given (USDA, 2010).

Another report on mineral contents of aquatic species emphasized that the most abundant micro-element in fish were Zn and Fe followed by Cu (Saadettin *et al*., 1999) and that these minerals (as ash) are higher in marine than in fresh water species. The mineral constituent of fishes are affected by many factors some of which are seasons (Effiong and Mohammed, 2008), health status, habitat and environment. For example, the mineral content in marine species are higher than those fresh water fishes (Omotosho and Olu, 1995) and between species of the same size found within the same milieu (Kriton, 2007).

These minerals are valuable to man as food constituents, if the occurred within some threshold away from limits they constitute a potential hazard to health when consumed (Asuquo *et al*., 2004; WHO, 1998).

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Table 1: Proximate composition of some mackerel and catfish species (gm/100 gm)

Nutrients	Moisture (g)	Protein (g)	Fat (g)	Ash (g)	Carbohydrate (g)	Energy (Kcal)
Fish species						
[a]Mackerel	46.87	20.98	15.67	1.34	0.00	230.56
[a]Catfish	102.35	26.78	11.46	1.67	0.00	217.36
[b]Blue mackerel	65.20	19.80	11.90	3.00	-	-
[b]Jack mackerel	71.40	18.60	5.90	4.10	-	-

[a]USDA (2010), [b]Vlieg (1988)

Table 2: Chemical components of mackerel and catfish species in mg/100 gm (USDA, 2010) National Nutrient database for standard reference

Element	Ca^{2+}	Fe	Mg	P	Na^{+}	Cu^{2+}	Zn	K
Fish species								
Mackerel	13.20	1.38	85.36	244.64	73.04	0.08	0.83	352.03
Catfish	12.87	1.17	37.18	350.35	114.40	6.17	1.50	459.03

Table 3: Proximate composition of *S. scombrus*, *T. trachurus* and *S. pilchardus* imported into Nigeria

	Proximate composition (%)					
	Moisture	Protein	Fat	Ash	Carbohydrate	Energy (Kcal)
S. scombrus	68.40±0.15	19.53±0.13	9.94±0.11	1.46±0.15	0.58±0.53	169.97±0.68
T. trachurus	68.01±0.01	18.35±0.02	7.43±0.21	1.53±0.51	4.67±0.30	158.90±0.97
S. pilchardus	63.53±0.15	14.02±0.02	9.46±0.25	1.30±0.20	11.67±0.40	188.00±0.70

Table 4: Some elemental composition of *S. scombrus*, *T. trachurus* and *S. pilchardus* imported into Nigeria (mg/100 gm)

	Mineral composition					
	Phosphorus	Iron	Copper	Calcium	Magnesium	Nitrate
S. scombrus	0.62	0.05	0.04	2.60	1.62	3.13
T. trachurus	0.57	0.03	0.03	2.08	1.13	2.93
S. pilchardus	0.42	0.03	0.04	2.11	1.04	2.24

Therefore this study focuses on the food quality of some of these imported exotic fish species with the view to determine their suitability for human consumption after prolonged storage in ice.

MATERIALS AND METHODS

Specimens of *Sardina pilchardus*, *Trachurus trachurus* and *Scomber scombrus* used for this study were bought from Watt market, Calabar, Nigeria. In the laboratory, each specimen was filleted, weighed and dried in an oven at 75°C for 24 hrs. The specimens were re-weighed after drying and their moisture content was calculated.

Determination of proximate composition of the species: The dried fillets were powderised and stored in an air tight container as stock sample for analysis. Methods extant in (AOAC, 2000) were used for the determinations of the proximate composition and mineral contents of the homogenized fillets. The crude protein was determined using the Micro-kjeldahl method, fat by Soxhlet extraction, ash by furnace ashing at 600°C for 12 hrs while NFE was by difference (AOAC 2000). The minerals contents were determined from the solution obtained by dissolving the ash (residues left after burning in furnace) in distilled water containing a few drops of concentrated HCL. Sodium and Potassium were determined with flame photometer (AOAC, 2000). Iron, Manganese, Calcium was measured with the Spectrophometer at different wave lengths.

The differences in proximate composition and macro- and trace elements were tested with the one way Analysis of Variance (ANOVA) method (Sokal and Rohlf, 1969). Comparison of concentrations of minerals etc of the tested fish species were made directly by matching standard threshold data with the data measured from the tested species.

RESULTS

The mean percentage composition of protein, moisture, fat, ash, carbohydrate and energy for *Scomber scombrus*, *Trachurus trachurus* and *Sardina pilchardus* are presented (Table 3). Moisture in the three species were not significant ($p>0.05$).

Fat in *S. scombrus* and *S. pilchardus* were similar ($p>0.05$) but different in *T. trachurus* ($p>0.05$). The concentration of carbohydrate in the species were significantly different giving 0.58, 4.67 and 11.67% in *S. scombrus*, *T. trachurus* and *S. pilchardus* respectively (Table 3).

All species involved in this investigation showed low level of macro and micro elements (Table 4). ANOVA showed that their concentration were not significantly different from each other ($p>0.05$). However, Calcium concentration showed minor differences (Table 4) while copper and iron were not significantly different from each other in the species.

DISCUSSION

Eyo (2001) reported that lack of sufficient protein is one of the most widespread nutritional deficiencies in many tropical countries. *Scomber scombrus* and *Trachurus trachurus* has significantly higher protein content (19.53% and 18.35% respectively) than that measured in Sardina *pilchardus* of this study (Table 3). Chilima (2006) reported that, on fresh weight basis, fish generally contain a good quantity of protein within the range of between 18%-20%; but that measured in this study in *Sardina pilchardus* (14.02%) was low. This shift in the protein level in *S. pilchardus* as compared to the reported values for fish may be related the method and duration of storage of samples. Castrillion *et al.* (1997) reported a protein content of 20.27% and 53.56% for wet and dry samples of *Clupea pilchardus* (Sardine). In this study, the level of protein is high in *Scomber scombrus* and *Trachurus trachurus*. It is reported in literature that the protein content of mackerel species were higher (Table 1) compared to the results obtained in this study for two mackerels of study (Table 3). The low level of protein in *S. scombrus* and *T. trachurus* could probably be related to the length of freezing and storage time. Prolonged freezing of fishes are capable of contributing to the deterioration of the quality of protein and fat in fishes (Mills, 1975; Londahl, 1981; Omotosho and Olu, 1995; Arannilewa *et al.*, 2005; Saliu, 2008).

The moisture content determined in the three species are within known range for fishes. Judith and Jenny (1987) reported the moisture content of 69.5% and 64.0% for *S. scombrus* (frozen) and *T. trachurus* (Raw) respectively. It is also reported that loss of water in any food substance produces an uneven increase in the percentage of other nutrients (Castrillion *et al.*, 1996). Moisture content refers to the amount of water food in an organism. From literature, the moisture content in Mackerel was lower with higher protein and fat content (Table 1), while this study showed higher values of moisture and lower values for protein and fat for both *S. scombrus* and *T. trachurus*. This confirms the notion that the moisture content in a food had an inverse relation with fat in fish.

According to Chilima (2006) fat contributes to energy supply and assists in the proper absorption of fat soluble vitamins e.g. vitamins A, D, E and K in species. This suggests that the three species of this study being rich sources for fat could also be good source for these vitamins (Table 4). Abdullahi (2001) reported higher fat values for *Chrysicthys nigrodigitatus*, *Bagrus filamentosus* and *Auchenoglanis occidenntials* in the range of 30.0-303 gm/100 gm, while 26.77% (fat) is reported for catfish (USDA, 2010). Other ranges for fat are 2.6% and 6.8% in Tuna and Anchovy respectively (Suhendan *et al.*, 2008) and 9.8% by Judith and Jenny (1987). The 9.8% reported by Judith and Jenny (1987) is similar to 9.4% determined in this study for the fat content of *S. scombrus*. Therefore those values that are reported in other species may be attributed to the quality of those fish species in terms of handling and the status of their quality as at the time of analysis (Mills, 1975; Londahl, 1981).

Fish is generally reported to show low levels of carbohydrate (USDA, 2010). But high values of this nutrient were recorded for *Sardina pilchardus* (11.62%), *T. trachurus* (4.67%) while 0.58% was determined in *S. scombrus* of this study (Table 3). These results are unusual for carbohydrate in fish as reported in literature, 0% for most species (USDA, 2010) although earlier reports for New Zealand marine fish show high carbohydrate values (Vlieg, 1988). This seeming contradiction can probably be accounted for by several factors such as the food and feeding habit, habitat and geographical location, age, methods of handling/ processing, seasons and some other environmental factors (Ryder *et al.*, 1993; Omotosho and Olu, 1995; Nadcisa *et al.*, 2001; Suhenden *et al.*, 2008).

The energy values (K/cal) for all three species were high ranging from 158.9-188.0 (K/cal) with *Sardina pilchardus* showing greater value (Table 3). This probably implies that sufficient energy could obtain in the consumption of these species. These energy values are lower than those report generally for Mackerel species (USDA, 2010). It could be considered that the difference between the values obtained from this study and that reported by USDA (2010) could possibly originate from the fact that the results from the former study was obtained from fresh specimen as against that from the later obtained from frozen and stored specimens.

Ash is a measure of the mineral content of a food item (Omotosho and Olu, 1995). The ash contents of the species of this study match with that reported by USDA (2010) for mackerel (1.34%) and catfish (1.67%) (Table 1 and 3).

Generally, the mineral content in *T. trachurus*, *S. scombrus* and *S. pilchardus* of this study is low compared to reported values in similar species. Copper is a trace element in Mackerel species with a value of 0.083 mg/l (USDA 2010) and in the three species of this study value of 0.04 mg/l was determined in *S. scombrus* and *S. pilchardus* and 0.03 mg/l in *T. trachurus* (Table 4). There were no significant differences in copper and calcium in these species ($p<0.05$). When the values of the element in this study (Table 4) were compared with WHO (1998) standard values of permissible limit for metals in sea foods, it was found that Cu concentration exceeded the recommended permissible limit (WHO 1998). However, Iron (Fe) was lower and within limit. Asuquo *et al.* (2004) remarked that higher values of element above WHO standard are possible potential health hazards and should be avoided. This by implication is that most of the imported fish species, particularly the mackerels, have lost their food value and are no longer suitable for human consumption, especially in concerns copper and it carcinogenic nature in human system (WHO, 1998).

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