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Effect of Drying Methods on the Nutritional Composition of Three Species of Fish (*Bonga* sp. *Sardinella* sp. and *Heterotis niloticus*)

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Abstract: Three methods of drying (oven, sun and smoke) were used to dry the samples. The physico-chemical and minerals contents of the sample were determined using standard methods. *H. niloticus* oven dried recorded the highest (16.42%) moisture content while the least moisture content 9.27% were obtained in *Sardinella* sp. oven-dried and sun-dried. Highest protein content 51.06% was found in *Sardinella* sp. sundried while the highest and the least fat value of 60.36% and 12.13%, respectively were recorded for *H. niloticus* smoke-dried and sun-dried. *Banga* sp. have the highest ash content of all the fish evaluated for proximate composition. The highest value of the major elements were obtained in this decreasing order K > Na>Mg>Ca in *Sardinella* sp. (oven-dried) *H. niloticus* (sun-dried) *H. niloticus, (smoke-dried) and Isardinella* sp. (oven-dried). The highest value of major element K (250mg), Na (218 mg), Mg(183 mg) and Ca (150 mg) were obtained in *Sardinella* sp. (oven-dried), *H. niloticus* (sun-dried), *H. niloticus* (smoke-dried) and *Sardinella* sp. (oven-dried), respectively Zinc (Zn) recorded the highest value of all the trace elements determined while Copper (Cu) recorded the lowest value in the trace elements evaluated. The most palatable taste obtained from the group of panellist were found in smoke-dried and oven-dried sample. Most attractive colour was recorded for smoke-dried sample while the lest attractive colour was obtained in sun-dried sample.

Key words: Fish, chemical, minerals sensory, drying

INTRODUCTION

Nutritional quality of a food is very important. The nutritional importance of seafood has increased substantially because of beneficial effects of eating seafood fats and oils (Azam, *et al*., 2004). Seafood is also an important source of high-quality and highly digestable protein and a respectable source of essential minerals (Nettleton, 1992). The nutritional quality of seafood is affected by body part of the seafood being consumed, method of handling, processing (including cooking at home) season of harvest, sex and species (Krzynowek, 1988). Fish production is a major industry in those parts of Nigeria where revering settlements are established. The substantial percentage of the protein needs of the population of the surrounding villages and towns through fishing are produced through these communities (Ako and Salihu, 2003). Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body (Andrew, 2001).

The less developed countries capture 50% of the world harvest and a large proportion of the catch are consumed internally (FAO, 1985). In many Asian countries over 50% of the animal protein intakes comes from fish while in Africa; the proportion is 17.50% (Williams *et al*., 1988). In Nigeria fish constitute 40% of the animal protein intake (Olatunde, 1998). Fish accounts 63% of the animal protein supply in Bangladesh (Dof, 2001). During the year 1999-2000, Bangladesh exported 39.391 metric tonnes fish and fisheries product (Epm, 2001). Amongst total export volume and export earning, dried products accounted to 1286.00 mT (Dof, 2001). The annual fish demand in Nigeria between 1980-1990 was estimated as 1.2 million tons and was projected to increase appropriately to 2.0 million ton by the year 2000. Consumption of fish provides an important nutrient to a large number of people worldwide and thus makes a very significant contribution to nutrition. Fish has edge over meat in that it is cheaper and relatively more abundant in Nigeria (Eyo, 1983). The total food supply available from fisheries (Marine and Inland) would give an apparent availability as a line-weight equivalent of about 13 kg per year for each of world inhabitants. Availability in developed countries is 27 kg per capita in developing countries (James, 1998). Nevertheless, developing countries have a greater nutritional dependence on fish.

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There are 61 countries that derive more than 20% of their animal protein supply from fish, only very few are developed countries (James, 1998). Fish being a highly perishable, whether fishing is practiced on a commercial scale or for domestic consumption of the catches smoking is the preferred cheap method to preventing spoilage. This is carried out over smouldering wood, sawdust or other local source of energy using traditional kilns constructed with locally sourced materials. It is instructive that the design of kiln not withstanding, operation involved in smoking of fish are similar and the method has the effect of imparting a pleasant flavours to the product beside the preservative effect of the smoke itself (Burgress, *et al*., 1965; Tull, 1997). But smoke fish being a foreign exchange earner for Nigeria, researcher are concerned about the quality of products. This was apparent from the investors forum that was jointly organized recently by the Nigerian Institute for Oceanography and Marine Research and the Raw Material, Research and Development Council, where participants called for better handling, processing and packaging of products to meet the required standards set by authorities in the countries of export (Oyeleye, 2003).

Nevertheless, the pre-treatment of fish for smoking, packaging material and storage conditions may differ widely, so that fish obtained in the market have tremendously variables quality. It was therefore, imperative to conduct this present study to determine the concentration of food constituents and mineral composition in fish subjected to three methods of drying (oven drying, sundrying and smoke drying).

MATERIALS AND METHODS

The three species of fish (*Heterotis niloticus*, *Sardinella* sp. and *Bonga* sp.) were purchased from Oja Oba market in Akure, Ondo state, Nigeria. The fish samples were washed with tap water to remove the ice, rinsed with distilled water and then cut into slices and subjected to three methods of drying. The representative samples were taken from the head, rear and the middle of each species and blended together into powdery form kept in air-tight container; neatly labelled and stored in a refrigerator pending analysis. The crude fat was extracted with petroleum ether (40-60% boiling range) from the dry powdered sample. Using Soxhlet apparatus (Joslyn. 1970) and Carbohydrate concentration was estimated by difference. The protein (N×6.25) and crude fibre were determined using the method described by AOAC (1990). The moisture content was determined by evaporating the samples at 105°C and the ash content was estimated by dry-ashing at 550°C. The sensory evaluation was carried out by a group of panellist according to the method described by Potter (1968). The mineral analysis was carried out by dry-ashing the sample, dissolved in 10% HCl filtered and aspirated into atomic absorption spectrophotometer (Mode 372). Each metal was then determined using their corresponding pure salt (Perkin-Elmer, 1982).

Data obtained were subjected to analysis of variance by one way ANOVA, using the New Duncan's Multiple Range Test (Zar, 1984).

RESULTS AND DISCUSSION

Generally, fish has been regarded as good sources of protein and has been widely accepted to supplement the protein needs of the people especially in developing countries (FAO, 1985). Inadequate preservation technique would imply a substantial shortfall in fish availability (thereby affecting the protein intake of people in developing countries whose protein intake from fish ranges between 17.5 to 50% (Wilman *et al*., 1998). Drying is a common practice in meat, fish and other protein based industry. It preserved the quality for an extended time and offers several advantages such as insignificant alterations in the product dimension and minimum deterioration in product.

Proximate composition (%) of the three species of fish subjected to different drying methods is presented in Table 1.

The moisture content of the three species of fish subjected to different drying methods prior to analysis ranges from 9.79 to 16.42%. *H. niloticus* (oven dried) recorded the highest moisture content 16.42% compared to 4.47% obtained by Arannilewa *et al.* (2005) in *Sarotherodum galicaeus.*

The protein content, ash content, fat content and carbohydrate content varies with species and mode of drying. Highest protein content 51.05%, 49.30% and 31.34% obtained in the three species of fish were found in *Sardinella* sp. (Sun-dried), *Bonga* sp. (oven-dried) and *H. niloticus* (Oven-dried) respectively Table 1.

The highest fat content 60.36% was obtained in *H. niloticus* (Smoke-dried), while the least fat content 12.13% was recorded in *H. niloticus* (sun-dried).

The result obtained in this study indicates a wide variation in protein, fat, ash and carbohydrate composition in the fish species in respect to mode of drying.

This findings coincides with the result obtained by Azam *et al.* (2004) that protein, fat and ash content of ten fish species studied varies with the species and mode of drying. The lower protein content observed

Table 1: Proximate composition (%) of the samples

Samples	Parameters: Drying methods	% Moisture`	Ash %	Fat %	Protein %	Crude fibre %	Carbohydrate %
Bonga sp.	Oven	12.76±0.74^{b}	3.80±0.04^{a}	34.48±0.45^{c}	49.30±0.01^{c}	Not detected	12.42±0.01^{c}
	Sun	10.74±0.14^{a}	27.29±0.01^{b}	26.42±0.02^{a}	41.53±0.03^{b}	detected	4.76±0.02^{b}
	Smoke	14.12±0.08^{c}	27.23±0.01^{b}	31.43±0.54^{b}	40.54±0.04^{a}	ND	0.80±0.03^{a}
Sardinella sp.	Oven	9.79±0.17^{b}	3.97±0.11^{c}	34.18±0.09^{c}	40.39±0.07^{b}	ND	11.67±0.04^{a}
	Sun	9.79±0.17^{b}	2.42±0.01^{a}	12.29a±0.01^{a}	51.06±0.06^{c}	ND	24.44±0.07^{b}
	Smoke	14.77±0.77^{c}	3.35±0.08^{b}	12.73±0.03^{b}	24.44±0.04^{a}	ND	44.71±0.06^{c}
Heterotis niloticus	Oven	16.42±0.05	2.07±0.01^{b}	21.79±0.04^{b}	31.34±0.04^{c}	ND	28.38±0.03^{b}
	Sun	12.88±0.08^{a}	2.73±0.03^{c}	12.13±0.02^{b}	22.47±0.06^{b}	ND	49.79±0.08^{c}
	Smoke	15.61±0.04^{b}	1.13±0.04^{a}	60.36±0.08^{c}	13.04±0.04^{b}	ND	9.86±0.04^{a}

Means followed by the same letter on the vertical column are not significantly different p>0.05 from eachother using new duncan's multiple range test

Table 2: Mineral composition (%) of the samples

Samples	Parameters: Drying methods	Na (mg 100g^{-1})	K (mg 100g^{-1})	Ca (mg 100g^{-1})	Mg (mg 100g^{-1})	Pb (mg 100g^{-1})	Fe (mg 100g^{-1})	Cu (mg 100g^{-1})g	Mn (mg 100g^{-1})	Zn (mg 100g^{-1})
Bonga sp.	Oven	189.36±0.49^{f}	230.21±0.12^{d}	120.71±0.31^{h}	134.40±0.36^{g}	Not detected	5.64±0.01^{f}	0.03±0.02^{c}	2.02±0.02^{a}	10.69±0.49^{h}
	Sun	209.53±0.20^{h}	141.31±0.36^{c}	50.31±0.31^{c}	134.40±0.36^{b}	Not detected	3.64±0.05^{b}	0.34±0.01^{d}	3.07±0.02^{c}	7.67±0.06^{e}
	Smoke	120.52±0.05^{b}	201.36±0.51^{e}	55.36±0.34^{d}	99.20±0.26^{a}	Not detected	4.22±0.02^{e}	0.53±0.3^{g}	1.34±0.01^{c}	7.27±0.04^{d}
Sardinella sp	Oven	203.72±0.25^{g}	250.31±0.34^{c}	150.30±0.41^{i}	181.30±0.36^{h}	Not detected	5.80±1.10^{g}	0.37±0.01^{f}	2.77±0.01^{h}	9.60±0.08^{i}
	Sun	173.31±0.11^{e}	160.31±0.32^{d}	80.34±0.62^{f}	132.20±0.20^{f}	Not detected	8.18±0.05^{h}	0.49±0.30^{a}	1.58±0.01^{d}	6.44±0.04^{c}
	Smoke	172.70±0.20^{d}	238.32±0.62^{h}	60.42±0.38^{e}	130.30±0.30^{e}	Not detected	8.65±0.03^{i}	0.19±0.01^{i}	1.11±0.01^{b}	9.10±0.03^{f}
Heterotis niloticus	Oven	112.92±0.35^{a}	215.34±0.60^{f}	90.31±0.2^{g}	125.72±0.25^{d}	Not detected	4.20±0.01^{d}	0.25±0.02^{b}	1.73±0.05^{e}	4.88±0.07^{a}
	Sun	218.7±14.49^{i}	71.31±10.32^{a}	33.21±0.23^{a}	111.32±0.10^{c}	Not detected	3.44±0.02^{a}	0.53±0.2^{e}	0.96±0.02^{a}	5.68±0.07^{b}
	Smoke	137.90 ±0.41^{c}	92.31±0.34^{b}	46.31±0.81^{b}	183.51±0.25^{i}	Not detected	3.86±0.01^{c}	0.34±0.00^{h}	1.95±0.03^{f}	9.15±0.04^{i}

Means followed by the same letter on the vertical column are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

Table 3: Sensory evaluation of the sample

Samples	Parameters: Drying methods	Taste	Colour	Flavour	Appearance	Texture	Palatability	General acceptability
Bonga sp.	Oven	Good	Light brown	Good	Moderately	Moderately		
	Sun	Moderate	Ash colour	Poor	attractive	hard	Good	High
		Attractive	Very hard	Moderate	Moderate			
	Smoke	Very good	Fairly black	Very good	Very attractive	Soft	Very good	Very high
Sardinella sp.	Oven	Good	Dark brown	Good	Very attractive	Very hard	Good	High
	Sun	Moderate	Brown	Moderate	Attractive	Moderately hard	Moderate	Low
	Smoke	Very good	Dark brown	Very good	Very attractive	Soft	Very good	High
Heterotis	Oven	Good	Light brown	Good	Attractive	Very hard	Good	Moderate
niloticus	Sun	Moderate	Grey	Poor	Moderately attractive	Hard	Moderate	Moderate
	Smoke	Good	Brown	Good	Very attractive	Soft	Very good	High

in smoke-dried method could be connected with denaturation of fish protein during smoking.

The least fat content obtained in the three species that were sun-dried could be attributed to oxidation of fat during the periods of sun drying.

The mineral content (mg g^{-1}) of the three species of fish analysed is presented in Table 2. The highest value of the major element K (250 mg), Na (218 mg), Mg (183 mg) and Ca (150 mg) were obtained in *Sardinella* sp. (Oven-dried), *H. niloticus* (sun-dried) *H. niloticus* (smoke-dried) and *Sardinella* sp. (oven-dried), respectively with this decreasing order K> Na>Mg>Ca. This findings is similar to the result obtained by Oladimeji and Sadiku (1991) that decreasing order of this major elements K>Na>Mg>Ca was found in *Sarotheroduun galilaeus, Lates niloticus and Sprodonit sehal* (oven-dried). Teeny *et al*, (1989) reported a similar decreasing order in several species of fish.

In *Bonga* sp. (sun-dried) and *H. niloticus* (smoke-dried and sun-dried), no well-defined order of magnitude was evident in the major elements (Na, K, Mg and Ca. This result coincides with the findings of Ako and Salihu (2004) that no well-defined decreasing order of magnitude in the major element evaluated in several species of fish. However, the order of magnitude of the major element reported by Kirchagessner and Schwall (1986) was Ca>K>Na>Mg. With regards to the trace elements, copper was found to be lowest while Zn was found to be highest

in concentration among the element determined. This result tallies with the work of Teeny *et al.* (1984) that zinc was found to be highest in concentration among the element determined in fish samples. In this study a well-defined decreasing order of magnitude (Zn>Fe>Mn>Cu) was evident in all the three species of fish evaluated except in the case of iron (fe) were *Sardinella sp,* have the highest concentration (8.65 mg 100 g^{-1}) in sun-dried sample with this decreasing order Fe>Zn>Mn>Cu>Pb. The result obtained in this study similar to what was reported by Ako and Salihu (2004) that appreciable degree of consistency was evident in trace element evaluated in traditionally smoked samples producing the order of Fe>Mn>Li>Zn>Cu>Pb.

Other researchers have similar observation with regards to lack of agreement of different report on the order of magnitude of mineral content of a given species of fish.

This view is supported by the findings of Window *et al.* (1987) and Khan *et al.* (1987), which showed that variation in the concentration of elements from one sample of fish to another was due to the chemical forms of the elements and their concentrations in the local environment.

The sensory evaluation is presented in Table 3. There were significant change in colour, flavour, taste and texture in all the fish evaluated. The most palatable taste obtained from the group of panellist were found in smoked dried and oven-dried samples. Most attractive appearance was recorded for smoke-dried sample while least attractive was obtained in sun-dried samples.

CONCLUSION

It is pertinent to say that nutritional composition o fish muscles varies both in species to species, within species and mode of drying. High protein content can be obtain in *Bonga sp* and *H niloticus* through oven-dried method but in *Sardinella sp* is through sun-dried.

Oven-dried and smoke-dried method retained the taste and impact an attractive colour into the fish while sun-dried method reduce the fat content of the fish.

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