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# The Effect of Wood Type on the Organoleptic Properties of Smoked Atlantic Herring (*Clupea harengus*)

***Atanda Saburi Abimbola, Adekalu Olabisi Abidemi, Agoda Samuel, Benson Olusola Brown and Ihionu Godwin Chiwuike***

*[1]Nigerian Stored Products Research Institute 34 Barikisu Iyede Street, off University of Lagos Road, Yaba. PMB 12543 Lagos Nigeria.*

## Abstract

*This study assessed the effect of four different types of wood on the organoleptic properties of smoked fish. Frozen Atlantic herring Clupea harengus('shawa' in local parlance), dry wood of mango(Mangifera spp.), kolanut (Cola spp.), teak (Tectona grandis)and guava(Psidium spp.) were obtained from Bariga Market in Lagos State. Each of these woods was used to smoke the fish for a period of one and half hours (1.5 hr) in a smoking kiln. All the smoked fish did not contain any filth or dirt. The organoleptic assessment of the smoked fish showed that there were slight sensory differences in taste, aroma, appearance, and colour of the smoked fish due to the different types of wood used but was not statistically significant (p>0.05).However, fish smoked with kolanut wood (Cola spp.) had the highest rating for taste (5.00), aroma (5.00), appearance (4.8) and colour (4.8) and was consequently judged the best. Variations in the proximate composition of the smoked fish using each wood were observed. However, differences in the protein (23.07 %) and oil (10.90 %) contents of all the smoked fish were not statistically significant (p>0.05) though they were lower when compared to the unsmoked counterpart (protein (46.0%) and oil (16.1%)) while the ash and crude fibre contents increased significantly (p<0.05) in relation to the unsmoked fish (1.18 and 1.68% for ash and crude fibre, respectively). Results from this study can be used by the fish processing industry for consumer preference analysis.*

**Key words**: Smoked fish, C*lupea harengus,* wood, organoleptic property.

## Introduction

Fish are important of resource worldwide providing one –sixth of world protein especially as food. They are important culturally through ages providing income for millions of people. It provide almost three billion people with almost twenty per cent of their average per capita intake of animal protein and four billion people with fifteen of such protein. In Nigeria, it accounts for about thirty seven per cent of total protein intake. It provides twenty two per cent 22% of the protein intake in Sub-Sahara Africa (1, 2, 3). Fish is a highly perishable commodity that begins to spoil as soon as it is harvested. Once spoilage sets in, the odour/flavour, texture, colour, and sometimes the chemical composition changes. It is estimated that post-harvest losses of fish are often more than 50% in developing countries. The loss represents a net reduction in the amounts of nutrients potentially available to the consumer. A greater percentage of fish is processed using various traditional methods for consumption and storage; these include smoking, drying, salting, frying, and fermenting and various combinations (4, 5, 6).

Smoking was originally intended to extend the shelf life of products and has been reported in physical changes in colour, flavour and texture of fish. It is the most important method of preservation in Nigeria (4). Most type of wood, hard or soft, can be used for fish smoking. Many of the important compounds present in smoke from woods lead to production of flavour, colour, anti-oxidative, bacteriostatic and bactericidal compounds (4, 7). The combustion of softwoods generates smoke that consists chiefly of phenols and cresols that impart a rather 'heavy' aroma and bitter flavour to the product whereas smoke obtained from the pyrolysis of wood from deciduous trees consists of compounds that contribute a mildly fragrant aroma in the smoked product (8). Variations in the quality of the fish products produced due to the type of wood used for smoking have been reported in previous studies .This is in form of taste, aroma, colour and consumer acceptability. It was reported that smoking of fish with Eucalyptus wood resulted in smoked fish with golden brown colour, desirable texture, appealing smoky aroma with more consumers willing to purchase (21).

Recently, the quality of smoked fish in Nigeria has been poor as a result of the various smoking materials used by smoked fish processors and there is a need to improve product quality by introducing other woods as fuel for fish smoking. The aim of this study was to determine the organoleptic properties of Atlantic Herring (*Clupea harengus)* smoked using dry woods of mango *(Mangifera spp.),* kolanut *(Cola spp.),* teak *(Tectona grandis)* and guava *(Psidium spp.)*.

## Materials and Methods

### *Fish handling and processing*

A hundred whole frozen Atlantic herring (*Clupea harengus)* of average weight of 400 g were obtained from a fish shop in the Bariga area of Lagos State and stored in NSPRI ice fish box. The box was designed by NSPRI to

**Corresponding Author's E mail**:** abimbola91@yahoo.com*

preserve and maintain the quality of fish in fresh form between twenty four and seventy two hours (24-72 hr) depending on the ratio of fish to ice. Twenty five (25) fish were selected at random from the ice fish box and placed in a container at the NSPRI Fish Processing Centre and thawed at room temperature for one hour, gutted to remove gills and intestine, washed repeatedly using tap water until no sign of blood was observed, drained to get rid of excess water for less than one hour (1 hr). It was made into a round shape by putting the tail in the mouth with the aid of a tiny stick and the container was covered with a lid to keep away flies.

***Fish smoking process***

Twenty five (25) fish of the "rounded" Atlantic herring were loaded onto trays in the NSPRI smoking kiln. The smoking kiln was designed by the NSPRI to dry agricultural produce. It is an all metal structure with insulation in-between the inner and outer metal sheets. It has an opening (vent) on each side of the combustion chamber to allow in air for combustion and a fan powered with a solar battery to aid combustion and provide proper circulation of air within the kiln. This feature makes smoking faster with better fuel efficiency. Dried wood of mango (*Mangifera spp.*), kolanut (*Cola spp.*), teak (*Tectona spp.*) and guava (*Psidium spp*.) obtained from a local wood dealer in the Bariga area of Lagos was used separately for each batch of fish. The kiln was lit using small chunks of each wood twenty minutes before the actual smoking process. The trays containing the prepared fish were then transferred into the kiln. The fish were smoked for a period of one and half hours (1.5 hr) using a hot wet smoking process at 90$^{o}$C for each type of wood. The temperature was regulated by removing large chunks of pyrolised wood and addition of new woods at intervals and it was confirmed by the reading on a datalogger. The kiln was opened and the fish were turned at intervals of fifteen minutes to achieve uniform smoking. The first batches of fish were smoked with mango wood and the rest of the batches were kept in the ice fish box. The smoked fish were later removed from the kiln and allowed to cool and packaged in a 100 micro-gauge polythene film and stored on a shelf at the prevailing room temperature 28 $^{o}$C for three days before analysis.

Plate 1: Thawed Atlantic Herring before processing

Plate2: Kolanut wood smoked Atlantic Herring

Plate 3: NSPRI smoking kiln

***Proximate analysis***

Proximate analysis was carried out on both the raw fish and smoked fish. The twenty five smoked fish from mango wood were divided into three sets of 9, 8, and 8 fish where each set is a replicate of one another. Representative samples obtained from randomly selected smoked fish totalling five pieces were de-boned and mixed thoroughly to make up the required quantity. This procedure was repeated for the other woods. The analyses include moisture content, protein, oil, ash and crude fibre. Each analysis was carried out in triplicates.

*Moisture content determination:* Moisture content was determined using the standard AOAC method with oven drying of 5 g of smoked fish at 105°C until a constant weight was obtained (9).

*Protein content:* The protein content of a 1.0 g sample was analyzed using the Kjeldahl Method as described by AOAC. Protein content was obtained as% total nitrogen x 6.25 (9).

*Oil content*: Oil was exhaustively extracted using 5.0 g of sample in a Soxhlet apparatus using petroleum ether (boiling point range 40-60$^{o}$C) as the solvent according to AOAC. The oil content was determined by the following formula: % oil = (weight of oil/original weight of sample) x 100 (9).

*Ash content:* Ash content was determined by the incineration of 2.0 g of sample placed in a muffle furnace and maintained at 550$^{o}$C for 5 hours as described in the standard AOAC method (9).

*Crude fibre content*: Crude fibre was obtained by digesting 2.0 g of sample with $H_2SO_4$ and NaOH and incinerating the residue in a muffle furnace maintained at 550°C for 5 hours (10). The crude fibre content was expressed as a percentage of the initial mass of the test portion.

***Organoleptic Assessment***

Organoleptic assessment of the smoked fish obtained using the different woods was done. Ten (10) panellists comprised of 5 males and 5 females were drawn from the staff of NSPRI, Lagos Station. They were trained on how to do the requested sensory evaluation procedure.The panellists were advised not to eat or smoke 1 hour before the sensory evaluation and also to avoid perfumes. They were also certified to be free from any oral or nasal infection, e.g., a cold. Rinsing the mouth between samples was done using water. The panel assessed attributes such as appearance, aroma, taste, and colour of the smoked fish following the scoring procedure described by Wokoma and Aziagba on a scale of 5, 4, 3, 2, 1 which represented excellent, very good, good, fair, and poor, respectively (11).

***Statistical Analysis***

Data obtained for the organoleptic assessment and proximate composition were subjected to statistical analysis using the Statistical Packages for Social Science (SPSS 20). Differences between means and levels of significance of the data were determined using Duncan Multiple Range Test (DMRT) at5% significant difference level. It was assumed that the sensory responses scale could be treated as a linear scale (12).

## Results and Discussion

Table 1 showed moisture content (50.20±0.20%), oil content (11.10±0.20%), protein (26.01±0.30% ), ash (1.18±0.01%) and crude fibre (1.68±0.11%) for the fresh Atlantic herring. Table 2 showed the moisture content 10.0 %- 14.5 %), oil content (10.8 %-11.1%), protein (23.07 %- 22.4 %) and crude fibre (2.11%-2.76 %) of smoked Atlantic herring using mango, kolanut, teak, and guava woods. The proximate composition results showed no statistical difference ($p>0.05$) except the moisture content which was statistically significant ($p<0.05$) with decreasing moisture in the order of guava > mango >kolanut> teak.

Table 1: Proximate composition of fresh Atlantic herring

| Moisture | Protein | Crude Fibre | Ash | Oil |
|---|---|---|---|---|
| 50.20±0.20 | 26.01±0.30 | 1.68±0.11 | 1.18±0.01 | 11.10±0.20 |

*Values (%) are expressed as Mean ± SD, n=3.*

Table 2: Proximate analysis of smoked Atlantic herring

| Wood | MC | Protein | Ash | Crude Fibre | Oil |
|---|---|---|---|---|---|
| Mango | $13.3±0.4^b$ | $22.4±0.9^a$ | $2.35±0.13^a$ | $2.11±0.12^a$ | $10.9±0.1^a$ |
| Kola nut | $11.8±0.3^c$ | $23.4±0.7^a$ | $2.40±0.03^a$ | $2.32±0.37^a$ | $11.1±0.5^a$ |
| Teak | $10.0±0.2^d$ | $23.1±0.4^a$ | $2.57±0.30^a$ | $2.74±0.16^a$ | $10.8±0.5^a$ |
| Guava | $14.5±0.4^a$ | $23.07±0.5^a$ | $2.55±0.09^a$ | $2.76^a±0.12^a$ | $10.8±1.5^a$ |

*Results (%) are expressed in Mean ± SD, n=3. Values with different superscripts in the same column showed statistical differences (p<0.05) at 5% level of significance*

Table 3 showed mean values for assessment of organoleptic properties of smoked fish using different woods. The overall merit points calculated for each wood increased as follows; guava < mango < teak < kolanut (4.3, 4.4, 4.6, 5.0) A survey was carried out on the most widely smoked fish and the most commonly used woods for fish smoking in some selected markets in Lagos State. This was done by administering a questionnaire to one hundred smoked fish traders in Bariga, Agege, Mushin, and Makoko. The survey was carried out by the Extension Department personnel of Nigerian Stored Products Research Institute (NSPRI), Lagos.

Table 3: Organoleptic Properties of Atlantic herring smoked with different types of wood

| Wood | Organoleptic Properties | | | |
|---|---|---|---|---|
| | Taste | Aroma | Appearance | Colour |
| Mango | $4.4±0.5^a$ | $3.0±0.8^b$ | $4.0±0.6^a$ | $3.0±0.1^b$ |
| Kolanut | $5.0±0.1^a$ | $5.0±0.2^a$ | $4.8±0.2^a$ | $4.8±0.2^a$ |
| Guava | $4.3±0.5^a$ | $4.5±0.2^a$ | $3.0±0.0^b$ | $3.0±0.1^b$ |
| Teak | $4.6±0.4^a$ | $4.2±0.5^a$ | $4.0±0.5^a$ | $4.0±0.0^a$ |

*Results (%) are expressed as Mean ± SD, n=3. Values with the same superscripts in same column are not significantly different (p>0.05) at 5% level of significance.*

The survey revealed that the most popular fish smoked was Atlantic herring (*Clupea harengus)* and the commonly used woods are: guava, kolanut, teak, and mango (depending on the availability of the woods).

Organoleptic evaluation scores for kolanut wood smoked fish were higher than others in taste (5.0), aroma (5.0), appearance (4.8) and colour (4.8). The taste and aroma were appealing and inviting for all the smoked samples. Brownish to golden brownish, oily and glossy appearance was observed for all of the smoked fish samples. The attractive colour observed was similar to fish smoked with charcoal and sawdust (18, 19).The appearance was found to be alluring and soft for all the smoked samples. Atlantic herring smoked with kolanut wood (*Cola spp.*) was judged to be the best wood from the results of the organoleptic attributes because it had the highest rating for each sensory attribute. The result showed that kolanut wood had the best score for taste, aroma, appearance, and colour compared to the other wood types. However, the limited panel size meant that in some cases these numbers were not statistically significant ($p > 0.05$).

The differences in the moisture content of all the smoked fish was due to moisture loss when compared to the fresh fish (72.2%) and this was in agreement with the findings of a previous study that reported that moisture loss was generally high for fish smoked with various smoking kilns except for the Watanabe smoking kiln whose fire source was separate from the smoking fish (13). This is opposed to another finding which showed moisture content of smoked herring fillets as 46.7% (14). The significance of this parameter is the ability of the smoked fish to have good storage tendencies. Moisture content is one of the determining factors for storage at ambient conditions. Low moisture content is a good indicator against spoilage.

Protein and oil contents of all the smoked fish obtained in this study were lower compared to the unsmoked fish. This loss may arise from the denaturing and exudation of protein occasioned by the loss of heat labile essential amino acid lysine during the smoking process. Carbonyls present in the smoke might have reacted with lysine which caused the reduction. This is consistent with previous studies (15, 16, 20). The loss of oil in the smoked fish in contrast to the unsmoked fish could also be due to exudation which agrees with a previous report (18).High oil content might lead to increase rancidity in the course of storage. The significantly increased ($p < 0.05$) ash and crude fibre contents of the smoked fish relative to that of the unsmoked fish may be due to the loss of the other components (17).

***Conclusion***

Smoking of Atlantic herring fish with the different wood types have effect on their organoleptic properties and proximate composition. Kolanut wood (*Cola spp.*) was judged to be the best wood from its organoleptic results. Differences observed in the protein and oil contents of all the smoked fish were not statistically significant ($p>0.05$) though they were lower when compared to the unsmoked fish while the ash and crude fibre contents increased significantly ($p<0.05$) in contrast to the unsmoked fish. This study provides data that suggest that the quality and acceptability of smoked fish was improved using kolanut wood. In the light of the findings in this research, the use of kolanut wood for fish smoking is recommended. However, the wood(s) that may best inhibit microbial spoilage and changes in quality during storage over a period of time was not ascertained. This could serve as a basis for further research work.

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