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Quality assessment of smoked-dried fish from five different markets in Lafia, Nigeria.

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Abstract
The organoleptic, proximate composition and microbial load of smoke-dried Clarias species in Lafia from five different markets, namely; Alamis market (XALM), Lafia main market (XLMM), Fish market (XFM), Agyaragu market (XAGM), and Doma market (XDM) and that of fresh fish average weight 500g (XCTL) purchased in Lafia, were assessed. The fresh fish was smoked-dried using the improved smoking kiln in the Department's Fisheries Unit. The sensory evaluation revealed that appearance, odor, and flavor of XCTL were the most preferred. Percentage moisture content 8.11 in XCTL implies better keeping quality while percentage crude protein was highest in XCTL (61. 26). Nine microorganisms were identified; aggregate lowest mean microbial count was 52.44 x 10^5 CFU/g for XCTL and highest (69.47 x 10^5 CFU/g) for XFM. It therefore, concludes that fish smoked with improved smoking kiln are of better quality and most preferred for consumption than that of five different markets.

Keywords: Fish, Organoleptic assessment, proximate composition, Microbial load, Market.

1. Introduction
The nutritional quality of fish has been adjudged first class. However, this status becomes short-lived soon after the fish dies. Normal micro-flora which was once helpful turns harmful. They graduate to becoming pathogenic when environmental factors like temperature and relative humidity in association with bad handling, poor hygiene, and delayed processing and preservation sets in. Fish provides not only animal protein but also serves as a major means of livelihood to humans. Fish is the healthiest meat option due to its long chain poly-unsaturated fatty acids content which promotes good health and prevent diseases particularly at old age. In Nigeria, fish constitutes 40% of animal protein intake and is highly accepted for its quality, availability and affordability (Kabaherda, Omony and Hiisken, 2009) [1].

The choice of wood greatly influences acceptability; hard wood with appreciable hemicelluloses serves well than soft woods. Among the good quality food protein sources, fish is the most perishable source. An estimated 50% of the fish produced in the remote coastal centers and hinterland perish before they get to the consumers as a result of poor handling, preservation and processing practice adopted by the artisanal fishermen, commercial fishermen, and fisheries entrepreneurs (Akintola and Lawal, 2011) [2].

The aim of food processing and preservation is to inhibit microbial growth, improve acceptability and above all extend the shelf-life of the products either by way of use preservatives, refrigerating or traditionally by either salt-curing or smoking. In Nigeria, the social-economic status of rural fish farmers and consumers make smoking the most preferred choice of processing. According to Ighodaro and Abolagba (2010) [3], smoking reduces the moisture content of fish to a point that it impairs the activities of spoilage microbes.

The source of any product determines it quality as no two products of different sources are the same. Some sources have got poor sanitary practices, thus, product from such sources ought to be avoided. Nigerian consumers of fish bother more about quantity and less about quality as a result they buy the product without considering health implications.

The objective of this study is to determine the organoleptic quality, proximate composition and microbial load in the smoked fish products in relation to source, processing and quality.

2. Materials and Methods

2.1 Collection of Samples

Three smoked-dried Clarias species each were purchased from three different sellers in five different markets namely; Alamis market (XALM), Lafia main market (XLMM), Fish market (XFM), Agyaragu market (XAGM), and Doma market (XDM). Another three fresh fish average weight 500 g (XCTL) each was purchased from private farms in Lafia L.G.A. All the three fresh fish were smoked using the improved smoking kiln in the Department's Fisheries Unit. A total of 18 fish samples used for this study were analyzed for organoleptic quality, proximate composition and microbial load at the laboratory.

2.2 Proximate Composition

The proximate composition of the samples was determined according to Association of Official Analytical Chemists methods (AOAC, 2005) [4]. The following parameters were assessed: moisture, crude protein, crude fiber, ash, fat and nitrogen free extract.

2.3 Organoleptic Assessment

A panel of 30 judges, where selected at random to assess the samples. The qualities assessed were: appearance, odor, flavor, taste and texture. A 4-point hedonic
Scale (4= excellent, 3= good, 2= fair, 1= poor) (Eyo, 2001) [5] was adopted. Each quality attribute was evaluated separately.

2.4 Preparation of Samples

A sterilized knife was used to cut fish samples of about 1.0 g from the fish samples starting from sample 1 to the 6th sample. Each sample cut was weighed using the top loading balance and was blended and suspended in 10 ml normal saline. To make a stock suspension; 1.0 ml of the stock solution was transferred by pipetting to a 9.0 ml diluent. This process was repeated for the rest of the samples (Olokor, Ihuahi, Omojowo, Falayi and Adelowo, 2007) [6].

2.5 Sterilization/Culture Media Preparation

Working surfaces and glassware were thoroughly cleaned and disinfected while wire loop was flamed before use. A measuring cylinder was used to measure 500 ml of distilled water into a conical flask. 31 g of Sabouraud's Dextrose Agar was weighed using a weighing balance. The Sabouraud's Dextrose Agar was soaked for 10 minutes, mixed well and was sterilized at 121 ^{o}C for 15 minutes, cooled to about 47 ^{o}C and the plates were poured. The poured plates were incubated for 24 hours before use.

2.6 Culturing/Incubation

Incubation of each sample was done by surface plate technique, by Nutrient Agar using Aliquot of 1.0ml dilution of each of the fish stock dilution of the samples. The plates were incubated at room temperature for 24 hours in an inverted position to prevent condensation and colony observation was done a day later. In the case of fungi, incubation was also at room temperature, however, for three to five days and without inverting the plates. Microbial counts and identification were carried out using standard procedure and biochemical tests such as gram staining techniques, catalase test, coagulase test and oxidase test were also carried out (Fawole, 2005; Baker, Silverton and Pallister, 2000) [7, 8].

2.7 Statistical Analysis

The data were subjected to Analysis of Variance and a significant test for differences between samples means were done using Duncan's Multiple Range test at 5% level of significance.

3. Results

3.1 Sensory Evaluation of Smoked-Dried Catfish form Five Different Markets and that of Improved Smoking Kiln.

The sensory qualities and consumers' acceptability of XCTL was most preferred to the five different sources. The appearance, odor, flavor, taste and texture of XCTL were the most preferred by the panelists while the odor of XAGM and the texture of XDM were adjudged fair all other qualities from different source were within acceptable range.

Table 1: The Sensory Evaluation of Smoked-Dried Catfish from Five Different Markets and that of Improved Smoking Kiln.

Quality	XCTL	XLMM	XALM	XFM	XAGM	XDM
Appearance	3.56^{b}	3.40^{b}	3.46^{b}	3.30^{ab}	3.03^{a}	3.43^{b}
Odor	3.40^{b}	3.06^{ab}	3.10^{ab}	3.40^{b}	2.96^{a}	3.13^{ab}
Flavor	3.50^{b}	3.03^{a}	3.33^{ab}	3.23^{ab}	3.26^{ab}	3.26^{a}
Taste	3.60^{b}	3.06^{a}	3.36^{ab}	3.23^{ab}	3.26^{ab}	3.26^{ab}
Texture	3.03^{ab}	3.26^{bc}	3.30^{bc}	3.46^{c}	3.13^{abc}	2.76^{a}

Means on the same column with same superscript are not significantly different (P>0.05).

3.2 The Proximate Composition of Smoked-Dried Catfish from Five Different Markets and that of Improved Smoking Kiln.

The proximate composition of smoked-dried fish from five different sources and that of improved kiln shows that the percentages of moisture range from 8.11 to 11.64, fish from XALM has the highest percentage and that of XCTL has the lowest which entails better keeping quality. Percentage of crude protein range from 48.72 to 61.26, with XCTL having the highest crude protein. According to Mauron (1970) [9], series of Chemical reaction take place during heat treatment. Percentage of crude fiber range from 3.54 (XCTL) to 11.70 (XALM), smoked Clarias has low crude fiber as reported by Effiong and Tafa (2005) [10]. Percentage of fat range from 4.94 (XALM) to 13.58 (XCTL), the fat content reduce during smoking due to losses. Percentage of Ash range from 4.13 (XCTL) to 17.67 (XALM). The ash content is high in XALM than XCTL. Smoking perhaps increases the ash content of fish

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Table 2: The Proximate Composition of Smoked-Dried Catfish from Five Different Markets and that of Improved Smoking Kiln.

Source	%Moisture	%CP	%CF	%Fat	%Ash	%NFE
XCTL	8.11[b]	61.26[a]	3.54[e]	13.58a	4.13[d]	9.55[c]
XLMM	11.54[a]	51.11[c]	5.16[c]	10.95b	6.94[c]	14.28[a]
XALM	11.64[a]	48.72[d]	11.70[a]	4.94d	17.67[b]	5.32[e]
XFM	10.59a	58.31[a]	6.07[c]	10.03b	7.69[a]	7.39[d]
XAGM	10.63[a]	54.82[a]	8.23[b]	9.17[c]	6.77[c]	13.37[b]
XDM	11.54[a]	52.16[a]	5.92[d]	10.23[e]	6.67[c]	13.48[b]

Means on the same column with same superscript are not significantly different (P>0.05).

3.3 Microbial Count on Smoked-Dried Catfish from Five Different Markets and that of Improve Smoking Kiln.

The results from table four indicate that smoked fish from five different sources had the highest microbial load (bacteria and fungi) when compare with the smoked fish by the researcher. Furthermore, it also gives a vivid account of the higher load of microbes on fish obtained from the five different sources. This can be attributed to contamination by microorganisms in the surrounding environment during and after the smoking process. The fungi were the yeast *Aspergillus species* Micheli, 1729 which was common in all market samples, Mucor species Micheli, 1821, Neurospora species Shear and Dodge, 1927, Rhizopus species Ehrenb, 1820 while *Staphylococcus aureus* Rosenbach, 1884, Streptococcus species Rosenbach, 1884, *Escherichia coli* Migula, 1895, *Klebsiella species* Trevisan, 1885 and Bacillus species Cohn, 1872 were the bacteria isolated. These bacteria possess health risk. The microorganisms encountered here were also reported by Martin (1994) [11].

Table 3: Microbial Types on Smoked Fish from Five Different Markets and that of Improved Smoking Kiln.

Market	Sample	Identified Fungi Isolated	Identified Bacteria Isolated
XCTL	a	*Aspergillus sp.*	*Staph. aureus*
	b	*A. sp.*	*S. aureus*
	c	No growth	*Streptococcus sp.*
XLMM	**a**	*M. sp.*	*S. aureus*
	b	*M. sp.*	*Klebsiella. sp.*
	c	*A. sp.*	*Bacillus. sp.*
XALM	**a**	*A. sp.*	*E. coli*
	b	*A. sp.*	*E. coli*
	c	*A. sp.*	*E. coli*
XFM	**a**	*N. sp.*	*S. aureus*
	b	*Mucor. sp.*	*E. coli*
	c	*M. sp.*	*S. sp*
XAGM	**a**	*A. sp.*	*B. sp.*
	b	*A. sp*	*S. sp*
	c	No growth	*B. sp.*
XDM	**a**	*Rhizopus. sp.*	*B. sp.*
	b	*A. sp.*	*K. sp.*
	c	*N. sp.*	*B. sp.*

3.4 Bacteria and Fungi Count on Smoked Fish from five Different Markets and that of Improve Smoking Kiln.

The summary of means and standard error of Bacteria and Fungi count of smoked-dried fish from five different sources and that of improve smoking kiln.

Table 4: Bacteria and Fungi Count on Smoked Fish from Five Different Markets and that of Improved Smoking Kiln.

Source	Bacteria No of colonies (CFU x 10^5)	Fungi No of colonies (cfu x 10^5)	Mean (cfu x 10^5)
XCTL	4.33±3.29	2.37±1.94	3.35
XALM	130.67±5.78	2.03±0.15	66.35
XLMM	120.00±5.78	2.63±0.43	61.32
XFM	136.67±12.01	2.23±0.40	69.45
XAGM	109.00±13.82	1.26±0.60	55.13
XDM	119.67±11.83	2.60±0.38	61.14

3.5 Summary of Results for Mean Microbial Count (cfu x 10^5)

The aggregate lower mean of microbial count was 52. 44 x 10^5 cfu/g for XCTL while the highest count of 69. 47 x 10^5 cfu/g was for XFM. There is no significant differences (P>0.05) between all means of the various sources of the smoked fish except the control.

Table 5: Summary of Results for Mean Microbial Count (cfu x 10^5)

	XCTL	XALM	XLMM	XFM	XAGM	XDM
Bacteria	103.70[a]	130.00[a]	116.70[a]	136.70[a]	109.00[a]	119.60[a]
Fungi	1.17[a]	2.07[a]	2.63[a]	2.23[a]	1.17[a]	2.60[a]
Mean	52.44[a]	66.04[a]	59.67[a]	69.47[a]	55.09[a]	61.10[a]

Means on the same column with same superscript are not significantly different (P>0.05).

4. Discussion

Sensory qualities results showed that appearance, odor, flavor and taste of XCTL were preferred by most panelists due to the nature and the quality of the product while the odor of XAGM and texture of XDM has lowest score due to poor handling. According to Karim, Akanji and Olopade, (2007) [12], flavor is an important factor in consumer's acceptability. There is no significant difference in the entire sources aside the odor of XAGM and the texture of XDM which was adjudged fair, all other sources were adjudged good.

The percentage moisture content range from 8.11-11.64, with XCTL (control) having the least value XALM have the highest value. A study on the influence of traditional smoke drying on the quality of fish by Ali, Amodou, Mohamadou, Saidou and Tenin (2011) [13], showed that percentage moisture content was the least in smoked-dried fish compared to that sun-dried and had longer shelf life and keeping quality. Thus, the drying of XCTL will have a much better keeping quality. The percentage of crude protein ranges from 48.72-61.26 with XCTL having the highest crude protein. The chemical reaction that takes place during smoking reduces the percentage crude protein of fish (Ime-Ibanga and Fakunle, 2008) [14]. However, this is more adverse if the smoking is not properly carried out as might be the case of XALM. The percentage fat ranges from 4.94-13.58 with XCTL having the highest value. The percentage crude fiber ranges between 3.54 (XCTL) to 8.23 (XAGM), the low percentage crude fiber obtained for XCTL may be due the correlation between percentage crude protein and percentage crude fiber.

All fishes from the different sources yield both fungi and bacteria count, except XCTL that was smoked using improve smoking kiln has low growth of fungi and bacteria. Pardo, Marin, Sanchis and Ramos (2005) [15] reported an optimum biotic growth factors interaction (relative humidity [RH] and temperature) for *Aspergillus fumigatus* Fresenius, 1863 of 80-89% RH and 30 ºC. Thus, the relatively high humidity and high temperature of about 32 ºC might have favored or provided optimum growth environment. Also the unacceptable direct contact with the hands of purchasers and hawkers alike during hanging for price (Mepba, Achinewhu, Aso and Nwachukwu, 2008) [16] could be an alternative source contributing significantly to the prevalence of different microbes. The prevalence of *A. species* in nearly all sources was in line with the findings of Abolagba, Adekule, Dede and Omoigui (2011) [17] and Odu, Njoku and Mepba (2012) [18] who both reported *A. species* among the commonest fungi associated with smoked fish. The health significance of *A. species* cannot be over emphasized, as it is known to produce aflatoxins. Adebayo-Tayo, Onilude and Patrick (2008) [19] detected aflatoxin B1 and G1 that might pose serious pulmonary health risk. According to Adams and Moss (2008) [20] the carcinogenic risk of aflatoxin as it relates to humans has not been proven despite its status of the most carcinogenic agent of all natural products for some animals. Contrary to the report of Akise, Abolagba and Eyong (2013) [21]. Our study revealed the predominance of *A. species* to *M. species.*

On the other hand, four bacteria similar to those isolated by Odu *et al.* (2012) [18] were identified and isolated; they include *S. aureus, S. species, K. species, B. species* and *E. coli*. Some of these bacteria isolated are normal flora of fish as those identified by Abolagba *et al.* (2011) [17]. Normal microbial flora of fish are often beneficial as they safe-guard against invasion of flesh by other microbes, however, they graduate to becoming pathogenic when enabling environment (temperature and relative humidity) in association with bad handling, poor hygiene, and delayed processing and preservation favors population growth. *S. aureus, S. species* and *B. species* were each isolated in three separate sources whereas *E. coli* and *K. species* were each isolated in two separate sources. The spoilage potentials of *S. aureus* on smoked fish have been highlighted in the report of Okonta and Ekelemu (2005) [22]. Fang, Wie, Liao, Hung and Wang (2003) [23] noted that the presence of *E. coli* might be due to cross contamination from other food contact surfaces or poor handling. *E. coli* can cause diarrhea and nausea leaving infected person weak; also they produced toxins that damages the kidney and weakens the small intestinal walls in children. According to North Carolina Department of Health and Human Services, each year in the United States, *E. coli* infection cause approximately 265,000 illnesses and about 100 deaths.

The count of bacteria and fungi as represented in table 4 and 5, are within class B of the microbiological quality category of ready-to-eat foods. A look at fungi reveals that both XCTL and XAGM had the lowest count of 1.17 x 10^5cfu/g while XALM had the highest fungi count of 2.63 x 10^5cfu/g. In the case of bacteria, XCTL has the least count of 103.70 x 10^5cfu/g while XFM had the highest count of 136.70 x 10^5cfu/g. On a general note; the researchers source XCTL had the least microbial load of 52.44 x 10^5cfu/g because it was smoked with improve smoking kiln under proper control, care and handling. While XFM has the highest microbial load of 69.47 x 10^5cfu/g due to poor handling.

5. Conclusion

In conclusion, the sensory evaluation of the fish from the improved smoking kiln (XCTL) had the best acceptable quality response by the panelist compared to that from five different sources. Proximate composition showed that fish from improved smoking kiln had the lowest moisture content and highest crude protein an indication of better keeping quality and acceptability. Fish from XALM has the highest moisture content. Type and level of Bacteria and fungi count was highest in XALM and insignificant in fish from the improved smoking kiln.

This study has demonstrated that proper processing/preservation and handling will not only enhanced proximate composition but will also reduce microbial load and enhance general acceptability by consumers. Thus, recommends that fishes should be properly handled when

processing; they should be thoroughly washed, disposable hand gloves should be used and glass boxes should be used for display in the market.

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