

(RESEARCH ARTICLE)



Evaluation of microbiological quality and organoleptic properties of smoked dried fish sold in Wukari markets Taraba state, Nigeria

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Abstract

This study was conducted to investigate and assess the microbiological quality and organoleptic properties of smoked dried fish sold in Wukari markets, Nigeria. Eight samples of smoked dried fish (SA,CA,MB,SC,TP,CO,SA1,SA2) were analyzed for microbial quality and organoleptic properties using standard methods. The total bacteria aerobic plate count of bacterial cells ranged from 1.31×10^6 to 2.22×10^7 , coliform count 1.00×10^5 to 7.40×10^6 , Staphylococcal count 4.00×10^6 to 6.10×10^6 and fungi 1.50×10^6 to 8.3×10^6 cfu/g in the fish samples respectively. The microbial load of all samples was higher than the acceptable limit of 5.0×10^5 cfu/g. Identification of bacterial isolates revealed the presence of *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus spp*, *Pseudomonas spp*, *Escherichia coli*, *Salmonella typhi* and *Klebsiella spp*. The mould isolates were *Aspergillus niger*, *Aspergillus flavus*, *Penicillium* and *Clasporium*. From the sensory evaluation of all samples, shawa was the most preferred in terms of appearance, colour, tenderness, aroma and general acceptability. Kulungu was the least preferred in terms of appearance, colour and texture, catfish and tilapia were the least preferred in terms of aroma and ragon ruwa was the least preferred in terms of tenderness and general acceptability. In conclusion, the presence of some pathogenic microorganisms isolated from this study is an indication that samples were contaminated and can potentially pose a health hazard to the consumers. Thus, there is need for smoked fish sellers and marketers to take hygienic measures during smoking and handling of smoked fish so as to avoid contamination.

Keyword: Bacterial isolates; Health hazards; Microbial load; Microbiological quality; Organoleptic properties; Smoked dried fish

1. Introduction

Fish is a vertebrate animal, living in fresh and seawater. Most of the catch comes from oceans, seas, rivers and lately from man made ponds. [1] stated that Africa is endowed and constitute a rich source of numerous species of fresh fish. Such species include *Clarias spp*, *Bagrus spp*, *Tilapia spp* amongst others [1].

The demand for fish is on the increase due to the increase in world population. It is also relatively cheap unlike the meat protein. Fish has a potential in the relief from malnutrition because of its superior protein quality unlike meat, milk and egg [2]. The presence of Omega -3- unsaturated fatty acids attach medicinal values to fishes in controlling conditions such as arthritis, asthma, coronary heart disease and cancer[3].

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, poor hygiene, increase in ambient temperature, relative humidity, delayed processing and preservation practices adopted by the artisanal fishermen, commercial fishermen, and fisheries entrepreneurs [4,5]. This triggers favorable conditions for microorganisms to thrive. Thus, the quality of fish as well as

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its potential keeping time deteriorates rapidly leading to food loss with regards to acceptable quality. This deterioration is due to growth of microorganisms or non-microbial causes such as lipid oxidation [1].

Fish is one of the main sources of animal protein foods available for human consumption and it represents about 14% of all animal proteins on a global basis [3]. The presence of this nutrient aids the proliferation of microbes such as bacteria (*Staphylococcus aureus*), yeast (*Saccharomyces cerevisiae*) and mould (*Aspergillus niger* and *Aspergillus flavus*) which are commonly associated with smoked dried fish [1]. Also, due to high amount of water and soft tissues, fishes are highly susceptible to microbial contamination and spoilage [6].

In many communities in Nigeria, smoked fish are usually hawked or sold openly in the markets without taking cognizance of the microbial contamination from the environment [7]. Careful implementation of microbiological quality control at the production level of smoked dried fish will ensure adequate keeping quality and wholesomeness of the product. Consumers make their preferences in selecting smoked dried fishes by using some physical attributes such as colour, texture and flavour when selecting the quality of smoked dried fish to purchase. This preference usually differs as each consumer has their unique preferences in determining the quality of smoked dried fishes [8]. Determining the sensory quality also helps to assess the quality attributes that influences the choice of people in purchasing smoked dried fish [8]. It was against these background that this study was initiated to investigate the microbiological quality and organoleptic properties of smoked dried fish sold in Wukari markets.

2. Material and methods

2.1. Study location

This study was carried at the Department of Food Science and Technology Federal University wukari , Taraba State.

2.2. Study design

Completely randomized design was used in the study and principal factor was dried smoked fish of different types (CO,SA,SC,MB,TP,CA,SA1,SA2).

2.3. Sample collection

Samples of smoked dried fish were purchased from vendors randomly from old and new markets in wukari, Taraba State. The samples were collected in a sterile container and convey to the laboratory for analysis.

2.4. Sample preparation

The samples were prepared using the method as described by[9] . The fish sample was cut using a sterile knife , then pounded in a sterile laboratory mortar and pestle.

2.5. Sample analysis

The samples were analysed for microbial characteristics and sensory attributes. The effects of the principal factors on these parameters was determined.

2.6. Microbiological analysis

The isolation and enumeration of total bacterial count was determined using the methods as described by [9]. Serial dilution (10-fold) and aliquots of appropriate dilutions ((10⁻⁴,10⁻⁵,and 10⁻⁶) were plated on Nutrient agar, MacConkey agar, Manitol salt agar and Eosine methylene blue agar, using pour plate method. Incubated at 37 OC for 24 – 48 hours for total bacterial and coliform count. All enumerations were expressed as colony forming units per milliliter (cfu/ml) of plated samples. Bacterial isolates were identified and characterized based on their morphological, cultural and biochemical tests using standard methods as described by [5,10,11,]. The isolated organisms were then confirmed as described by[12].

2.7. Organoleptic evaluation

Organoleptic evaluation of the smoked fish samples were performed with the aid of 15 panelists which were selected at random using the affective method of sensory evaluation. The qualities analyzed were: tenderness, aroma, colour, appearance, texture and overall acceptability on a 9-point hedonic scale as described by[13]); 9 = like extremely, and 1 = Dislike extremely.

2.7. Statistical analysis

Analysis of Variance (ANOVA) was used to test levels of significant values ($p \leq 0.05$). Mean values were separated using Duncan multiple range test. Data analysis was carried out using the statistical package for social sciences (SPSS) version 20.0 and the results were presented as mean with standard deviation.

3. Results and discussion

3.1. Microbial load of smoked dried fish

The total aerobic plate count for bacteria, coliform, Staphylococcal and fungi counts from samples of smoked dried fish obtained from some markets in Wukari, Nigeria is shown in Table (1). The total aerobic plate count for bacteria cells ranged from 1.31×10^6 cfu/g – 2.22×10^7 cfu/g in Shawa (SA), Catfish (CA) and Mackerel (MB). The total coliform counts ranged from 1.00×10^6 cfu/g - 7.40×10^6 cfu/g for samples of shawa (herrings), Scombia (SC) and Catfish (CA). The Staphylococcal count ranged from 4.00×10^6 cfu/g - 6.10×10^6 cfu/g in Shawa (SA) and Scombia (SC) samples. The fungi count ranged from 1.50×10^5 cfu/g – 8.30×10^6 cfu/g for Shawa (SA) and Scombia (SC) samples.

There were high counts of bacterial cells in sample SA which indicates contamination of the smoked fished sample. The total aerobic bacterial count of all samples obtained from this study was higher than the acceptable limit of aerobic plate count of 5.0×10^5 cfu/g as stipulated by International Commission on Microbiological Specification for Food [14]. This may be due to the different handling method, preservation and marketing methods employed by smoked fish vendors. Cross contamination by bargaining customers and exposure to the markets environments without proper covering of the smoked fish could also be a factor that contributes to the high microbial load obtained from this study. The result from this study is in agreement with the report of [15] who noted that the microbial density is a reflection of different processing methods and poor hygienic level of processors and sellers.

The population density of microbial counts obtained from this study is comparable with the work of other researchers such as [3][16,17][18, 19,][20,21,22] which also had high count of bacterial cells from smoked dried fish from various markets in different parts of the country.

3.2. Isolates identification

The results in Fig (1), showed the microbial biota found in smoked dried fish in sold Wukari markets, Nigeria. The microorganisms identified for bacteria include; Staphylococcus aureus (80%), Esherichi coli (85.7%), Bacillus spp (20%), Salmonella typhi (54.3%), Pseudomonas spp (68.6%), Klebsiella spp (77%). For mold Aspergillus niger, Aspergillus flavus, Penicillium, Clasporium spp and Mucor spp. were isolated as shown in Table (2). The result obtained from this study is in line with the report of other researchers these include [17,20,] [23,24,25][26,27,28] who also isolated similar organisms from smoked dried fish sold in different markets in Nigeria.

There is similarity in microbial isolates among dried smoked fish samples in relation to the species of organisms identified. This could be associated with the processing method, handling, storage and marketing pattern [21]. The result obtained from this study is in agreement with the report of other researchers who studied on microbial quality of smoked dried fish and identified similar bacteria and moulds as revealed in this study [1,18].

Table 1 Bacteria cells (cfu/g) obtained from smoked dried fish sold in Wukari markets, Nigeria

Parameters (cfu/g)	Fish samples					
	CO	SA	SC	MB	TP	CA
Total aerobic plate count	NG	2.22×10^7	6.00×10^6	3.60×10^6	NG	1.31×10^6
Coliform count	NG	7.40×10^6	1.10×10^5	NG	NG	1.00×10^5
Staphylococcal count	NG	6.10×10^6	4.00×10^6	NG	NG	NG
Fungi count	NG	8.30×10^6	1.50×10^5	NG	NG	NG

Key: CO = Control, SA = Shawa, SC = Scombia, MB = Mackerel, TP = Tilapia, CA = Catfish, NG = No growth

Most of the bacterial isolates identified in this study are among the ones that could cause food borne illness these include; E. coli, S. aureus, Salmonella typhi and Bacillus spp. This indicates that the fish is contaminated from the water

bodies where they are harvested. These enteric pathogens are capable of causing intestinal disease [29]. Most of the fungal species isolated such as *Penicillium*, and *Aspergillus* spp. is known to produce mycotoxins in food products. Mycotoxins are secondary metabolites produced by microfungi that could cause disease condition. Aflatoxin can occur in diversity of protein sources including plants and animals [19].

Table 2 Fungi isolated from smoked dried fish sold in Wukari markets, Nigeria

Isolates code	Microscopic	Colonial morphology	Suspected organisms
SA1	Non-branched conidiophores with bulb end carries conidia like sun rays. Non-branched conidiophores with bulb end and carries conidia. Conidiophores are more or less distinct from the vegetative hyphae, are erect, straight, unbranched only in apical region with geniculate sympodial elongation in some species	Pin-like black growth Pin-like green growth Colonies are slow growing, mostly olivaceous brown to blackish brown	<i>Aspergillus niger</i> <i>Aspergillus flavus</i> <i>Clasporium</i> spp
SA2	Brush-like conidiophores carries conida. Non-branched conidiophores with bulb end carries conidia like sun rays. Non-branched conidiophores with bulb end and carries conidia. Conidiophores are more or less distinct from the vegetative hyphae, are erect, straight, unbranched only in apical region with geniculate sympodial elongation in some species.	Green-greyish colonies Pin-like black growth Pin-like green growth Colonies are slow growing, mostly olivaceous brown to blackish brown	<i>Penicillium</i> spp <i>Aspergillus flavus</i> <i>Clasporium</i> spp
TP	Sporangia contain spores, do not have rhizoids	Cotton like white growth	<i>Mucor</i> spp

KEY: SA1 = Shawa 1, SA2= shawa 2, TP= tilapia

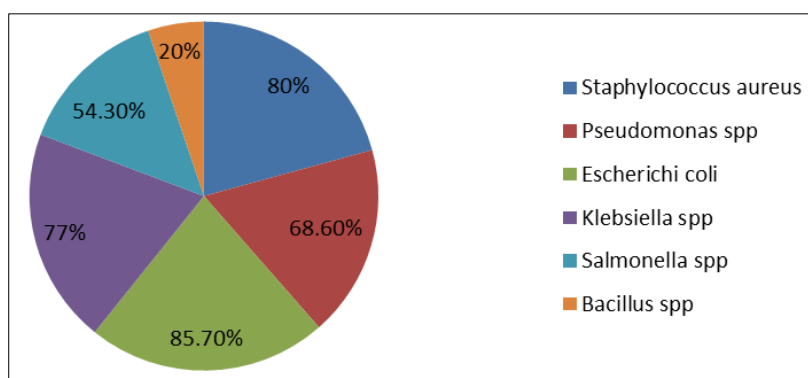


Figure 1 Pie chart for prevalence of microorganisms (bacteria) isolated from smoked dried fish samples sold in Wukari, Nigeria

3.3. Organoleptic assessment of smoked dried fish

The result from the organoleptic assessment of smoked fish samples sold in Wukari markets , Nigeria is presented in Table (3). The appearance ranged from 6.13 -8.27 with significant difference among the samples. Colour among the samples ranged from 6.27-8.13 and samples were significantly different among the samples ($p < 0.05$). Tenderness ranged from 6.47-8.13 with significant difference among the samples. Texture ranged from 6.53-8.07 with significant

different among the samples. Aroma ranged from 6.73-7.80 with significant difference among the samples. The general acceptability ranged from 7.07-8.47 with significant difference in the samples.

The result of the organoleptic assessment was compared to show consumer preference of the most preferred fish species sold in Wukari markets, Nigeria. The acceptance in terms of general acceptability, aroma, texture, tenderness, colour and appearance vary among the smoked fish samples.

The result also revealed that shawa (sample) D was the most preferred in terms of all the parameters used in assessing the organoleptic properties (appearance, aroma, texture, tenderness, colour and general acceptability) this could be as a result of the freshness of the fish. The smoked fish has also not lasted for 24 hours. The sample (D) also had a bright attractive colour which was impacted on the fish sample during smoking. The result of this study is in agreement with the work carried out by [30]. Sample F was the least preferred in terms of appearance, colour and texture this may be as a result of the level of drying of the fish. Sample G and H were the least preferred in terms of aroma this is as a result of strong aroma of the fish which was more predominant than the aroma impacted on the fish during smoking. Sample E was the least preferred in terms of tenderness and overall acceptability due to the hard surface of the fish after smoking. The least preferred samples were properly dried fish samples with little or no moisture and have all exceeded 24 hours after smoking. This result proves that consumers will preferred freshly smoked fish within 24 hours than other fish samples that have exceeded 24 hours.

Table 3 Organoleptic properties of smoked dried fish sold in Wukari markets, Nigeria

Attribute	Sensory mean scores							
	A	B	C	D	E	F	G	H
Appearance	7.67±1.11 ^{ab}	7.33±0.82 ^b	7.67±0.82 ^{ab}	8.27±0.88 ^a	7.07±1.33 ^a	6.13±1.30 ^c	7.53±0.99 ^{ab}	7.20±1.01 ^b
Colour	7.40±1.18 ^{ab}	7.27±1.71 ^{ab}	7.20±0.82 ^{abc}	8.13±0.92 ^a	6.93±1.22 ^{bc}	6.27±1.53 ^c	7.20±0.68 ^{abc}	7.07±1.16 ^{bc}
Tenderness	7.27±1.33 ^{ab}	6.87±1.77 ^b	6.87±1.25 ^b	8.13±1.13 ^a	6.47±1.36 ^b	6.80±1.08 ^b	7.13±1.06 ^b	7.00±1.00 ^b
Texture	7.33±1.11 ^{ab}	6.80±1.70 ^b	6.67±1.18 ^b	8.07±1.03 ^a	6.67±1.76 ^b	6.53±1.06 ^b	7.07±1.10 ^b	6.93±0.80 ^b
Aroma	7.47±1.13 ^{ab}	7.27±1.03 ^{ab}	6.73±1.62 ^b	7.80±1.15 ^a	6.80±1.15 ^b	6.87±1.30 ^{ab}	7.27±0.80 ^{ab}	7.27±1.22 ^{ab}
G.A	8.20±0.68 ^{ab}	7.53±0.92 ^{bc}	7.33±1.05 ^c	8.47±0.83 ^a	7.07±1.10 ^c	7.20±1.15 ^c	7.53±0.64 ^{bc}	7.67±0.82 ^{bc}

Attribute in mean ± standard deviation of 15 panelists response in a scale with 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = Neither Like nor Dislike, 4 = Dislike slightly, 3 = Dislike moderately, 2 = Dislike very much and 1 = Dislike extremely. Means in row with different superscripts are significantly different ($p < 0.05$).

KEY: Samples A = Mackerel, B = Scombia, C = Palia, D = Shawa, E = Ragon ruwa, F = Kunlugu, G = Catfish and H = Tilapia, G.A = General acceptability.

4. Conclusion

Based on the result of this study it can be concluded that most of the bacterial isolates identified in this study are among the ones that could cause food borne illness and can potentially pose a health hazard to the consumers. Thus, there is need for smoked fish sellers and marketers to take hygienic measures during smoking and handling of smoked fish so as to avoid such contaminations. Therefore, it is recommended that the adoption of good processing practices of smoked fish products (e.g. adequate smoking of fish products, proper hygiene practices etc.) should be adopted by all involved in the processing and selling of the smoked dried fish in the locality so as to ensure that safety standards are maintained and market worthiness of the final products.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

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