Original Research Article

~~Nutritional quality and~~ evaluation of somemicrobial flora of smokedfishsold in some public markets in the city of Abidjan (Côte d'Ivoire).

ABSTRACT

Objective : The general objective of thisworkis to evaluate the microbiologicalquality of somesmokedfishsold in the markets of the city of Abidjan.

Methodology : The collection of samples for analysistook place in the markets of the communes of Cocody,~~les~~ II- Plateaux (Sococe) and Cocody Centerr~~e~~, Abobo, Adjamé Williamsville and the big market~~Grand Marché~~. A quantity of 10 samplescomposed of 5 smokedfish per samplewerecollected by market in sterilestomascherbags, thentransported in a coolercontainingice to the laboratory to performmicrobiologicalanalysis.

insufficientmethodology

Resutats : Aftervarious tests, differentmicrobial flora of alterationwerefound in the smokedfishsold in the differentmarkets of Abidjan. These are fungal flora (yeasts/molds), aerobicmesophilicgerms and enterobacteria. All samplesfrom the studymarketswerecontaminatedwiththesedifferentmicroflora. The CFU load/g for mesophilicaerobicgermsvariedfrom 38.106 ± 12 to 65.106 ± 12 CFU/g. For the fungal flora, the loadsvariedfrom 103 ± 11 to 284 ± 14 CFU/g. As for enterobacteria, the loadsoscillatefrom 183± 10 to 418 ± 11 CFU/g.

Smokedfishsold in the various public marketscontainpotentiallypathogenicbacterialspecies, in particular*Escherichia coli* and *Staphylococcus aureus*. Thesetwobacterialspecies are found in all sampleswithverydifferentloads. The loads of *Escherichia coli* are very high and varyfrom 51 ± 12 to 86 ± 12 CFU/g whereas the standard onlyprovides for 10 CFU/g. The loads of S. aureus varybetween 125 ± 13 and 437 ± 13 CFU/g. Theseloads do not complywith the criteria set by the standard.

lack of results on nutritionalquality

Conclusion : The analyses have identified the germsreflecting a lack of good hygiene practices such as spoilage and contamination flora, flora of faecalorigin, in the smokedfishsamples. The high presence of thesegermswouldexplain a lack of good hygiene practices in the differentmarketsduring the smoking process, whichwouldrepresent a danger for the consumers. Thus, fish in the differentmarkets of Abidjan studied must bewellboiledbeforeconsumption.

Keywords: smokedfish, microbialquality~~, microbial, nutritional~~.

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1. Introduction

Fish is an important source of food and livelihood in the world, providing accessible protein to the vastmajority of populations, especially for African populations [1]. It alsoplays an important role in the economy of these countries throughtrade and exports, particularly in the coastal states of West Africa, including Côte d'Ivoire.

In Côte d'Ivoire, itoccupies an important place in the dietwith a share of 50%, and representsbetween 15 and 16 kg/year of consumption per capita [2].Fish provides high qualityproteinthatiseasy to digest and alsohelps combat micronutrientdeficiencies. In addition, a 150 g portion of fishcovers 50-60% of an adult'sdailyproteinrequirement [3]. Fish are rich in potassium and phosphorus and are apreferred source of water-soluble vitamins, notably B6 and B12, and fat-soluble vitamins, A, E and D. Along withmilk and dairyproducts, they are the main dietary sources of iodine, contributing more than 8% of the average iodine intake of children [4]. Therefore, thisfoodis accessible to low-incomehouseholds, especially in developing countries where the price of meatremainsbeyond the reach of the average consumer [5].

Althoughfishis a vital resource. It remains a rapidlyperishablecommoditywith a relatively high rate of spoilage due to itschemical-physical and microbiologicalcharacteristics [6]. However, to maintain the quality of fish over time, severalpreservation and processing techniques are used. Theseoperationsvarysignificantlydepending on the country and dietary habits. The techniques generallyused are freezing, drying, smoking, salting [3]. In addition, the lack of hygiene in production and

poorpreservationconsiderablyfavor the microbial contamination of products. Thus, the contaminatedfishobtained can be the cause of foodpoisoning [7].

Infectiousfoodbornediseases in Côte d'Ivoire are thought to berelated to the presence of microorganisms in food. In addition, theyconstitute a public healthproblemthatiswidespreadthroughout the world and generate a social and economicproblemthatrepresents a threat for the population [8].It istherefore important to find solutions to the risks of fish contamination. It is in thiscontextthatthisworkisregistered. The general objective of thisworkis to evaluate the microbiologicalquality of somesmokedfishsold in the markets of the city of Abidjan.

2. Material and methods

2.1 Sampling

The collection of samples for the analyses took place in the city of Abidjan. All sampleswerecollected by purchase in some public markets of the city of Abidjan. Thesewere the markets of II- Plateaux Sococe, Cocody Centerre, the biglargemarket of Abobo, the market of Williamsville and the biglargemarket of Adjamé. The fishwerecollected in sterilestomascherbags. A quantity of 10 samplescomposed of 5 smokedfish per samplewerecollected per market. Theyweretransported in a coolercontainingice to the laboratory for microbiologicalanalysis.the sampleissmall

2.2. Microbiologicalanalysis

A 25g sample of smokedfishisweighedaround the Bunsen burner on a balance (KERN). A volume of 225 mL of sterileBuffered Peptone Water (BPW) isadded. The wholeiscarefully mixed for 5 minutes. The resulting solution isleft to stand for one hour. Approximately 1 mL of the stock solution iswithdrawnnear the Bunsen burner flame using a sterilegraduated pipette and transferred to a test tube containing 9 mL of steriledistilled water. Five (05) successive dilutions rangingfrom 10^{-1} to 10^{-5}wereperformed [9].

2.3. Enumeration of the differentmicrobial flora

The selected dilutions wereplated. This is the plating in the mass whichtookintoaccount the Sabouraud media withchloramphenicol, VRBL, PCA, BEA VRBG. One milliliter of each dilution obtainedwasintroducedinto the Petri dishes. A quantity of 20 mL of previouslyprepared medium ispouredinto the Petri dish. The wholeiswellhomogenized. The plates are left on the bench for the solidification of the agar. Surface plating by spreadingthatconsidered E. coli Rapid 2 and Baird Parker media. A quantity of 0.1 mL of eachdecimal dilution concernedisplaced in a Petri dishcontaining 20 mL of previouslyprepared and poured agar. The 0.1 mListhen spread on the agar surface using a sterilespreader. The solidified plates are incubated at 25°C for 7 days for yeasts and molds, at 30°C for 24 hours for total coliforms, at 30°C for 72 hours for aerobicmesophilicgerms, at 37°C for 24 hours for Enterobacteriaceae and at 37°C for 24-48 hours for Streptococcus. Similarly, at 45°C
0 for 24 h for the detection and enumeration of E. coli and 37°C for 24 to 48 h for the detection and enumeration of Staphylococcus aureus. The enumerationissignificantwhen the number of germsfound per plate isbetween 30 and 300 colonies for GAM, 15 and 150 colonies for streptococci, enterobacteria, yeasts and molds, coliforms, Staphylococcus aureus and E. coli [10; 11; 12; 13; 14; 15; 16].

2.4.Search for Salmonella

The search for Salmonella iscarried out in four stepswhich are [17]:
Step 1: Pre-enrichmentwhichconsists in diluting 25 g of sample to beanalyzedin 225 mL of EPT. The suspension obtainedisleft for about 30 minutes on the bench and thenincubated at 37°C/24h.
Step 2: Enrichmentwhichconsists in putting 0.1 mL of suspension after 24h of incubation in 10 mL of sterileRappaport de Vassiliadisbrothpreviouslyprepared and poured in tube. The seeded tube isincubated at 44°C/18 to 24h.
Step 3. Isolation whichconsists of streaking on Hektoen medium previouslyprepared and poured on Petri dish at a rate of 20 mLiscarried out fromVassiliadisRappaportbroth. The seeded plates are incubated at 37°C/24h.
Step 4: This last stepconsists of reading and identification. Colonies with black centers are takenintoaccount for furtherwork.

lack of methods on nutritionalquality

3. Results

3.1 Microbiologicalquality of smokedfish

3.1.1. Tainting and contamination flora

Differentmicrobial flora of alterationwerefound in the smokedfishsold in the differentmarkets of Abidjan. These are fungal flora (yeasts/molds), mesophilicaerobicgerms and enterobacteria. All the samplesfrom the studymarketswerecontaminated by thesedifferentmicroflora. However, except for yeasts and molds, the otherparametersanalyzeddid not complywith the criteria set by the standard in force. The CFU load/g for mesophilicaerobicgerms varies from $38.10^6 \pm 12$ to $65.10^6 \pm 12$ CFU/g. For the fungal flora, the loadsvaryfrom 103 ± 11 to 284 ± 14 CFU/g. As for the enterobacteria, the loadsoscillatefrom 183 ± 10 to 418 ± 11 CFU/g (Table I).

Table I: Averageloads of spoilage and contamination flora in smokedfish

	Averageloads of microbiologicalparameters (cfu/g)		
Samples	**MesophilicAerobicGerms (MAG)**	**Yeast and Moulds**	**Enterobacteriaceae**
E1	$41.10^6 \pm 10$	284± 14	232 ± 11
E2	50.10^6± 11	107 ± 13	183± 10
E3	39.10^6± 10	196 ± 13	311 ± 11
E4	38.10^6± 12	103 ± 11	264 ± 10
E5	56.10^6± 13	142± 11	312± 12
E6	42.10^6± 14	128± 11	418 ± 11
E7	$65.10^6 \pm 12$	189 ± 11	367 ± 10
E8	58.10^6± 10	156± 12	309± 10
E9	45.10^6±13	168 ± 13	464± 12
E10	57.10^6±12	165± 16	548± 11
Microbiologicalcriteria	**10^6CFU/g**	**10^5CFU/g**	**10 FC/g**

3.1.2. Fecal contamination flora

The averageloads of the smokedfishanalyzedvaryfrom one sample to another. All loadswereabove the microbiologicalquality standard criteria for fecalstreptococci and fecalcoliforms. Fecalcoliformloadsrangedfrom 214 ± 11 to 405 ± 10 CFU/g, whilefecalstreptococciloadsrangedfrom 123 ± 11 to 196 ± 12 CFU/g. The standard called for a total absence of germs in the fecalstreptococci (Table II).

Table II: Averageloads of fecal contamination flora in smokedfish

	Averageloads of microbiologicalparameters (CFU/g)	
Samples	**Fecalcoliforms**	**FecalStreptococci**
E1	234 ± 12	108± 11
E2	299 ± 11	169 ± 11
E3	253 ± 12	154 ± 12
E4	214 ± 11	123± 11
E5	333 ± 11	162± 11
E6	352± 11	136 ± 12
E7	405 ± 10	142± 12
E8	333± 13	142± 12
E9	340± 11	178± 11
E10	352± 58	196± 12
Microbiologicalcriteria	**10^2CFU/g**	**Absence**

3.2 Potentiallypathogenicspecies

Smokedfishsold in the different public marketscontainpotentiallypathogenicbacterialspecies, notably Escherichia coli and Staphylococcus aureus. Thesetwobacterialspecies are found in all sampleswithvery diverse loads. The loads of Escherichia coli are very high and varyfrom 51 ± 12 to 86 ± 12 CFU/g whereas the standard onlyprovides for 10 CFU/g. The loads of S. aureus varybetween 125 ± 13 and 437 ± 13 CFU/g. Theseloads do not complywith the criteria set by the standard (Table III).

Table III: Averageloads of potentiallypathogenicspecies in smokedfish

	Averageloads of microbiologicalparameters (cfu/g)	
Samples	***Escherichia coli***	***Staphylococcus aureus***
E1	69± 12	252± 13
E2	70± 15	125± 13
E3	62± 14	301 ± 13
E4	51± 12	216 ± 13
E5	61 ± 13	209 ± 11
E6	75 ± 14	354 ± 12
E7	66 ± 12	328± 13
E8	71± 14	437 ± 13
E9	83 ± 12	347± 12
E10	76 ± 13	284± 14

Microbiologicalcriteria	**10 CFU/g**	**10^2CFU/g**

3.1 Pathogenicspecies: Salmonella

The genus Salmonella waspresent in the majority of the samples and in all the public markets in Abidjan thatwereused for the study. However, itshouldbenotedthat the genus Salmonella was absent fromsamples 1, 2 and 6 from the II-plateaux market and the Grand marché d'Abobo respectively (Table IV).

Table IV: Investigation of Salmonella genus in fresh and smokedfish

Sites sampled	Samplesanalyzed	Smokedfish
II-PLATEAUX	E1	-
	E2	-
COCODY CENTRE	E3	+
	E4	+
GRAND MARCHE ABOBO	E5	+
	E6	-
WILLIAMSVILLE	E7	+
	E8	+
GRAND MARCHE ADJAME	E9	+
	E10	+

Presence : + , Absence : -

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4. Discussion

The presentstudyallows to assess the microbiologicalquality of smokedfishsold in some public markets of the city of Abidjan. The microbiological analyses of the fishrevealed the presence of variousmicroorganisms. These are the flora of alteration and contamination, flora of faecalorigin, potentiallypathogenicbacterialspecies and pathogenicspecies.

Regarding the flora of alteration and contamination, we count the aerobicmesophilicgerms (AMG) both in smokedfish and freshfishwithloadsthatexceed the microbiological standards. Theseloads are respectivelyevaluatedbetween 38.10^6 and 65.10^6 CFU/g for smokedfish. This wouldberelated to the conditions underwhich the fish are sold. Indeed, in thesemarkets, smokedfish are sold in the open air and sometimesneargarbageheaps and toiletswith the remarkablepresence of fliesaround the fish. Theseresults are similar to those of a recentstudyconducted by [18] in Côte d'Ivoire and by [19] on smokedfishsold in the markets of Abomey Calavi.

As for yeasts and molds, they are present in smokedfish at verylowlevelscompared to the microbiological standard. Theirloads are between $1.03.10^2$ CFU/g and $2.84.10^2$ CFU/g. The results of the study are consistent withthose of [18] whoobtainedlowloads of Yeast and Molds in smokedfish.

The presence of enterobacteria in smokedfishwouldexplainthat the samples have undergonetoomuch handling. This wouldberelated to the insalubrity of the immediateenvironment.

As for the flora of fecalorigin, all the loads are higherthan the criteria set by the microbiologicalquality standard. The loads of fecalcoliforms for smokedfish range from 214 ± 11 to 405 ± 10 CFU/g, whilethose of fecalstreptococcivaryfrom 123 ± 11 to 196 ± 12 CFU/g. The standard foresaw a total absence of germs at the level of fecalstreptococci. The high presence of these flora couldbeexplained by the fecal contamination of

humans and warm-bloodedanimals. These data are in agreement withthose of the works [20] whichcountedgerms of fecalorigin, in particularfecalcoliforms in smokedfish.

The different analyses performed on the smokedfishsamplesrevealed the absence of salmonella in somesamples. This couldbeexplained by the fishing in unpolluted waters, the high temperature of smoking and the low water content in the smokedfish. Theseresults are consistent withthoseobtained by [21] whoalsoshowed the absence of thesegerms in somesmokedfish.

Othersamples, however, showed the presence of Salmonella. Our results are in agreement withthose of [22] whofound the presence of thesegerms at 75% in fishsamples. This compliance couldbeexplained by poor handling of the fish.

For the potentiallypathogenicspecies, the smokedfishsamplesanalyzed are contaminatedwith Staphylococcus aureus and E. coli. In fact, smokedfishcontains more Staphylococcus aureus germswith a loadbetween 125 ± 13 and 437 ± 13 CFU/g. Theseresults are not in conformitywith the standard (10^2 CFU/g). Our results are similar to those of [23] who have shown by recentstudiesthat the presence of Staphylococcus aureus couldbe due to human contamination of foodstuffs, giventhatthisbacteriumis commensal of the skin and mucous membranes of humans. This would show the non-compliance with good hygienic practices and the ineffectiveness of the product in thesedifferentmarkets. The results of the study are alsodifferentfromthosefound by [24], whichrevealed the absence of thesegerms in samples of smokedfish. This differencecouldbe due to the factthat the sources of supply, and the smoking conditions are different.

The results of the microbiologicalanalysis of Escherichia coli revealed the presence of thesegerms in all the samples of the differentmarketsstudied. Moreover, theseresults do not meet the microbiologicalcriteria (10 CFU/g). The presence of Escherichia coli in all the samplesattests to a contamination of fecalorigin. The results of thisstudy do not agreewiththose of [25]. This wouldexplainwhy the fish are not soldunder the right conditions. Also, the lack of application of good hygiene practices acceleratesbacterialproliferation and compromises the quality of fishsold in the differentmarkets of the city of Abidjan. Moreover, theseresults are also consistent withthose of previousworkcarried out by [26] whohaddetected the presence of thesegerms in smokedfish. This conformitycouldbe due to the lack of respect for good hygiene practices and the unsanitaryenvironment, as well as the stagnant water around the markets. This istherefore at the origin of the microbial contamination of the samples by Escherichia coli. In addition, smokedfish are kept in basins or baskets previouslylinedwithpaper or cardboardthat has already been used for packaging. This couldalsobe a source of contamination of the product by thesepathogens.

4. Conclusion

The presentstudy on smokedfishrevealed the healthrisksassociatedwiththeirconsumption. The non-observance of good hygiene practices and the lack of hygiene at the smoking sites in the city of Abidjan are contrary to the requiredhygienic standards. The analyses identifiedgermsthatreflect a lack of good hygiene practices such as spoilage and contamination flora, flora of fecalorigin, in the smokedfishsamples. As for the potentiallypathogenicspecies, Escherichia coli ispresent in smokedfish. The pathogenicspecies, Salmonella wasdetected in almost all samples of ouranalysis. The high presence of thesegermswouldexplain a lack of good hygiene practices in the differentmarketsduring the smoking process, whichwouldrepresent a danger for consumers. Thus, fish in the differentmarkets of Abidjan studied must bewellboiledbeforeconsumption.

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