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Influence of Manufacturing Methods on the Microbiological and Nutritional Characteristics of Kilichi, Dry Meat of Niger

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A B S T R A C T

In Niger, the kilichi, thin slices of dried meat, is one of the most popular products both domestically and internationally. Our objective through this study is to contribute to the improvement of the sanitary quality of the kilichi of Niger. For this purpose, the microbiological and nutritional characteristics of 3 variants ("Fari", "Ja" and "Rumuzu" for both methods, for a total of 6 products, including 3 from a modern process and 3 from a Traditional processes are compared: From a microbiological point of view, the desired microorganisms are mesophilic aerobic flora, total coliforms, faecal coliforms, Salmonella, yeasts and molds, and anaerobic sulphuro-reductive levels in accordance with national standards. are fractionated by the determination of calcium and zinc contents. The results of the microbiological analyzes Revealed That kilichi variants derived from the traditional method are loaded with microorganisms Significantly more than Those derived from the modern method and by aussi standards. Indeed, the results of kilichi "fari 1"and "rumuzu 1"are clearly above the norms for all tested germs, and "fari 2"and "rumuzu 2" for the first two germs. Faecal coliforms have been found, although they are substandard. The kilichi "ja 1"has exceeded the norms for all the first two germs but is below the kilichi "ja 2"results. These results are encouraging for the modern method, despite the measures taken. However, hygiene needs to be strengthened for a better health of kilichi of Niger.

Introduction

Niger, a breeding country par excellence, is a major producer of meat (Zakari, 2010). Meat processing in Kilichi is an economic activity conducted by meat professionals throughout the country, in both rural and urban areas. It is a food product that is the pride of Nigerians, because it is one of the precious and authentic gifts of the soil that Nigerians like to offer to foreigners during their travels. For example, in 2013, 6092 Kg of Kilichi were exported (Beidari and Mounkaila 2014). It is a meat product, usually beef, dried and grilled into strips seasoned with a spicy peanut paste (Yacoube, 2009; Kalilou, 1994). In Niger, its manufacture is an artisanal activity commonly practiced by butchers. It is a potentially interesting product for the Sahelian markets. It is popular in both rural and urban areas (URL: fao.org). Kilichi meat processors, who are usually butchers by profession, have acquired the technique of processing at 98% by inheritance and that from generation to generation for many years.

In fact, these Kilichi professionals, who had remained for a long time in anonymity and in the informal, thought of organizing themselves. In 2012, they created an association called “Nigerian Association for the Promotion of Kilichi (ANIPROK)". It is a national association of which in principle all professionals of Kilichi are members with representations at National level.

This study is a research and action conducted by the University of Niamey and the Directorate General of Production and Animal Industries (DGPIA) to contribute to the drafting of the specifications for the actors of the kilichi sector for a better regulation of the sector outside the Niger scrub. In addition, some studies have shown a high microbial load in products derived from traditional methods (Mbawala *et al.,* 2010; FAO, 2014).

The present study on geographical indications of Kilichi in Niger comes at a time when several development programs are intervening in the sector, focusing on the transformation of meat into Kilichi, or in general, the processing of agricultural products. sylvo-pastoral and fisheries in their plan of action. Some producers are trying to replicate the kilichi production technique. However the results are not always satisfactory.

The following objectives are assigned to this study: To determine the organoleptic and microbiological characteristics of Kilichi resulting from modern and traditional methods; Determine the nutritional value of Kilichi; Compare the analytical results of the two types of Kilichi production (modern and traditional).

Materials and Methods

Animal material

The main raw material is boneless, good quality red meat, which does not have too much fat compared to meat.

The meat for implementation is purchased at the slaughterhouse.

Production kilichi

Three kilichi manufacturing variants are implemented by method. That is a total of 6 samples for both traditional and modern methods. The three variants are: kilichi 'Ja'; kilichi 'fari' and kilichi Rumuzu. They have the following characteristics:
Kilichi 'Ja': red color, dry appearance, thick slices in the form of flat sheets of various sizes;

Kilichi 'fari': whitish color, dry appearance, thick slices in the form of flat sheets of various sizes;

Kilichi Rumuzu: dark brown color, dry appearance, thin slices in the form of flat sheets of various sizes.

Microbiological analysis methods

Samples immediately produced are transported to the laboratory for microbiological analyzes to avoid contamination. The desired germs and methods of analysis are summarized in the following table 1.

Nutritional analysis methods

The water content was determined on the mill by oven drying according to the method (AOAC, 1984). Ashes are obtained after dry mineralization of the previously dried mill (AOAC, 1984). Total proteins are determined according to the KJELDAHL reference method (Wolf, 1968). The lipids are extracted by soxhlet and percolation of hexane according to the IUPAC method (1968). The ashes are solubilized in hydrochloric acid. The zinc and calcium contents are determined by atomic absorption spectrophotometry.

Results and Discussion

Results of microbiological analyzes

The results obtained are compared to the standards of the Standardization Council, which has defined the normal characteristics of Kilichi from a microbiological point of view. According to the Council, the kilichi must have:
Aerobic total mesophilic flora less than 10,000 / g of product;

A total coliform level of less than 100 / g of product;

A yeast and mold load of less than 100 / g of product and

Absence of mold visible to the naked eye;

A sulfo-reducing anaerobic rate of less than 10 / g of product

Absence of salmonella in 25g of product

Results of microbiological analyzes of samples from the modern kilichi transformation method

This variant of kilichi is charged for the first two germs. If not for the last five, the values obtained are lower than the norms; all the same it is about an unfit food unhealthy.

The observations of the above variant are valid here, except that enterococci have not been observed in Ja1.

The kilichi rumuzu 1 is acceptable from a point of view Microbiological.

Results of microbiological analyzes of samples from the traditional kilichi transformation method

The kilichi fari2 is a loaded variant and there is even the presence of fecal coliforms. It is considered an unhealthy food.

Ja2, after microbiological analysis shows a charge that makes it unfit for consumption

The kilichi rumuzu 2 as before is also unfit for consumption. Fortunately, the absence of faecal coliforms is noted.

Results of nutritional analyzes

From a nutritional point of view, water contents range from 6.96 to 8.37%;for proteins from 37.47% to 62.02%;lipids from 10.85 to 33.35% and ashes from 2.22 to 3.21%.

There is a great variability between the

variants for the two minerals. Indeed, zinc levels range from 62.05 to 439.18 mg / 100g and calcium from 99.34 to 6273.68 mg / 100g.

This part is devoted to the comparison of the finished products resulting from the traditional method and those resulting from the standard method on the main criteria of quality namely the organoleptic characteristics, the safety, and the price.

It is the inability of the food product to endanger the health of the consumer. This variable will be evaluated by the results of microbiological analyzes.

This comparative table 2 shows that the Kilichi "fari 1"results are clearly above the norms for all the germs tested, which is a direct consequence of the hygiene measures taken during the processing of this food. While the results of Kilichi "fari 2"have largely exceeded the norms for the first two germs. Faecal coliforms have even been found, although inferior to the norms, this can be avoided by washing hands with soap at the exit of the toilets. The food is classified unfit for human consumption, in relation to the microbial load it contains, can cause serious health problems.

This comparative table 3 shows that the Kilichi "ja 1"results exceeded the norms for all the first two germs but are below the "ja 2"Kilichi results, which is encouraging. It remains to find ways to improve the safety of modern kilichi and lower results in -Dessous standards (Table 4–12).

As for "fari 1"the results of Kilichi "ja 2"have largely exceeded the norms. The food is also classified as unfit for human consumption, with regard to the microbial load it contains, can cause serious health problems. Here too, the Kilichi "rumuzu 1"results are clearly above the norms for all the tested organisms, which is a direct consequence of the hygiene measures taken during the processing of this food. While the results of Kilichi "rumuzu 2"have largely exceeded the norms for the first two germs. The food is classified as unfit for human consumption, with regard to the microbial load it contains. If one refers to at critical points related to the five "m's" and their control the results lead to the following comments:

Table.1 Summary methods of microbiological analyzes

Wantedsprouts	Used media	Seeding techniques	Incubation temperature	Incubation time
Mesophilicaerobicflora	FCA + GB 15ml + 5ml	Double flood	30 ° C	24H-72H
Total coliforms	VRBL / mac EFA	streaks	30 ° C	24H-48H
Fecalcoliforms	VRBL / EMB EFA	streaks	44 ° C +/- 1	24H-48H
Salmonella	Selenite-Rap Hektoen	streaks	37 ° C	24H-48H
Yeasts and molds	OGA	staggering	37 ° C	24H-48H
Anaerobic Sulfur Reduction Rate	TSN (20ml)	In the mass		24H-48H

Table.2 Results of kilichi "fari 1"analyzes

seeds	Results	standards	
Aerobic total mesophilicflora	> 100000 / g	≤ 25000 / g	Unhealthy food
Total coliforms	<100 / g	<1000 / g	
Fecalcoliforms	00 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
salmonella	Absence	00 / 25g	
Enterococcus	<10 / g	<100000 / g	

Table.3 Results of Kilichi "ja 1"analyzes

seeds	Results	standards	
total mesophilic aerobicflora	> 150000 / g	≤ 25000 / g	Acceptable sanitation
total coliforms	> 1000 / g	<1000 / g	
Fecal coliforms	00 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
salmonella	Absence	00 / 25g	
Enterococcus	00 / g	<100000 / g	

Table.4 Results of Kilichi Rumuzu 1 Analyzes

Seeds	Results	standards	
Total mesophilic aerobicflora	> 1000 / g	≤ 25000 / g	Acceptable sanitation
Total coliforms	> 10 / g	<1000 / g	
Fecal coliforms	00 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
Salmonella	Absence	00 / 25g	
Enterococcus	00 / g	<100000 / g	

Table.5 Results of Kilichi "fari 2"analyzes

seeds	Results	standards	
total mesophilic aerobicflora	> 25000 / g	≤ 25000 / g	Unhealthy food
total coliforms	> 10,000 / g	<1000 / g	
Fecal coliforms	<10 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
salmonella	Absence	00 / 25g	
Enterococcus	> 10,000 / g	<100000 / g	

Table.6 Results of Kilichi "ja 2"analyzes

seeds	Results	standards	
total mesophilic aerobicflora	> 100000 / g	≤ 25000 / g	Food unfit for human consumption
total coliforms	> 1000 / g	<1000 / g	
Fecal coliforms	<10 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
salmonella	Absence	00 / 25g	
Enterococcus	-	<100000 / g	

Table.7 Results of Kilichi Rumuzu 2 Analyzes

seeds	Results	standards	
total mesophilic aerobicflora	> 50000 / g	≤ 25000 / g	Food unfit for human consumption
total coliforms	> 10,000 / g	<1000 / g	
Fecalcoliforms	<00 / g	<10 / g	
Yeast and moldload	Absence	<1000 / g	
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	
salmonella	Absence	00 / 25g	
Enterococcus	> 10,000 / g	<100000 / g	

Table.8 Water content, proteins, lipids, and ash in g / 100g of Kilichi

products	Water	Protein (% MS)	Lipids (% MS)	Ash (% MS)
F1	8.37	50.75	20.95	2.31
F2	7.27	49.82	30,01	3.01
J1	7.77	37.47	18.11	3.21
J2	8.04	51.52	33.35	2.52
R1	6.96	62.02	10.85	2.22
R2	7.18	55.78	29,21	2.91

Table.9 Content of Ca and Zn in mg / 100g dry matter of kilichi

Elements	F1	F2	J1	J2	R1	R2
Ca	3776.26	6273.68	119.33	162.43	99.34	6602.94
Zn	62.05	408.16	383.68	261.92	439.18	68.45

Table.10 Comparison of the two "fari"

Seeds	"Fari 1"	standards	"Fari 2"
total mesophilic aerobicflora	> 10000 / g	≤ 25000 / g	> 25000 / g
total coliforms	<100 / g	<1000 / g	> 10,000 / g
Fecal coliforms	00 / g	<10 / g	<10 / g
Yeast and moldload	Absence	<1000 / g	Absence
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	00 / g
salmonella	Absence	00 / 25g	Absence
Enterococcus	<10 / g	<100000 / g	> 10,000 / g

Table.11 Comparison of the two "ja"

Seeds	"Ja 1"	standards	"Ja 2"
Total mesophilic aerobicflora	> 50000 / g	≤ 25000 / g	> 100000 / g
Total coliforms	> 1000 / g	<1000 / g	> 1000 / g
Fecal coliforms	00 / g	<10 / g	<10 / g
Yeast and moldload	Absence	<1000 / g	Absence
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	00 / g
Salmonella	Absence	00 / 25g	Absence
Enterococcus	00 / g	<100000 / g	-

Table.12 Comparison of the two "Rumuzu 1"

Seeds	"Rumuzu 1"	standards	"Rumuzu 2"
total mesophilic aerobicflora	> 1000 / g	≤ 25000 / g	> 50000 / g
total coliforms	> 10 / g	<1000 / g	> 10,000 / g
Fecal coliforms	00 / g	<10 / g	<00 / g
Yeast and moldload	Absence	<1000 / g	Absence
Anaerobic Sulfur Reduction Rate	00 / g	<100 colonies / g	00 / g
Salmonella	Absence	00 / 25g	Absence
Enterococcus	00 / g	<100000 / g	> 10,000 / g

Middle

From the barn to the consumer's table, the Kilichi processing environment is a real source of contamination that must be mastered in order to achieve a healthy food that meets the sanitary standards set.

Raw material

The raw material of Kilichi is meat. However, it has been shown above that the medium affects the quality of the meat. To improve the quality of Kilichi meat safety must be guaranteed from the beginning to the end of the process.

Workforce

Sick workers who handle meat and non-compliance with hygiene measures are the most common sources of contamination of food-borne diseases.

Equipment

From the knife used to slaughter the animal to the plate in which the Kilichi is served by passing the means of transport, the tables, the containers, the knives, the displays of the transformers and all the rest are sources of direct contamination of the Kilichi.

Method

The kilichi transformation method has not changed much over the years. And it is not appropriate to avoid contamination and thus ensure the safety of Kilichi.

At the end of the critical-point analysis, the safety of the kilichi can be obtained by inexpensive gestures such as washing hands with soap, cleaning and disinfecting equipment, and wearing appropriate work clothes.

In the literature very little work on the microbiological analysis of kilichi is met. Nevertheless, in Nigeria, a bacteriological analysis concerned the kilichi of 3 localities (AbdulMajeed, 1996). Five bacterial species in total, namely: *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Bacillus subtilis* were isolated. Content Total sample bacteria

ranged from 2.4 x 104 to 3.5 x 104 colony forming units / g, enterobacteria from 2.61 x 104 to 2.90 x 104 colony forming units / g, the number of *S. aureus* from 1.6 x 104 to 2.05 x 104 colony forming units/g. *E. coli* in all samples was lowest, ranging from 1.2 x 101 to 3.8 x 101 colony forming units/g.

Staphylococcus aureus enterotoxin is an extremely potent gastrointestinal toxin; 100 ng is enough to cause symptoms of intoxication (Evenson *et al.,* 1988; Rasooly, 1997). The high number of Enterobacteriaceae in the samples indicates a possibility of enteric contamination (Brown and Baird-Parker, 1982).

The number of E. coli between 1.2 X 101 and 3.8 X 101 colony forming units / g for samples from all sources is high. This is a public health concern given the role of E. coli in foodborne infection (Goepfert, 1976).

Niger samples should be searched for these bacteria

In Cameroon, of the four spicy and uncooled kilichi samples, seven traditional manufacturing and sales sites in the city of Ngaoundéré (North Cameroon) are being studied (Mbawala, 2010). The aim of this study is to test the hypothesis that the total microbial load of kilichi samples and the type of germ they contain would influence the hygienic quality of the product.

This is a hus that mesophilic aerobic flora, coliforms, yeasts and molds, *Staphylococcus aureus, Clostridium sulphite, Bacillus cereus* and *Salmonella* spp. Were counted on these samples. Results show that 33.34% and 50% of kilichi pepper samples are infected with *B. cereus* and *Salmonella* spp., respectively, while 83.34% of unpimed kilichi samples are contaminated with these two microorganisms. The average level of contamination u kilichi non spiced is 0.43 (sulfite-reducing Clostridium) with a maximum value of 0.63.

These high values represent risks food poisoning of consumers as well as samples from Niger. They also noted that regardless of the type of microorganism counted, all non-chili kilichi samples are more contaminated than chipped kilichi samples (Mbawala, 2010).

As regards the nutritional value, according to the literature, in general the values obtained in Niger are found in the intervals encountered. Indeed, the chemical characteristics of the kilichi all variants combined are as follows: water content: 7-20%, protein content: 5 to 70%, lipid content: 15-20% and iron content 35% (Beidari *et al.,* 2013). The contents AC and zn are very interesting and can meet the needs of the population because their s deficiencies pose problems public health. The thicknesses of the lamellae influence also c e s contents.

The main ingredients (peanut paste or nutmeg paste, water, spices mainly composed of, black pepper, anise, nutmeg, garlic, chilli, soumbala, ginger, onion, cooking salt, red dye, clove, flavor (aroma maggi) utiized in the manufacture of kilichi can influence its nutritional value. In these ingredients, we find protein - oleaginous sources (peanut, nutmeg, soumbala) and sources of minerals (ginger, pepper, pepper, etc.).

The results of this study can be used to supplement the specifications of the Niger kilichi from a microbiological and nutritional quality point of view.

At the end of this study, the desired microorganisms were mesophilic aerobic flora, total coliforms, fecal coliforms, Salmonella, yeasts and molds, and anaerobic sulfuro-reducing ratio for 6 products,

including 3 variants for the modern method and 3 for the method. Traditional Microbial loads above Nigerian standards are observed in the traditional method. Apart from the solar dryer used for the modern method, strict hygiene measures are also observed. By respecting the good practices of hygiene and sanitation the sanitary quality of the kilichi of Niger can be improved and be competitive internationally.

Regarding, the nutritional value, the raw material used being meat, is a good source of animal protein and minerals. Ingredients of plant origin reinforce these potentialities. So the kilichi of Niger is a good source of macro and micronutrients.

The results from our study show that Kilichi's modern processing method is very effective in improving the safety of this product, which Nigerians and foreigners alike are experiencing.

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