

(RESEARCH ARTICLE)



## Microbiological quality of Dockounou banana added to cassava flour

Ekoua Regina Krabi <sup>1,2,\*</sup>, Koffi Maïzan Jean-Paul Bouatenin <sup>1</sup>, Kohi Alfred Kouamé <sup>1</sup>, Affoué Marina Konan <sup>1</sup> and Marina Koussemon <sup>1</sup>

<sup>1</sup> Department of Food Sciences and Technology, Laboratory of Biotechnology and food Microbiology, Nangui Abrogoua University, Abidjan, Côte d'Ivoire, 02 BP 801 Abidjan 02.

<sup>2</sup> Félix Houphouët-Boigny University, UFR Biosciences, Laboratory of Biotechnology, 22 BP 582 Abidjan 22, Côte d'Ivoire.

GSC Biological and Pharmaceutical Sciences, 2023, 25(01), 106–113

Publication history: Received on 05 June 2023; revised on 08 October 2023; accepted on 12 October 2023

Article DOI: <https://doi.org/10.30574/gscbps.2023.25.1.0391>

### Abstract

Banana *Dockounou* with cassava flour is a food made from senescent bananas. This food has a relatively short shelf life. This does not guarantee the safety of the product. Thus, the aim of this study was to assess the microbiological quality of banana *Dockounou* with cassava flour during storage, in order to ensure consumer safety. To achieve this objective, two methodological approaches were adopted. Firstly, a consumer survey on banana *Dockounou* with cassava flour was carried out to update data on its consumption in the city of Abidjan. Secondly, some microbiological parameters of the sample of *Dockounou* added to cassava flour taken from five (5) women producers were determined during its conservation at room temperature (30°C) for eight (8) days. These studies revealed the presence of aerobic mesophilic germs (AMG) whose load varied from  $(2,5 \pm 0,1) \times 10^1$  to  $(2,2 \pm 0,7) \times 10^7$  CFU/g after 8 days of storage. At the end of these 8 days, the AMG loads recorded in the various *Dockounou* are higher than the microbiological criteria ( $3.0 \times 10^4$  CFU/g). The germs most frequently encountered during the conservation of *Dockounou* were *Staphylococcus*, *Bacillus*, total coliforms, yeasts and moulds. However, an absence of *Salmonella*, *Clostridium*, faecal coliforms was noted in all the samples analysed.

**Key words:** *Dockounou* with cassava flour; Microbiological; Physico-Chemical; Conservation

### 1. Introduction

Plantain is a widely consumed food worldwide. It ranks 4th among the world's most important foodstuffs, after rice, wheat and maize [1]. In Côte d'Ivoire, plantain is the 3rd most important food crop, after yam and cassava, with annual production of around 1,577,043 tonnes [2, 3]. It forms the staple diet of indigenous populations in the south and is the most widely consumed foodstuff in the west and centre-west of the country [4]. In addition to being a cheap and easy-to-produce source of energy, it is also rich in vitamins A, C and B6 [5]. However, the phenomenon of rapid ripening leads to losses of this fruit once mature after 5 to 9 days of packaging. To help reduce post-harvest losses and also improve the value of plantain in Côte d'Ivoire, it is most often used in the preparation of certain traditional dishes such as a loco, claclo, apiti, *Dockounou* .etc [3]. Banana *Dockounou* is a traditional plantain cake found in Côte d'Ivoire and some West African countries. It's made from mashed senescent banana pulp mixed with cassava, wheat, corn and rice flours, and cooked either in water, steam, on a grill or in a traditional oven. Steamed banana dockounou is commonly called donclou or loclon in Baoulé country (Côte d'Ivoire), while those baked and grilled are called apiti in Agni country [6]. To prepare apiti, senescent bananas are washed, peeled by hand and ground to a homogeneous paste in a mortar. The paste obtained is mixed with cereal (rice, corn) or tuber (cassava) flours used as binders. The mixture is wrapped in *Thaumatococcus daniellii* leaves, commonly known as "feuilles d'attiéké" or banana (*Musa parasidiaca*) leaves, before being cooked to produce *loclon*, *apiti*, *pkaga* or *pka*, depending on the ethnic group and cooking method. [2, 6]. This food can be stored at room temperature, and sun-drying is sometimes recommended [2, 6]. This method of preservation

\* Corresponding author: Ekoua Regina Krabi.

does not seem to offer any guarantee of curbing the proliferation of microorganisms after several days. For example, unit operations such as peeling and grinding in the mortar are carried out in the open air, while packaging in vegetable leaves exposes the product to contamination by microorganisms from the immediate environment, which could affect the quality of the finished product. Numerous manipulations during production and packaging at room temperature are conducive to the contamination and growth of numerous microorganisms. Some of these microorganisms could have an impact on health or lead to a rapid deterioration in product quality. In fact, the manufacture of *Dockounou* is still artisanal and informal, and relies on empirical knowledge based on the traditional experience of women producers [7]. Faced with sanitary problems and the need to reduce post-harvest losses in bananas, [7] has been 'interested in characterizing and optimizing *Dockounou* from cereal flours, notably rice and corn. However, few data exist on *Dockounou* obtained from tuber flour (cassava). In the interests of consumer health, the aim of this study is to determine the microbiological characteristics of banana *Dockounou* made with cassava flour during preservation.

## 2. Materials and Methods

### 2.1. Survey sheet

A survey form was drawn up and used to conduct surveys on consumption and knowledge of *Dockounou* in 5 Abidjan communes (Abobo, Adjamé, Yopougon, Treichville and Cocody). Production was also monitored by five women producers

### 2.2. Biological material

The study material consisted of banana *Dockounou* with cassava flour (Figure 1) supplied by women producers living in the communes of Anyama, Adjamé, Yopougon, Treichville, and Abobo in the city of Abidjan (Côte d'Ivoire).



**Figure 1** Banana *dokounou* in cassava flour

### 2.3. Survey design

The sampling method adopted for this study was random sampling. The questionnaire was submitted to 500 people, 100 per commune. The questionnaire was explained question by question to the respondents. For respondents who could not read or write, a local person who could read and write and who spoke the same ethnic group as the respondents was asked to act as interpreter. The questions were multiple-choice, with 2 to 6 possible answers, or yes/no answers.

### 2.4. Sampling

*Dockounou* were sampled immediately after production in five Abidjan municipalities (Anyama, Treichville, Abobo, Yopougon and Adjamé). For this purpose, five (5) female producers were selected, one from each commune. They were chosen for their availability and willingness to take part in the study. *Dockounou* was prepared, packaged and ready for consumption in stomacher bags at each producer's premises. For one run, two 500 g samples were taken from each producer. For three different runs (day 0, day 4 and day 8), 30 samples (6 per municipality) were taken from the 5 municipalities. After sampling, the samples were placed in a cooler containing carboglass and transported to the laboratory within thirty minutes of sampling for analysis.

## 2.5. Microbiological analysis

Aerobic mesophilic germs (AMG) bacteria were counted on PCA agar (Plate count Agar; Oxoid LTD, Basingstore Hampshire, England) in accordance with NF V08- 051, 1999. The detection and enumeration of *Staphylococcus aureus* was carried out on Baird Parker agar according to the method of [8]. Presumptive colonies of *Staphylococcus aureus* were either shiny black, whole, convex, surrounded by clear zones extending into the opaque medium, or shiny black, whole, convex, with no well-defined clear zone. The culture medium used for *Bacillus* enumeration was Mossel agar as described by [9]. Lactose-bile agar with crystal violet and neutral red (VRBL agar) was used for coliform enumeration in accordance with NF ISO 4832 July 1991. RAPID' E. coli agar was used for the detection and enumeration of *Escherichia coli* in accordance with NF ISO 16140, 2003. Presumptive *Escherichia coli* colonies are purple to pink. Chloramphenicol Sabouraud agar (Fluka, Bochemica 89579, Sigma-Aldrich 28 Chemie GmbH, India) was used for yeast and mold enumeration in accordance with NF ISO 6611, 1996. Sulfito-Reducing Anaerobes (SRA) were enumerated in the mass using tryptone sulfite neomycin agar (TSN, BioMérieux, France) by the method of [10]. *Salmonella* was detected using the method described by [11].

## 2.6. Statistical analysis

R. 3-01 software, ANOVA method with Duncan's posthoc test, significance level 5% was used. This software was used to calculate the means and standard deviations of microbiological parameters. It was also used to compare the sample averages for microbiological parameters, in order to determine whether the differences observed in these averages were significant at the 5% level

## 3. Results and discussion

Banana *Dockounou* with cassava flour is made from mashed banana pulp cooked in boiling water, steam, on a grill or in a traditional oven. With the aim of enhancing the value of this food and ensuring consumer safety, a consumer survey was first carried out to find out whether this type of *Dockounou* is part of the eating habits of the Ivorian population. Secondly, samples were taken in the municipalities of Anyama, Treichville, Abobo, Yopougon and Adjamé to highlight their microbiological qualities. The microbiological parameters studied varied from one site to another. Analysis of variance based on Duncan's test confirms this with probability levels ( $p < 0.05$ ). This indicates that each producer, depending on her ethnicity, has her own manufacturing technology, in this case the variety of banana, the duration and type of cooking and the ingredients added [7]. During the survey carried out on the consumption of Banana *Dockounou* with cassava flour, 86.2% of respondents acknowledged having consumed it (Table 1). Most consumers (52.06%), consume this dish once a day, at breakfast, for its high energy content (65.85%) (Table 2 and 3).

**Table 1** Knowledge and consumption of *Dockounou* banana added to cassava flour

Parameters (n=500)	Number of surveyed	Frequency (%)
Knowledge of <i>Dockounou</i> (n=500)		
Yes	479	95.8
No	21	4.2
<i>Dockounou</i> consumption (n=479)		
Yes	413	86.2
No	66	13.8

**Table 2** Time and frequency of *Dockounou* consumption

Time of consumption (n=413)	Number of surveyed	Frequency (%)
Breakfast	203	49.15
Lunch	104	25.18
Dinner	71	17.19
Any time	35	8.48

Frequency of consumption (n=413)		
One time	215	52.06
Two times	135	32.67
Three times	40	9.69
More than three times	23	5.58

**Table 3** Benefits of *Dockounou* consumption

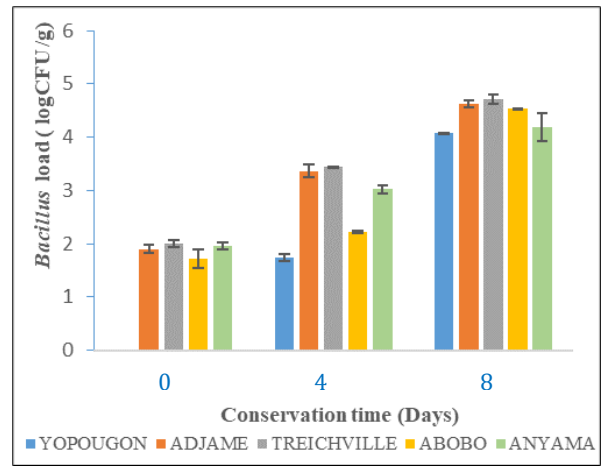
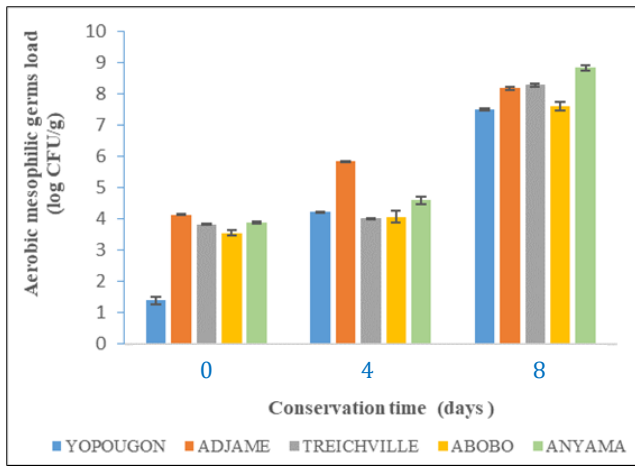
Advantage of <i>Dockounou</i>	Number of surveyed	Frequency (%)
Energy	272	65.85
Vitamin	16	3.87
Good growth	28	6.77
Good digestion	76	18.40
No	21	5.11

This richness in energy comes from the carbohydrate compounds in plantain pulp, which represent around 32% of the fresh matter, and also from cassava [12]. According to [13], the consumption of banana *Dockounou* with cassava flour depends not only on local habits and cultures, but also on the region in which the population lives [14]. These observations show that consumption of *Dockounou* banana with cassava flour is based on a set of criteria linked to their own origins and habits. However, 2.48% of consumers claimed to have experienced discomfort following consumption of *Dockounou*. The most recurrent symptoms were vomiting (1.21%), followed by diarrhoea (0.73%) (Table 4).

**Table 4** Discomfort associated with *Dockounou* consumption

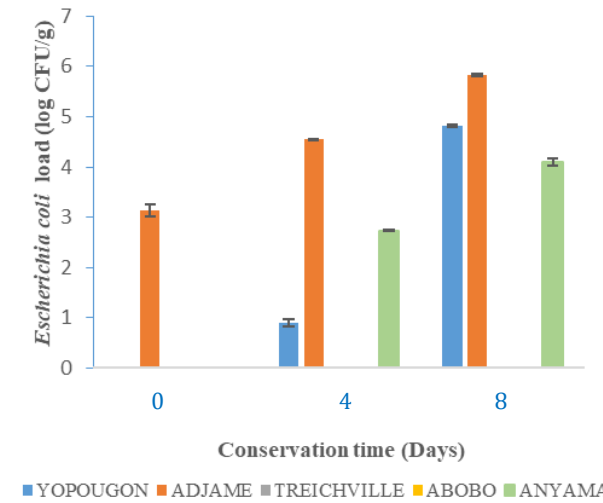
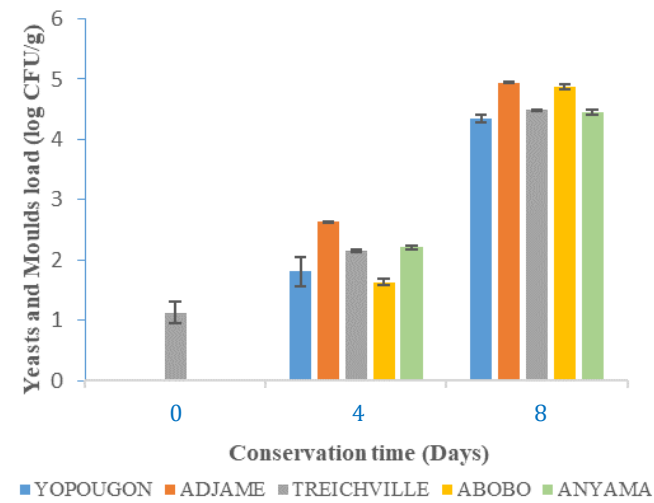
	Number of consumers	Frequency (%)
<b>Discomfort (n= 413)</b>		
Yes	10	2.48
No	403	97.52
<b>Symptoms (n=413)</b>		
Diarrhea	3	0.73
Vomiting	5	1.21
Headaches	1	0.24
Bloating	1	0.24
No	403	97.58
<b>Duration of symptoms (n=10)</b>		
1 day	10	100
<b>Hospitalization (n=10)</b>		
Hospitalized	0	0
Outpatients	10	100

This indicates that the food may contain microorganisms that can affect consumer health. For this reason, *Dockounou* bananas with cassava flour collected in the Abidjan district were analyzed over a storage period of 4 to 8 days (Figure 2).



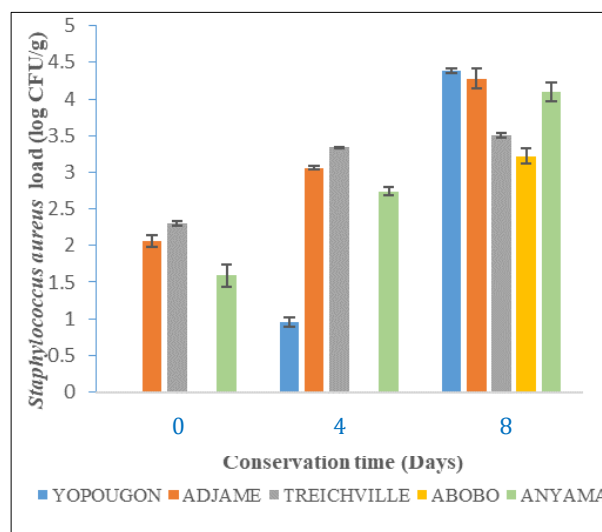
A

B



C

D



E

**Figure 2** Microbial load of aerobic mesophilic germs (A), *Bacillus* (B), yeasts and moulds (C), *Escherichia coli* (D), *Staphylococcus aureus* (E), in the Dockounou samples analysed.

During this period, the loads of aerobic mesophilic germs (AMG) observed in the *Dockounou* samples up to the fourth day of storage were below the microbiological standard ( $<3.10^4$  CFU/g) prescribed by [15]. With the exception of Anyama ( $5 \pm 0.1$ )  $\times 10^4$  CFU/g and Adjamé ( $7 \pm 0.7$ )  $\times 10^5$  CFU/g. After eight (8) days of storage, the loads of all samples multiplied and were above the microbiological standard (Figure 2). This work concurs with that of [16], who showed that the micro-organisms detected in *Dockounou* packaged in attiéké or banana leaves, conditioned at room temperature, multiply and their loads reach high proportions exceeding the measurements prescribed by the international standard after conservation.. Indeed, the multiplication of AMGs is facilitated by the storage temperature (30°C), which corresponds to an optimal growth factor for micro-organisms such as the *Bacillus* responsible for food poisoning. *Bacillus* was thus detected in the samples analyzed. The *Bacillus* load detected in *Dockounou* cassava flour from Yopougon, Treichville, Abobo, Adjamé and Anyama was respectively (0 CFU/g),  $(1 \pm 0.1) \times 10^1$  CFU/g,  $(5.5 \pm 0.2) \times 10^2$  CFU/g,  $(8 \pm 0.1) \times 10^1$  CFU/g,  $(9 \pm 0.1) \times 10^1$  CFU/g after cooking. Following preservation, these loads in the various samples multiply to reach a load of  $(1.2 \pm 0.7) \times 10^4$  UFC/g in the Yopougon *Dockounou*,  $(1.7 \pm 0.9) \times 10^4$  UFC/g in the Anyama *Dockounou*,  $(5.2 \pm 0.1) \times 10^4$  UFC/g in the Treichville *Dockounou*,  $(3.5 \pm 0.1) \times 10^4$  UFC/g Abobo,  $(4.2 \pm 0.6) \times 10^4$  UFC/g Adjamé. *Bacillus* spores are resistant to heat treatment and, once ingested by humans, can cause gastroenteritis, vomiting and often death [17]. It should also be noted that yeasts and moulds were detected from the fourth (4) day of storage in samples from Yopougon with a load of  $(6.9 \pm 0.6) \times 10^1$  UFC/g, Abobo with a load of  $(4.3 \pm 0.4) \times 10^1$  UFC/g, Treichville with a load of  $(1.4 \pm 0.7) \times 10^2$  UFC/g, Anyama with a load of  $(1.6 \pm 0.1) \times 10^1$  UFC/g and Adjamé with a load of  $(4.4 \pm 0.2) \times 10^2$  UFC/g. Yeasts and moulds deteriorate the marketability of products and can constitute a public health problem, as certain types of moulds are capable of producing lethal, heat-resistant toxins [18]. Their presence is thought to be due to the high sugar and moisture content of the samples. In addition, *Escherichia coli*, indicators of faecal contamination, were detected in ready-to-eat *Dockounou*, especially from the commune of Adjamé. The *E. coli* load detected in *Dockounou* from Yopougon was  $(6.7 \pm 3.6) \times 10^4$  CFU/g, that from Anyama was  $(1.2 \pm 0.2) \times 10^4$  CFU/g and that from Adjamé was  $(6.7 \pm 0.3) \times 10^5$  CFU/g after conservation. This points to a lack of hygienic handling, inefficient processing (insufficient heat treatment) (Pasteurization), and a lack of cleanliness of the premises and equipment used for production. All these factors point to a lack of respect for hygiene rules by female producers, especially those in Adjamé. As a result, all the samples analyzed had average loads of presumptive *Staphylococcus aureus* exceeding the microbiological criteria. This load varied respectively from  $(1.1 \pm 0.2) \times 10^2$  CFU/g to  $(1.9 \pm 0.6) \times 10^4$  CFU/g in the Adjamé sample, from  $(2 \pm 0.1) \times 10^2$  CFU/g to  $(3.2 \pm 0.2) \times 10^3$  CFU/g in the Treichville samples, and from  $(4 \pm 0.1) \times 10^0$  CFU/g to  $(1.2 \pm 0.3) \times 10^4$  CFU/g in the Anyama sample during the eight days of storage.

**Table 5** Minority microorganisms isolated in *Dockounou* with cassava flour

Municipalities	Germs	Day 0	Day 4	Day 8
Abobo	Coliforms	< 1	< 1	< 1
	<i>Clostridium</i>	< 1	< 1	< 1
	<i>Salmonella</i>	Nd	Nd	Nd
Adjamé	Coliforms	< 1	< 1	< 1
	<i>Clostridium</i>	< 1	< 1	< 1
	<i>Salmonella</i>	Nd	Nd	Nd
Anyama	Coliforms	< 1	< 1	< 1
	<i>Clostridium</i>	< 1	< 1	< 1
	<i>Salmonella</i>	Nd	Nd	Nd
Treichville	Coliforms	< 1	< 1	< 1
	<i>Clostridium</i>	< 1	< 1	< 1
	<i>Salmonella</i>	Nd	Nd	Nd
Yopougon	Coliforms	< 1	< 1	< 1
	<i>Clostridium</i>	< 1	< 1	< 1
	<i>Salmonella</i>	Nd	Nd	Nd

This indicates a high level of handling of *Dockounou* at the production sites. In fact, *Staphylococcus aureus* is an indicator of food contamination by soiled hands [19]. In other hand, a total absence of coliforms, *Clostridium perfringens* and *Salmonella* was observed in the samples analyzed (Table 5).

The absence of these microorganisms is due to the acidic pH generated and maintained by the presence of lactic and acetic acid, which is unfavorable to the growth of pathogenic and non-lactic flora [20]. By accepted standards, the microbiological quality of banana *Dockounou* with cassava flour produced in the city of Abidjan is unsatisfactory. Hygiene measures for handlers, equipment and premises need to be applied in production areas.

---

#### 4. Conclusion

In the interests of consumer health, the aim of this study was to assess the microbiological quality of *Dockounou* added to cassava flour during storage. All samples submitted to microbiological control were affected beyond four (4) days of storage by aerobic mesophilic germs (AMG), notably *E. coli*, *S. aureus*, *B. cereus*, yeasts and moulds. After four (4) days of storage, the loads of microorganisms present in the samples exceed the authorized microbiological criteria. In short, Banana *Dockounou* with cassava flour is of unsatisfactory microbiological quality after 4 days of storage. This food exposes consumers to a risk of toxi-infection after 4 days of storage. As a result, hygienic measures must be applied in the production areas before and after all production operations, with regard to handlers, equipment and premises.

---

#### Compliance with ethical standards

##### *Acknowledgments*

The authors are grateful the Sellers and Consumers of *dockounou* who freely agreed to participate in this study.

##### *Disclosure of conflict of interest*

Authors have no conflict of interest regarding the publication of paper.

##### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

---

#### References

- [1] Lassoudière A. The banana tree and its cultivation. Versailles, France: Éditions Quæ;p; 2007
- [2] Kouassi BY, Traoré A, Sirpé G.. Food processing and consumption in central West Africa: Burkina Faso, Ivory Coast and Ghana. KARTHALA Editions; 2008 .180 p.
- [3] FAOSTAT. Food and Agricultural Organization, Agricultural Data. Crops and products domain. <http://faostat.fao.org/site/339/default.aspx> Rome, Italy. consulté le 18/01/2021 ; 2012
- [4] Tetang, J. Plantain: Production of healthy seeds using the PIF technique, Management of a plantain farm and The most productive varieties. *The voice of the peasant* 260; 2013. 6-14.
- [5] Dhed'a, Djailo B, Adheka GJ, Onautshu OD, Swennen R. The cultivation of bananas and plantains in the agroecological zones of the Democratic Republic of Congo, *University Press UNIKIS, Kisangani* ; 2019. 72p.
- [6] FIRCA. Directory of yam and plantain conservation and processing technologies. Interprofessional Fund for Agricultural Research and Consulting. Prestige Group (Cocody-Abidjan) ; 2010. 155 p.
- [7] Akoa EF. Valorization of plantain banana (*Musa* spp.) in senescence: food formulations of banana dockounou from different types of cereal flours. Single thesis, Félix HOUPOUËT-BOIGNY University ;2014. 227 p.
- [8] Capita R, Alonso-Calleja MCB, Garcia-Fernandez MC. Assessment of Baird-Parker agar as screening test for determination of *Staphylococcus aureus* in poultrymeat. *Journal Microbiology* ; 2001 (39) : 321–325.
- [9] Mossel DA, Koopman MJ, Jongerius E. Enumeration of *Bacillus cereus* in foods. *Applied Microbiology* ; 1967 (15) 650–653.
- [10] Harmon SM, Kautter DA, Peeler JT. Comparison of media for the enumeration of *Clostridium perfringens*. *Applied Microbiology* ; 1987 (21) : 922–927

- [11] Hendriksen RS. Laboratory Protocols Level 1: Training Course Isolation of *Salmonella*. A Global *Salmonella* Surveillance and Laboratory Support Project of the World Health Organization, 4th ed. Geneva: WHO.p ; 2003
- [12] Cordenunsi BR, Lajolo FM. Starch breakdown during banana ripening: sucrose synthase and sucrose phosphate synthase. *J. Agric. Food Chem.* ; 1995 (43) : 363 – 372.
- [13] Daniel C, Roudot AC. Food texture terminology. *META: J. of translators*; 2007 (52) : 342-351.
- [14] Honfo FG, Tenkouano A, Coulibaly O. Banana plantain-based foods consumption by children and mothers in Cameroon and Southern Nigeria : A comparative study. *Africane. Journal of Food Sciences* ; 2011 (5): 287-291.
- [15] CODINORM, Draft Ivorian standard on attiéké, Attiéké-Specification PNI 03-08-001 ; 2001.
- [16] Yao KA, Koffi MD, Irié, BZ, Niamke LS. Conservation of plantain (Musa AAB) in a green state using polyethylene films of different thicknesses. *Journal of Animal & Plant Sciences*. 2014 (3): 3677-3690.
- [17] Harvey S. Development of a training software tool for volunteers and a model proposing principles adapted to this context. Unpublished doctoral thesis, University of Quebec in Montreal.p ; 2007 ?
- [18] Yandju D, Matondo K, Mummguizi B. Toxigenic molds involved in the softening of cassava tuberous roots during dry fermentation. In Agbor (E.), Brauman (A.), Griffon (D.), Trèche (S.) ed. : *Food Processing of Cassava*. Orstom. Paris ; 1995. pp 367-372.
- [19] Murray B, Carter R, Imrie C, Evans S, O'Suilleabhain C. Diclofenac reduces the incidence of acute pancreatitis after endoscopic retrograde cholangiopancreatography. *Gastroenterology* ; 2003 (124):1786-1791.
- [20] Kouamé KA. Identification of hazards and critical control points for the implementation of a HACCP system for the production of attiéké in Ivory Coast. Single doctoral thesis, Abobo-Adjamé University; 2013. 147 p.

### Consumption survey of "banana dockounou added to cassava flour".

1 - Do you eat cassava-based *dockounou*? 1- Yes  2 - No  if yes

2 - what time day ?

1- Breakfast  2- Lunch  3- Dinner  4- Rarely  5- Anytime   
6- None

3 -Combien de fois consommez-vous le *dokounou* par jour ?

1- One time  2 - Two times  3 - Three times  4 - More than three times   
5 – None

4 - what are the advantages of cassava-based *dokounou*?

1- Energy  2- vitamin  3- Good growth  4- Good digestion   
5- None

5 - Have you ever been ill from eating cassava-based *dockonou*?

1- Yes  2 - No

6 - What are the symptoms of eating cassava-based *dockounou*?

1- Fever  2- Vomiting  3- Diarrhea  4- Belly bloating   
5 – Stomach ache  6 - None

7 - How long did the discomfort last?

1- One day  2- Two days  3- Three days  4- More than three days   
5 - None

8 - Did the illness require hospitalization

1 - Yes  2- No