Microbiological and nutritional quality of *bêdê* produced in four zones of the Côte d'Ivoire

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Received 09 December 2021; received in revised form 06 June 2022; accepted 07 June 2022

Abstract

Bêdê is a food obtained by retting cassava consumed during the lean season in Côte d'Ivoire. Presently, its consumption is on the decline. In order to enhance the value of this local product, physico-chemical and microbiological parameters of *bêdê* taken from four sites (Krindjabo, Appropronou, M'batto and Abidjan) in Côte d'Ivoire were analysed. The results showed that the *bêdê* produced at Appropronou was more acidic with a pH of 4.53 ± 0.07 and a high titratable acidity of 0.66 ± 0.02%. However, the hydrocyanic acid level recorded was lower in the samples from Appropronou (0.10± 0.01 mg/100g) and Abidjan (0.10± 0.01 mg/100g) than those from M'batto and Krindjabo, which were 0.16± 0.25 and 0.13± 0.33 mg/100g respectively. However, the average moisture content of *bêdê* is 50.88 ± 1.78% and the average ash content is 0.42 ± 0.10%. The average protein, lipid and carbohydrate contents in the sample were 1.45 ± 0.16%, 2.56 ± 1.2% and 44.02 ± 2.65%, respectively, for an energy value of 208.29 ± 8.43 kcal/100g. On the microbiological level, the Mesophilic Aerobic Germs (MAG) microbial load of the *bêdê* analyzed varies from (1.8±0.5).10^5 CFU/g (M'batto) to (2.5±0.3). 10t CFU/g (Abidjan). This load was not only lower than the standard prescribed by CODINORM but also the absence of pathogens (*Staphylococcus aureus, Escherichia coli,* Sulfito-reducing Anaerobes and *Salmonella*) was observed in all the *bêdê* samples analyzed. *Bêdê* is therefore a food of satisfactory microbiological quality.

Keywords: *Bêdê*, Cassava food, Côte d'Ivoire, Microbiological, Nutritional quality.

Introduction

In Côte d'Ivoire, cassava (*Manihot esculenta Crantz*) is the second most important food crop after yam (FAO, 2018). Its annual production is estimated at 4.56 millions tons in 2016 and a consumption of 100 to 110 kg/year per capita living in urban areas (FAO, 2018). Despite these assets, cassava has some limitations including low protein content, rapid post-harvest deterioration and toxicity due to the presence of cyanogenetic glycosides (Stupak et al., 2006). However, in Africa, traditional cassava processing processes (retting, drying, fermentation, etc.) have been developed both by farmers' ingenuity and research to improve them and reduce cyanogenetic toxicity. These processes have led to the production of several finished products classified into two main categories including non-fermented products such as foutou, attoupkou, les, croquettes and fermented products including gari, fùfù, placali, attiéké and *bêdê...etc.* (N'Zué et al., 2013;Yéboué et al., 2017). *Bêdê* is one of the products derived from cassava, little known and consumed exclusively in the family setting by the Agnis and Baoulés living in Côte d'Ivoire during periods of famine. The *bêdê* is a yellow semolina, with grains that are not very moist, compact and characterized by a sour taste. For the preparation of

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bêdê, it is rather the sweet varieties of cassava that are used because they soften easily and give a pleasant taste to the food. Its preparation covers a combination of steps including root washing, retting, pressing, sieving, drying and steaming. These practices are carried out in deplorable hygienic conditions, mainly provided by small-scale production units, making quality control difficult. The production of *bêdê* is based on empirical knowledge, based on the traditional experience of the producer. There is no scientific data on the production and consumption of this food in Côte d'Ivoire. In order to enhance the value of this endangered food and to ensure a standard for *bêdê*, it would be important to know the characteristics of this food. Thus, the general objective of this study is to enhance the value of *bêdê* in Côte d'Ivoire and throughout the world.

Materials and Methods

Experimental Material

The study material consists of *bêdê* (Fig 1.) provided by women producers from the sites of Krindjabo (commune of ouéllé located in the center-east of Côte d'Ivoire), Appropronou (Department of Abengourou located in the east of Côte d'Ivoire), M'batto (located in the center-east of Côte d'Ivoire) and Abidjan (located in the south - east of Côte d'Ivoire).

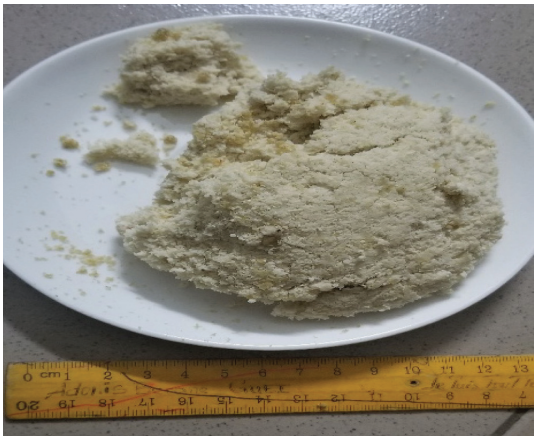

Figure 1. *Photograph* of *bêdê*

Study sites

Sampling took place at 4 sites in Côte d'Ivoire (Abidjan, Ouéllé, Appropronou, M'Batto, located respectively 298.6 km; 237.6 km and 129 km from Abidjan). The preparation of *bêdê*, although it is endangered, is often consumed in the family setting by the Agnis and Baoulés living in Côte d'Ivoire.

Production follow-up

Production monitoring has been carried out in all units involved in the study. Visit to the producers had been regularly done, during production. Four production sites were concerned by the follow-up. The aim of the follow-up was to observe the processors in the preparation of the *bêdê*, to support certain points if necessary by asking specific questions according to the observation made. Thus, work methods, hygiene practices and processing procedures were carefully identified. This enabled to draw up the production protocol for *bêdê*, and also to explain certain results of the microbiological and physico-chemical analysis.

Sampling

The samples of *bêdê* used during this study were taken from four production sites of Krindjabo (commune of ouéllé located in the central-eastern part of Côte d'Ivoire), of Appropronou (department of Abengourou located in the eastern part of Côte d'Ivoire), of M'batto located in the central-eastern part of Côte d'Ivoire and of Abidjan located in the south-eastern part of Côte d'Ivoire precisely in the commune of Cocody. These regions were chosen because they are home to the main ethnic groups which originated the production of *bêdê*. These are the Agnis and Baoulés. Of these four different production sites, eight samples were taken from each site on different dates over a period of 2 months. These samples were packaged in 500 g batches in sterile "stomacher" bags, placed in a cooler containing ice and transported to the laboratory of the Swiss Centre for Scientific Research in Abidjan, (Côte d'Ivoire) where they were put in the refrigerator before analysis. A total of thirty-two (32) samples were taken under these

conditions and analyzed at the laboratory of the Swiss Centre for Scientific Research, Abidjan, (Côte d'Ivoire).

Biochemical analysis

Forty grams of inoculum samples were ground in 300 ml of distilled water in a porcelain mortar and then centrifuged at 4000 tours/min for 30 min. The pH was determined on 50 ml of the supernatant using a pH-meter (P107 Consort). Total titratable acidity (TTA) was determined by titrating 30 ml of supernatant used for pH determination against 0.1 M NaOH using phenolphthalein as indicator. TTA was calculated as percentage of lactic acid. Water-soluble carbohydrates were determined by the phenol sulphuric acid method according to Dubois et al. (1956) and the values were expressed in g/ 100 g of fresh matter, while the reducing sugars were quantified as described by Bernfeld (1955) and expressed in mg/100 g of fresh matter. Starch content was determined based on the colorimetric method as described by Oteng-Gyang (1979).The percentage of dry matter and Moisture content were determined gravimetrically in an oven at 105° C until a stable weight was obtained (AOAC, 1995). The results were shown in grams of moisture per 100g of fresh sample. The extraction of the lipid fraction was carried out using a Soxhlet Tecator in accordance to Association of Official Agricultural Chemists (AOAC, 1995) method. The results were shown in grams of total lipids per 100 g of fresh sample. The total nitrogen determination was carried out using the Kjeldahl method (AOAC, 1995) and total protein was calculated by multiplying the total nitrogen by 6.25, the conversion factor calculated from the amino acid of total sample. The results were expressed in grams of total protein per 100 g of fresh sample. The total carbohydrate content was obtained by the difference of protein, moisture, lipid and expressing the sum in grams of total carbohydrates/100 g of fresh sample. Total ash content was determined by previous carbonization of the dry samples followed by incineration in an oven at 550° C (AOAC, 1995).The results were expressed in grams of total ash/100 g of sample. The total energy value (TEV) was calculated using the traditional conversion factors for proteins (4kcal/ gram), lipids (9kcal.gram^{-1}), and carbohydrates (4kcal.gram^{-1}) according to FAO (2006).The results were expressed in kcal/100g of fresh sample.The hydrocyanic acid content of *bêdê* was determined by the alkaline titration method of Holleman and Aten (1956). The sample (27 g) was first maceratedin 200 mL water for 3 hours and then distilled by steam distillation. The distillate containing cyanogenic ions was collected in a 5% NaOH solution and was determined after 2/5 dilution with 0.02 N silver nitrate solution in the presence of 8 mL potassium iodide. Cyanogenic ions in aqueous solution complex with the silver ions. One molecule of AgNO3 reacts with two molecules of HCN, i.e. 54 g of HCN for an AgNO3 solution of 1 N normality. For a solution (1 mL) of AgNO3 at 0.02 N, (54 g × 0.02 / 1) 1.08 g HCN is required.

Microbial analysis

The microbial analysis were carried out to determine the microbiological loads of inoculum samples. Preparation of stock solutions, inoculation of agar plates, cultivation and quantification of microorganisms were carried out according to Coulin et al., 2006. For all determinations, 10 g of samples (*bêdê*) were homogenized in a stomacher with 90 ml of sterile peptoned buffered water (AES Laboratoire, COMBOURG France). Ten fold serial dilutions of stomacher fluid were prepared and spread plated to determine microorganism counts. Aerobic mesophilic were counted on PCA (Plate count Agar) agar (Oxoid LTD, Basingstore, Hamsphire, England) after two days of incubation at 30° C according to AFNOR Standard NF V08-051,1999. Yeasts and moulds were enumerated on plates of Sabouraud chloramphenicol agar (Fluka, Bochemica 89579, Sigma-Aldrich Chemie GmbH, Inda) incubated at 30 °C for 4 days. The research and counting of *Staphylococcus aureus* was done on Baird Parker agar after one day incubation at 30° C using (Capita et al., 2001) method. The eosin methylene blue agar (Becton Dickinson GmbH,

Heidelberg, Germany) was used to particularly enumerate and isolate *E. coli*, which grows on the medium giving a distinctive metallic green sheen colony. Violet crystal and neutral red biliated lactose agar (VRBL agar) was used for coliform count. After one day of incubation at 30° C for total coliforms and 44° C for faecal coliforms according to AFNOR Standard, NF ISO 4832 July 1991. *Bacilli* species were enumerated on plates Mossel agar (AES Laboratoire, COMBOURG France) after incubation at 30° C for 2 days. Sulfito-reductor bacteria were enumerated using tubes of Trypton Sulfite Neomycin agar (Biorad, Marnes-La-Coquette, France) at 37° C for 24–48 h. Enumeration of Lactic Acid Bacteria (LAB) was carried out using plates of de Man, Rogosa and Sharpe (MRS) agar (Merck, Darmastadt, Germany) which were incubated under anaerobic conditions (Anaerocult A, Merck) at 37° C for 72 h. The isolation and enumeration of *Salmonella* was carried out using Hendriksen (2003)method in several steps. This was achieved by pre-enrichment in a non-selective medium, followed by enrichment in a selective medium and culture on selective agar. For enrichment in non-selective or pre-enrichment media, a mass of twenty-five grams of samples were homogenized with 225 mL of peptonned water in a sterile jar, incubated at 37° C for 24 hours. For selective recording, one milliter (1 mL) of the pre-enriched culture was transferred using a sterile pipette into 10 mL of previously prepared sterile Rappaport Vassililiadis broth and incubated for 24 hours at 37° C. *Salmonella* enumeration was performed on *Salmonella-Shigella* agar (Oxoid). Each enrichment culture was streaked on *Shigella-Salmonella* (SS) agar and incubated at 37°C for 24 hours. On *Salmonella-Shigella* agar, the presumptive colonies were colourless, transparent, with or without a black centre.

Statistical analysis

Software R. 3-01, ANOVA method with Duncan's post-hoc test, 5% significance level was used. This software was used to calculate the means and standard deviations of the physico-chemical and microbiological parameters studied. It also made it possible to compare the means of the physico-chemical and microbiological parameters of the samples and to determine whether the differences observed in the means of the physico-chemical and microbiological parameters are significant at the 5% significance level. The principal component analysis (PCA) was performed using XLSAT version 2010 software. 4.04 was used to group the physico-chemical and microbiological parameters according to the production areas.

Results and Discussion

Bêdê is a little known food in Côte d'Ivoire. It was eaten exclusively by the Akan ethnic group, namely the Agnis and Baoulés people living in Côte d'Ivoire in times of famine. In order to enhance the value of this food, samples were taken in the towns of M'batto, Krindjabo, Abidjan and Appropronou to highlight its physico-chemical and microbiological characteristics. Considering each origin of *bêdê*, the

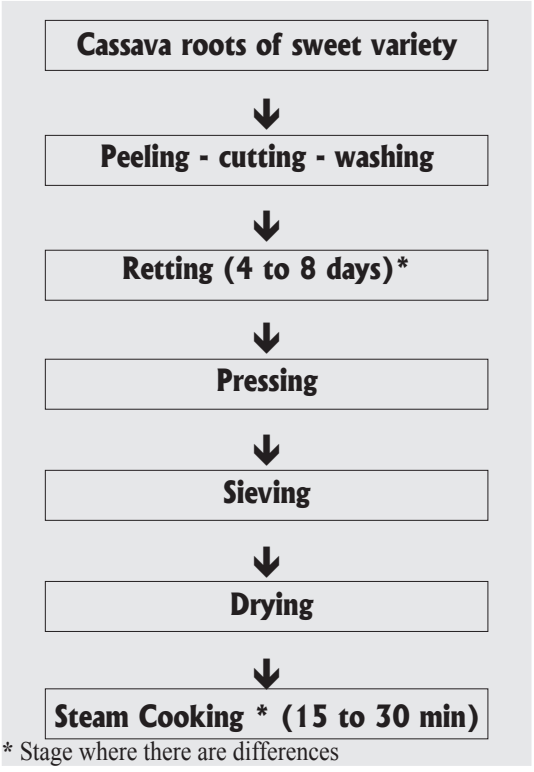

Figure 2. Diagram of *bêdê*.production

physico-chemical and microbiological parameters studied vary differently from one site to another. The analysis of variance based on Duncan's test confirms this with different levels of probability (pÂ0,05). This indicates that each ethnic group has its own technology for making *bêdê*, in this case the duration of retting, cooking and addition of ingredients (Fig 2.).

Thus, the *bêdê* from Appropronou seems to be the most acidic with a pH of 4.53 ± 0.07 and a titratable acidity rate of 0.66 ± 0.02% and the *bêdê* from Abidjan, the least acidic with a pH of 5.76 ± 0.10 and a titratable acidity rate of 0.51 ± 0.01% (Table 1).

For the same line, the mean values followed by different alphabetical letters are significantly different (P < 0.05) (Duncan multiple test). pH: hydrogen potential. These acidity values comply with the requirements of the Ivorian standard NI 03-08-003 and in accordance with the results of Coulin et al. (2006) on *attiéké* and those of other studies on foods fermented at cassava base (Obilie et al., 2004; Tapé, 2014). The dry matter levels observed in the samples of the *bêdê* studied vary between 47.63 ± 1.26 and 51.09 ± 1.85%. These values were included in the dry matter interval set for cassava-based foods by the Ivorian standard. However, the *bêdê* from Abidjan contains more sugars (6.76 ± 1.19%) than the *bêdê* from M'Batto (5.22 ± 1.62%); Krindjabo (4.80 ± 0.68%) and Appropronou (4.53 ± 1.27%). At the starch level, the rate varies from 33.93 ± 2.20% (Appropronou) to 38.79 ± 2.64% (Krindjabo). Compared to the prescriptions of the Ivorian standard, these values are very low (Table 1). However, they agree with those of other fermented cooked foods made from cassava (Dziedzoave et al., 1999**).** All of these observed differences suggest the application of practices specific to each ethnic group. In fact, the different dry matter, sugar and starch rates found in the *bêdê* would not only be related to the raw material (cassava variety), but also and above all to certain unitary operations in the production of *bêdê*. During this production process, an elimination of these substances, particularly starch, takes place during the retting stage, which allows the starch to be broken down into fermentable sugars, and during pressing. This observation is also made by Abe and Lindsay (1978); Okafor et al (1984) during the fermentation of cassava dough. This starch removal would thus be more important in the roots intended for the production of *bêdê* from Appropronou than that intended for the production of *bêdê* from Krindjabo. In addition, the rate of HCN was lower in *bêdê* from Abidjan and Appropronou (0.10 ± 0.1 mg/100 g) than in other samples from *bêdê* (Table 1). Indeed, the content of cyanogenic compounds varies according to plant organ, age, variety, and environmental conditions (Koffi et al., 2004 ; Nzigamasabo and Zhau, 2006). However,

Table 1. Physico-chemical and nutritional characteristics of *bêdê*

Parameters	Production sites				Nutritional quality of *bêdê*		
	Abidjan	Appropronou	Krindjabo	M'batto	Average values of *bêdê*	Standards	References
pH	5.76 ± 0.10^{b}	4.53 ± 0.07^{a}	5.10 ± 0.13^{b}	5.53 ± 0.09^{b}	5.23 ± 0.10	4-5	NI 486 : 2013
Titratable Acidity (%)	0.51 ± 0.01^{a}	0.66 ± 0.02^{b}	0.57 ± 0.02^{a}	0.54 ± 0.01^{a}	0.57 ± 0.01	-	-
Humidity (%)	52.37± 1.25^{a}	49.53 ± 0.86^{a}	48.91 ± 1.94^{a}	52.42 ± 0.43^{a}	50.88 ± 1.78	45-55	NI 308 : 1995
Dry matter (%)	47.63 ±1.26^{a}	50.47 ± 1.76^{a}	51.09 ± 1.85^{a}	47.58 ± 1.94^{a}	49.21 ± 1.7	-	-
Protein (%)	1.52 ± 0.32^{b}	1.13 ± 0.07^{a}	1.35 ± 0.13^{b}	1.81 ± 0.11^{b}	1.45 ± 0.16	1 - 2	NI 309 : 1995
Lipids (%)	0.92 ± 0.64^{a}	6.3 ± 0.64^{b}	1.33 ± 0.013^{a}	1.63 ± 1.76^{a}	2.54 ± 1.2	1 - 2	-
Reducing Sugars (%)	1.47 ± 0.4^{c}	0.67 ± 0.19^{a}	0.79± 0.14^{ab}	0.94 ± 0.13^{b}	0.96 ± 0.21	-	-
Total Sugars (%)	6.76±1.19^{a}	4.53 ± 1.27^{a}	4.80 ± 0.68^{a}	5.22 ± 1.62^{a}	5.32 ± 1.2	-	-
Starch (%)	34.84 ±3.62^{a}	33.93 ±2.20^{a}	38.79 ± 2.64^{b}	34.68 ± 2.90^{a}	35.56 ± 2.84	-	-
Carbohydrates (%)	44.73±1.78^{ab}	42.21 ± 2.39^{a}	45.39 ± 3.49^{b}	43.76 ± 2.96^{ab}	44.02 ± 2.65	75-80	NI 486 : 2013
Ashes (%)	0.47 ±0.01^{a}	0.42 ± 0.12^{a}	0.43 ± 0.08^{a}	0.37 ± 0.12^{a}	0.42 ± 0.10	< 1 ,4	NI 313 : 1993
Energy Value (kcal/100g)	193.43 ± 3.75^{a}	229.29 ±7.65^{a}	208.36 ± 10.63^{a}	202.09 ± 11.69^{a}	208.29 ± 8.43	-	-
Hydrocyanic acid (mg/100g)	0.10 ± 0.01^{a}	0.10 ± 0.01^{a}	0.13 ± 0.33^{a}	0.16 ± 0.25^{a}	0.12 ± 0.15	-	-

traditional transformation processes have been developed to reduce cyanogenetic toxicity. These traditional processes include retting, pressing, cassava drying and cooking (Bokanga, 2001). This indicates that these operations are practiced differently from one ethnic group to another. *Bêdê*, like other fermented cassava products, is rich in starch and low in protein (Sotomey et al., 2001; Essia et al., 2002). However, a significant amount of protein of the order of 1.8 ± 0.11% was obtained in *bêdê* from M'batto (Table 1). This result is higher than that obtained in cassava roots (0.54%) by Rawel and Kroll in 2003 for the production of cassava-based foods. It is fair to say that *bêdê* is considered to be the most protein-rich cassava food.In the same Table 1, the lipid content was found to be very high in *bêdê* from Appropronou (6.3 ± 0.64%) and has the highest energy value (229.29 ± 7.65 kCal/100 g). This high lipid content shows that *bêdê* is a high-energy food. Indeed, 1g of lipid produces 9 kCal. The lipid content obtained in our results is higher than that obtained in attiéké (Yao et al 2015). The difference in lipid value between the different *bêdê* analyzed could be explained by the amount of oil added by the producers during the production of the *bêdê*. According to the standard CODINORM NI 484-2013, the criteria for a good quality cassava-based food consists of a pH between 4 and 5, a dry matter content between 45 and 55%, an ash content of less than 1.4%, a hydrocyanic acid content less than or equal to 1 mg per 100 g and a protein content between 1 and 2%. The analysis of the physico-chemical parameters indicates that the various *bêdê* samples analyzed comply with the CODINORM NI 484-2013 standard. In order to characterize *bêdê* and to determine whether the physico-chemical characteristics differ from one group to another, a principal component analysis was carried out on the basis of the physico-chemical parameters of the *bêdê* samples. Thus the principal component analysis allowed us to group the characteristics of *bêdê* according to their origin. At the physico-chemical level, *bêdê* from M'batto and Krindjabo are similar in terms of protein, carbohydrate (starch) and hydrocyanic acid content. Furthermore, *bêdê* from Abidjan contains a lot of water, sugars (total and reducing) and is rich in ash. *Bêdê* from Appropronou is rich in lipids and has a high energy value. Titratable acidity and dry matter are also more observed in *bêdê* from Appropronou (Fig 3.).

As far as microbiological parameters are concerned, *bêdê* is usually packaged in plastic bags or bowls just after cooking. The entire production can be consumed the same day or a few days later. As packaged by the producers, *bêdê* does not present any microbiological risk with regard to the main germs enumerated in it. In fact, for the samples of *bêdê* analysed, a total absence of coliforms, *E.coli, Staphylococcus aureus, Clostridium perfringens* and *salmonella* is observed. Exceptions are made for the Mesophilic Aerobic Germs (MAG), lactic acid bacteria (LAB), *Bacillus sp*, yeasts and moulds which are present in the samples tested (Table 2).

For the same line, the mean values followed by different alphabetical letters are significantly

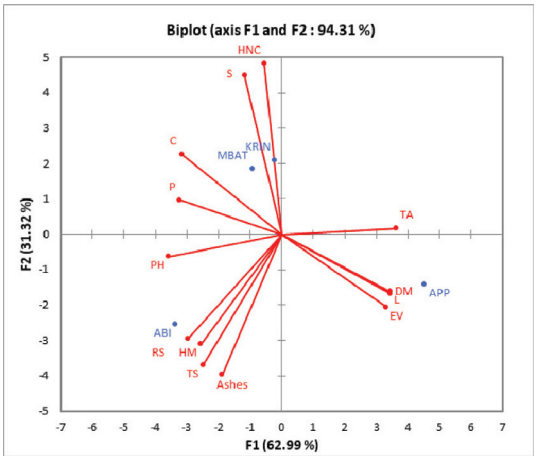

Figure 3. Principal component analysis (PCA) of the physico-chemical parameters of the *bêdê*, C: Carbohydrate, P: Protein, L: lipid, S: Starch, TA: TitratableAcidity, HNC: Hydrocyanic acid, pH: Potential of hydrogen, DM: Dry Matter, EV: Energy Value, TS: Total Sugars, RS: reducing sugar, HM: Humidity, MBAT : M'batto, APP :Appropronou, KRIN : Krindjabo, ABI : Abidjan

Table 2. Microbiological characteristics and sanitary quality of *bêdê*

	Production sites				Sanitary quality of *bêdê*		
Microbial Loads (CFU /g)	Abidjan	Appropronou	Krindjabo	M'batto	Average microbial loads	Standards	References
MAG	$(2.5\pm0.3)\times10^{4a}$	$(2.3\pm0.6)\times10^{4a}$	$(2.1\pm0.6)\times10^{4a}$	$(1.8\pm0.5)\times10^{5b}$	$(2.4\pm0.2)\times10$t	d" 3.10^5/g	NI 03 00 002
Total coliforms	nd	nd	nd	nd	nd	d" 10^3/ g	NI 03 00 005
Thermotolerant coliforms	nd	nd	nd	nd	nd	d" 10 / g	NI 03 00 007
E. coli	nd	nd	nd	nd	nd	< 1/ g	NI 03 00 003
LAB	$(2.1\pm0.5)\times10^{4a}$	$(2.1\pm0.7)\times10^{4a}$	$(2.2\pm0.5)\times10^{4a}$	$(2.5\pm0.5)\times10^{5b}$	$(7.8\pm1.7)\times10^4$	-	-
Yeast	2.5 ± 1.7^b	2.7 ± 0.2^b	1 ± 0.4^a	2 ± 0.4^b	2.1±1.1	d" 100/ g	ISO 21527-1 : 2008
Mould	1 ± 0.7^b	1.7 ± 0.1^b	0.6 ± 0.1^a	1.5 ± 0.4^b	1±0.1	< 10/ g	ISO 21527-1 : 2008
S.aureus	nd	nd	nd	nd	nd	d" 100/ g	NI 03 00 003
Bacillus sp	0G"	2.3 ± 0.6^a	2.3 ± 0.6^a	1.7 ± 0.3^b	1.6±0.1	< 10/ g	NI0300004
SRB	nd	nd	nd	nd	nd	d" 30/ g	NI0300004
Samonella	nd	nd	nd	nd	nd	Absence in 25 g	NI 03 00 004

different ($P < 0.05$) (Duncan multiple test). MAG : Mesophilic Aerobic Germs, LAB :Lactic Acid Bacteria, *E coli* : *Escherichia coli, S.aureus : Staphylococcus aureus,* SRB :Sulfito-reductor bacteria, nd : not detectedThe presence of the Mesophilic Aerobic Germs (MAG) such as *Bacillus sp* and moulds in the bean would be due to contamination after cooking by the production environment, instruments, product handling, contact of the product with the ambient air and the packaging inside which the producers blow to facilitate opening. According to Kouamé, (2013), a cooking temperature of 88 ± 3.33°C and a cooking time of 35 ± 1.37 min are sufficient to eliminate all vegetative forms except sporulated forms of *Bacillus sp* and moulds. However, the level of detection of these germs is well below the requirements of the Ivorian standard for cassava-based foods. All these samples of *bêdê* analyzed are therefore of satisfactory microbiological quality and could therefore be consumed without danger to the health of the consumer. In addition, some microorganisms would be of agro-food interest. They were lactic acid bacteria and yeasts. These bacteria would therefore be responsible for the acidification observed in the *bêdê* after cooking. These results are in agreement with those of (Coulin et al., 2006) which indicate a dominance of lactic acid bacteria in fermented cassava-based products. In fact, lactic acid bacteria (LAB), thanks to the organic acids they produce, ensure food safety and also give the food very particular characteristics of aroma and texture. The work carried out by Amoa-Awua et al. (1997) showed that lactic acid bacteria participate in the reduction of cyanide levels in cassava and are responsible for the sour taste in fermented products due to the production of lactic and acetic acids. Yeasts had previously been identified as the second predominant germs involved in cassava-based foods after lactic acid bacteria (Oyewole and Odunfa, 1988) capable of contributing to flavour development in fermented products (Zebre et al., 2011). The average loads of lactic acid bacteria ($(2.5\pm0.5).10^5$ CFU/g) and yeasts and moulds (3.5±2.7 CFU/g) were respectively highest in the *bêdê* from M'batto and Appropronou (Table 2). The presence of these spoilage microorganisms in *bêdê* is thought to be due to contamination after cooking. Thus the principal component analysis allowed us to group the microbiological characteristics of *bêdê* according to their origin, *bêdê* from Appropronou and *bêdê* from Abidjan are similar. These two *bêdê* are distinct from the *bêdê* from M'batto and Krindjabo. The *bêdê* from M'batto contains more lactic acid bacteria and the Mesophilic Aerobic Germs (MAG), while the *bêdê* from Krindjabo contains more *Bacillus* sp, yeasts and moulds (Fig. 4).

The aim of this study was to enhance the value of *bêdê* through the establishment of a scientific data

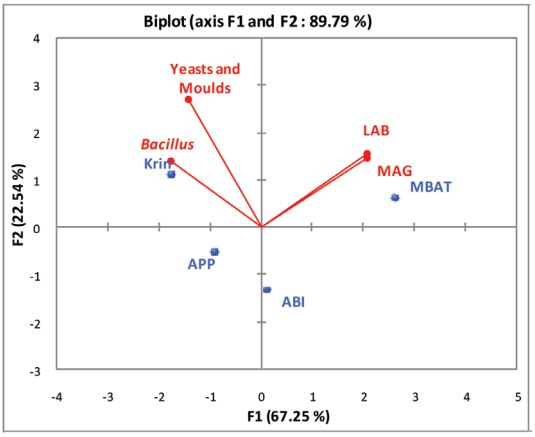

Figure 4. Principal component analysis of the microbiological parameters of *bêdê*. , MBAT : M'batto, APP : Appompronou, KRIN : Krindjabo, ABI : Abidjan MAG : Mesophilic Aerobic Germs, LAB : Lactic Acid Bacteria

base of this local product. Generally speaking, *bêdê* is an energetic food because it contains carbohydrates and lipids as well as a little protein. The *bêdê* collected from the different sites are characterized by each other. Thus, *bêdê* from Appompronou is rich in lipids and has a high energy value. The dry matter, carbohydrate and starch content are more observed in *bêdê* from Krindjabo. The M'batto *bêdê* is characterized by a high water content and is rich in protein. As for the *bêdê* from Abidjan, it is rich in ash and sugars (total and reducing). At the level of sanitary quality, not only does *bêdê* contain no pathogens but also its level of the Mesophilic Aerobic Germs (MAG) contamination is below the microbiological criteria proscribed by CODINORM 2013. To conclude, whatever the origin of the *bêdê*, it is of satisfactory microbiological quality.

Acknowledgement

The authors are grateful the *bêdê* producers who freely agreed to participate in this study.

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