GSC Biological and Pharmaceutical Sciences

eISSN: 2581-3250 CODEN (USA): GBPSC2

Cross Ref DOI: 10.30574/gscbps

Journal homepage: https://gsconlinepress.com/journals/gscbps/

(RESEARCH ARTICLE)

Check for updates

Physicochemical and sensory characteristics of m'bahou: A traditional dish consumed in Côte d'Ivoire

Arlette Akissi N'Guessan [1,*], Josi-Noelline Sinh [2], King Martin Luthere N'Gbo [3], Kwithony William Disseka [1], Yves Djina [1], Christelle Adjoua N'Goran [1] and Jean Tia Gonnety [1]

[1] *Department of Food Science and Technology, University NANGUI ABROGOUA, Abidjan, Côte d'Ivoire.*
[2] *National Institute of youth and the sports (INJS) Abidjan, Côte d'Ivoire.*
[3] *Department of Agriculture, Fishery Ressources and Agro-industry, University of San Pedro, Côte d'Ivoire.*

GSC Biological and Pharmaceutical Sciences, 2022, 18(03), 182–192

Publication history: Received on 14 February 2022; revised on 17 March 2022; accepted on 19 March 2022

Article DOI: https://doi.org/10.30574/gscbps.2022.18.3.0104

Abstract

M'bahou is a dish consumed in the eastern and central part of Côte d'Ivoire. This dish allows the use of senescent plantain, product relatively cheaper and often rejected on the market due to its high perishability. In this study, the nutritional properties as well as sensory characteristics (colour, shape, size, texture, general appearance, smell, aroma, taste, chewiness) of m'bahou were investigated. This dish produces, then dried had relatively low moisture (7.13%), ash (1.93%), fat (0.24%), proteins (3.07%), crude fiber (2.87%) contents and were good sources of carbohydrates (87.64%), starch (61.15%), energy (364,87 kcal/100 g), vitamin A (134.67 µg/100 g), vitamin B1 (49.57 µg/100 g) and vitamin B2 (564.87 µg/100 g). Mineral composition revealed that potassium (120.32 ± 0.21 mg /100 g dm) and calcium (85.50 ± 0.11 mg /100 g dm) was the most abundant mineral followed by sodium (55.71 ± 1.30 mg /100 g dm), phosphorus (48.10 ± 0.62 mg /100 g dm) and magnesium (46.23 ± 0.06 mg /100 g dm). For Phytochemical compounds, polyphenols (109.64 ± 7.40 mg GAE/100 g dm) were higher than phytates (50.42 ± 1.63 mg/100 g), tannins (27.01 ± 0.35 mg tannic acid/100 g), flavonoids (4.32 ± 0.38 mg quercetin/100 g). The mean scores of the sensory descriptors given by panelists for overall acceptability ranged from 6.40 ± 1.29 to 7.38 ± 1.19 on a 9-point scale, corresponding to pleasant level, so acceptable. Valorization of this dish would be more advantageous because it could contribute more to the reduction losses.

Keywords: M'bahou; Senescent plantain; Physicochemical characteristics; Acceptability

1. Introduction

Banana and plantain (*Musa* spp.) are cultivated in over 130 countries worldwide covering approximately 10 million hectares, with an annual production of 139 million tons [1]. In Central and West Africa, plantains account for about 50% of total Musa production [2], which feed approximately 70 million people with 25% of their carbohydrates and 10% of their food Energy [3]. This vegetable resource contributes significantly to food security and income for the people of Africa [4]. Despite all the advantages of plantain (economic and nutritional importance), it is very difficult to preserve because of its high perishability [5]. Under normal conditions of temperature (30 °C), it matures between 5 and 9 days after harvest, if physiological maturity is reached, but this time interval is reduced by faulty storage and lack of care during various post-harvest manipulations (transport, market display, etc.) [6]. This advanced maturity of fruits makes them not recoverable [7] and lose their market value, leading to post-harvest losses estimated at around 30-40% [8]. Several solutions were found to reduce these post-harvest losses such as fruit transformation into less perishable products (flours, ships, etc) is at far the most concrete of all, mainly as far as trading is concerned [9]. Above all, people have not only developed methods to increase plantain storage life, but they have also invented several dishes (fried,

* Corresponding author: Akissi Arlette N'Guessan
Department of Food Science and Technology, University NANGUI ABROGOUA, Abidjan, Côte d'Ivoire.

boiled and roasted plantain, porridge, pounded plantain) using unripe and ripe plantain fruits [10]. These fruits are most often used for the preparation of some traditional dishes such as foutou, foufou, ect… [7]. In order to contribute to the development of plantain by reducing post-harvest losses due to the non-use of this product at the senescent stage, research is underway to improve traditional products based on it. Thus Akoa *et al.* [11] improved the sensory characteristics of dockounou, a traditional dish made from senescent plantain. According to these authors this dish can be considered as an interesting solution, apt to contribute to the reduction of post-harvest losses and food security. ''*M'bahou* '' is a traditional couscous based on plantain banana from the culinary heritage Agni and Baoulé (ethnic group of eastern and central Côte d'Ivoire). It is made from the mixture of plantain puree and cassava flour, which is used as a binder [12]. It is an original method of valorization of the senescent plantain to avoid the rejection of it. This dish is eaten simple or with sauce. To date, no study has been conducted on the physicochemical composition of this dish. The purpose of this study is to enhance the senescent plantain by this dish and determine the physicochemical and sensory properties of m'bahou.

2. Material and methods

2.1. Materials

The plant material was constituted of senescent plantain (*Musa paradisiaca*), variety "Corne 1" and cassava roots (*Manihot esculenta* Crantz), variety "Bonoua". Plantain (*Musa paradisiaca*) were harvested at physiological maturity at the experimentation station of the Azaguié National Center for Agricultural Research (village located 50 km north of Abidjan 5 ° 38'N, 4 ° 05 'W). After harvest, plantain was stored in polypropylene plastic bags at room temperature for ripening until the 9th stage. As for cassava roots, they were purchased from Adjamé market (Abidjan, Côte d'Ivoire).

2.2. *Cassava flour* preparation

Cassava flour was obtained by the method described by [13]. The freshly harvested roots were peeled with a stainless-steel knife, washed with tap water and sliced in small pieces. The chips obtained were dried in an oven (Memmert) at 60 °C for 24 hours. The dried chips were crushed and sieved through at 500 µm mesh sieve.

2.3. Production of plantain puree overripe

The overripe plantains were washed and peeled. Then the slices were crushed in a blender (Moulinex, France) to obtain a mash.

2.4. Processing of m'bahou

The plantain puree and cassava flour were processed into semolina, called m'bahou (figure 1). The cassava flour produced was mixed with the puree and was added salt. The resulting mixture was sieved (2 mm) to obtain granules which were then rolled. The granules obtained were steamed for 20 min using a couscous maker. The precooked semolina was dried at an average temperature of 50 °C in an oven in order to reduce the moisture content. Figure 1 shows the step-by-step processing procedure for m'bahou production.

2.5. Proximate Analysis

pH, titratable acidity, moisture, ash, crude fiber, crude protein and lipid contents of flour samples were determined by standard methods developed by the Association of Official Analytical Chemists [14]. All analysis was carried out in triplicates.

The pH and titratable acidity were determined by using 10 grams (10 g) of the ground sample in 100 ml of distilled water. Ten milliliters of the filtrate were measured by using a pH measure (HANNA HI98240, China) and Ten milliliters of the filtrate was titrated against 0.1 N NaOH solution using phenolphthalein indicator for titratable acidity. The moisture content was determined by differential weighing of 5 g of sample before and after drying in the oven (Memmert, Germany) at 105 °C until constant weight. The lipid content was determined according to the Soxhlet extraction method. The total ash content was determined by incineration of 5 g of sample at 550 °C for 12 h. Fiber estimate was determinated from the loss in weight of dried residue following the digestion for fat-free samples with 1.25% each of sulfuric acid and sodium hydroxide solutions.

The crude protein was determined according to Kjeldahl's method. Crude protein was calculated as N × 6.25. Total carbohydrates content was determined sis using the following formulas [15]: Carbohydrates: 100 – (% moisture + % proteins + % lipids + % ash). The calorific value was calculated with 4 kcal/g for carbohydrates, 4 kcal/g for proteins and 9 kcal/g for lipids according to [16]: VE = (9 × Lipids (%)) + (4 × Proteins (%)) + (4 × Carbohydrates (%)).

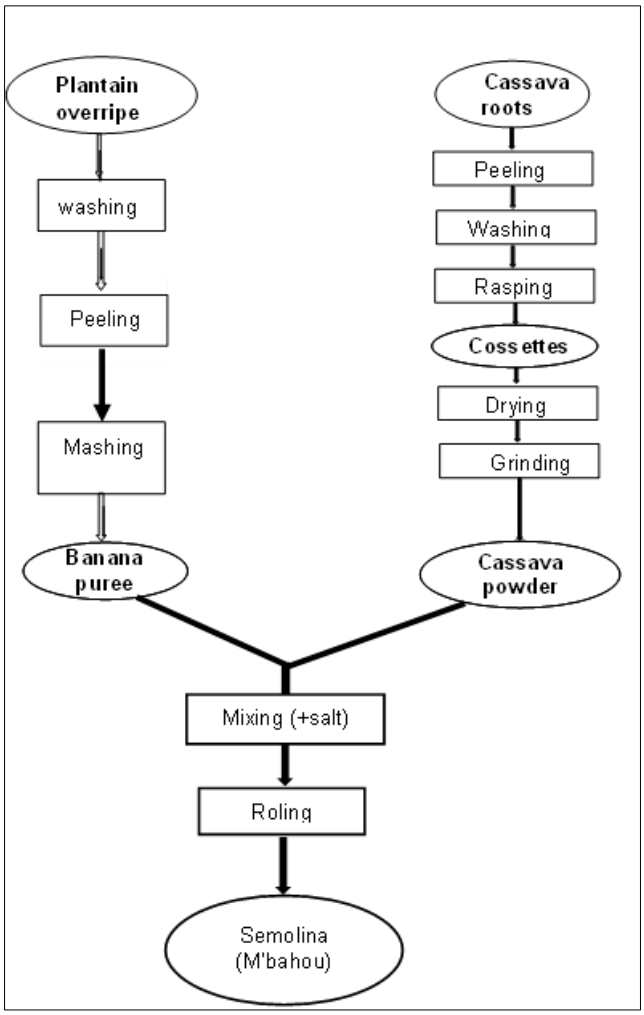

Figure 1 M'bahou Process

The reducing sugars were determined according to the method of [17] using 3.5 dinitrosalicylic acid (DNS). Total sugar content was determined by the phenol-sulfuric acid method according to [18]. Starch levels were deducted from those of total carbohydrates and reducing sugars [15]: Starch levels = 0.9 (% total carbohydrates - % reducing sugars).

2.6. Mineral's analysis

1 g of m'bahou flour with a mixture of concentration sulfuric acid (18.01 mol/L), nitric acid (14.44 mol/L) and perchloric acid (11.80 mol/L). After dilution, the mineral elements were determined by atomic absorption spectrophotometry according to the AOAC digestion method [14] and phosphorus content was determinated using the method of [19].

2.7. Vitamin's analysis

The contents of vitamins were determined according to the method described by [20]. In fact, a 10% (w / v) aqueous suspension of food whose pH was adjusted to 4.5 was delipidated using a solution of sulfuric ether and petroleum ether. The new mixture obtained was filtered through a Millipore filter and the pH of the filtrate was brought to 6.9. The resulting solution was lyophilized and the lyophilisate was brought to a volume of 30 mL. The determination of the vitamins was carried out after the calibration of the standards of each vitamin. An HPLC system (SHIMADZU SPD 20A, GERMANY) equipped with a UV detector (PAD) and C18 ODS column (250 x 4.6 from, Cluzeau, France) was used in isocratic mode for the analysis. The mobile phase consisted of acetonitrile (55 mL), tetrahydrofuran (37 mL) and water (8 mL) with a flow rate of 1.5 mL per min. Ten (10) µL of each sample was injected and the compounds were detected at a wavelength of 325 nm.

2.8. Phytochemical compounds

2.8.1. Determination of Polyphenols

Total Polyphenols were extracted with methanol by the method of [21]. One (1 g) of the sample flour was soaked in 10 ml of 70% (v / v) methanol. The mixture was centrifuged at 1000 rpm for 10 minutes. One (1) mL of the supernatant obtained was oxidized with 1 mL of Folin-Ciocalteu reagent and neutralized with 1 mL of 20% (w / v) sodium carbonate. The reaction mixture was incubated for 30 min at ambient temperature and absorbance was measured at 725 nm by using a Spectrophotometer (MS-V 5 100, China). The polyphenols content was obtained using a calibration curve of gallic acid (1 mg/mL) as standard.

2.8.2. Determination of Flavonoids

The total flavonoids were evaluated using the method reported by [22]. To 0.5 ml of methanolic extract, 0.5 ml of distilled water, 0.5 ml of aluminum chloride (10% w / v), 0.5 ml of sodium acetate (1 M) and 2 mL of distilled water were successively added. The mixture was allowed to incubate at ambient temperature for 30 min and the absorbance was measured by using a spectrophotometer (MS-V 5 100, China) at 415 nm. The total flavonoids were obtained using a calibration curve of quercetin (0.1 mg/mL) as standard.

2.8.3. Determination of Tannins

Tannins were measured to [23]. To one (1) mL of methanolic extract was mixed 5 mL of vanillin reagent. The mixture was allowed to incubate at ambient temperature for 30 min. Absorbance was read at 500 nm by using a Spectrophotometer (MS-V 5 100, China). This method used a calibration curve of tannic acid (2 mg/mL) as standard.

2.8.4. Determination of Phytates

The determination of phytates was carried out according to the method described by [24]. Thus, one (1) g of food was digested with 20 mL of hydrochloric acid (0.65 N) with magnetic stirring for 12 h at room temperature (28 °C). The mixture was then centrifuged at 12.000 rpm for 40 min. A 0.5 mL aliquot of the supernatant was diluted in 3 mL of Wade's reagent, then homogenized by manual shaking for 2 min at room temperature (28 °C). This new mixture was left to stand for 15 min at room temperature (28 °C) and the intensity of the coloration was read with a spectrophotometer (MS-V5100 visible, CHINA) at 490 nm against the control containing no phytate. The amount of phytate was determined using a standard line established from a sodium phytate stock solution (10 µg / mL).

2.9. Sensory properties

2.9.1. Descriptive test

15 subjects composed of men and women from Nangui Abrogoua University (Abidjan, Côte d'Ivoire) were selected on the basis of motivation, availability, ability to differentiate and describe, and then trained. Subjects were asked to describe m'bahou attributes and to quantify their perceptions of the intensity of each attribute using an 11-point descriptive scale ranging from 0 (attribute not perceived) to 10 (attribute very intense). The attributes were colour, shape, size, texture, general appearance, smell, aroma, taste and chewiness.

2.9.2. Hedonic test

Sensory quality characteristics of m'bahou such as colour, shape, size, texture, general appearance, smell, aroma, taste, chewiness was evaluated using a 55 subjects untrained panel, made up of staff and students of University. The subjects were first informed about the important knowledge of sensory evaluation. A 9-point hedonic score system [19] was used with the following ratings: 9=Like extremely, 8=like very much, 7=like moderately, 4=Like slightly, 5=Neither like nor dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much and 1=Dislike extremely. The sensory test was performed in a room equipped with individual booths.

2.10. Statistical analysis

All experiments were carried out in triplicate. The data generated were analyzed using analysis of variance (ANOVA), and means were separated using Duncan's Multiple Range Test at 5% level of probability.

3. Results

3.1. Proximate composition

The chemical composition and energy value of m'bahou are presented in table 1. The pH and titratable acidity values were respectively 5.55 and 5.00 meq/100 g. The ash (1.93%, dm), fat (0.24%, dm), crude fiber (2.87%, dm), protein (3.07%, dm) contents were low, while dry matter (92.87%), carbohydrates (87.64%, dm), energy value (364.87 kcal/100g dm) were relatively high. Reducing sugars and total sugars values (mg/ 100 g dm) were about 13.21 and 24.87, respectively.

Table 1 Proximate composition of m' bahou

Parameters	Values
pH	5.55 ± 0.01
Titratable Acidity (meq /100g)	5.00 ± 0.10
Dry matter (%)	92.87 ± 0.08
Ash (%)	1.93 ± 0.18
Fat (%)	0.24 ± 0.02
Proteins (%)	3.07 ± 0.12
Carbohydrates (%)	87.64 ± 0.30
Crude fiber (%)	2.87 ± 0.24
Starch (%)	61.15 ±0.46
Reducing sugar (mg/100g dm)	13.21 ± 0.96
Total sugar (mg/100g dm)	24.87 ± 0.90
Caloric Energy (Kcal/100g dm)	364.87 ± 1.07

Values are the mean ± standard deviation of three measurements (n = 3); dm (dry matter)

3.2. Mineral contents

Mineral contents and mineral ratios of samples are shown in table 2. The levels of Mg, K, Na, Ca, P and (mg/100 g dm) were 46.23 ± 0.06; 120.32 ± 0.21; 55.71 ± 1.30; 85.50 ± 0.11; 48.10 ± 0.62 respectively. Those of trace elements such as Cu, Zn, Fe were 0.39 ± 0.01; 0.10 10^{-3}± 0.01 and 0.83 10^{-3} ± 0.01 respectively. [Ca]/[P] ratios for m'bahou is 1.91 ± 0.02 and [Na]/[K] is 0.16 ± 0.02 (table 2).

3.3. vitamins composition

The vitamins composition (µg /100 g dm) of m'bahou were as follows (Table 3): Vitamin A (134.67), B1 (49.57), B2 (564.87) and C (8.92 mg /100 g dm) (table 3).

3.4. Phytochemical compounds

As revealed by the analysis in table 4, polyphenols content of m' bahou is 109.64 ± 7.40 mg GAE / 100 g DW, flavonoids content is 4.32 ± 0.38 mg Quercetin / 100 g DW.

As for the content of tannins, it is 27.01 ± 0.35 mg tannic acid/100 g DW and that Phytates is 50.42 ± 1.63 mg/100 g (Table 4).

Table 2 Composition in mineral elements and mineral ratios

Mineral elements	**Contents (mg / 100 g dm)**
Magnesium (Mg)	46.23 ± 0.06
Potassium (K)	120.32 ± 0.21
Sodium (Na)	55.71 ± 1.30
Calcium (Ca)	85.50 ± 0.11
Phosphorus (P)	48.10 ± 0.62
Copper (Cu)	0.39 ± 0.01
Zinc (Zn)	$0.10\ 10^{-3}$ ± 0.01
Iron (Fe)	$0.83\ 10^{-3}$ ± 0.01
Mineral ratios	
Ratios Ca/P	1.91 ± 0.02
Ratios Na/K	0.16 ± 0.02

* Values are the mean ± standard deviation of three measurements (n = 3); dm (dry matter)

Table 3 Vitamins composition of m' bahou

Compound	**Values**
Vitamin B1 (µg/100 g dm)	49.57 ± 1.51
Vitamin B2 (µg/100 g dm)	564.87 ± 4.85
Vitamin A (µg/100 g dm)	134.67 ± 1.42
Vitamin C (mg/100 g dm)	8.92 ± 0.25

Values are the mean ± standard deviation of three measurements (n = 3); dm (dry matter)

Table 4 Composition in few Polyphenols of m'bahou

Compound	**Values**
Polyphenols (mg GAE/100 g dm)	109.64 ± 7.40
Flavonoids (mg quercetin/100 g dm)	4.32 ± 0.38
Tannins (mg tannic acid/100 g dm)	27.01 ± 0.35
Phytates (mg/100 g dm)	50.42 ± 1.63

Values are the mean ± standard deviation of three measurements (n = 3); dm (dry matter)

3.5. Sensory properties of m'bahou

The descriptive profile of m'bahou is shown in figure 2. It showed that the color of m'bahou obtained an score of 8.93. This score is characteristic of the dark yellow. The characteristic smell of plantain was more perceived with an score of 6.27 compared to cassava flour (3.58). As concern to size, shape and uniformity, the subjects gave respective score of 5.1; 7.83 and 7.29. These scores attributed by the subjects indicate that the grains constituting m'bahou formulated were of score size with a round and homogeneous shape. In terms of adherence and texture, m'bahou was found to be

somewhat sticky with a score of 3.63 and a slightly soft texture (3.48). This dish was tender (6.83) with a sweet taste (6.75).

In addition to these descriptive results, the table 5 presents the averages of the scores obtained at the level of the descriptors used for hedonic test. These descriptors all have above average scores. The notes are respectively 6.98 ± 1.12; 7.00 ± 1.12; 7.38 ± 1.19; 6.78 ± 1.19; 6.40 ± 1.29; 7.07 ± 1.31; 7.18 ± 1.67; 7.42 ± 0.74 and 7.38 ± 1.01 for color, shape, size, texture, general appearance, smell, aroma, taste and chewiness.

Table 5 Average score out of 9 for sensory analysis of m'bahou

Sensory attribute	Score
color	6.98 ± 1.12
shape	7.00 ± 1.12
size	7.38 ± 1.19
texture	6.78 ± 1.19
general appearance	6.40 ± 1.29
smell	7.07 ± 1.31
aroma	7.18 ± 1.67
taste	7.42 ± 0.74
chewiness	7.38 ± 1.01

Values represent Mean ± SD (n = 3) dm (dry matter)

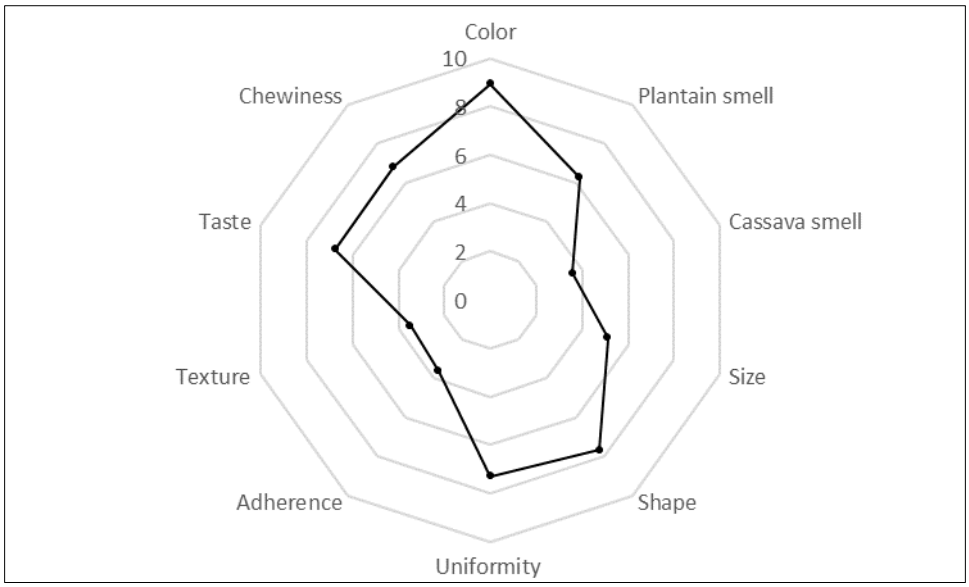

Figure 2 Plot of scoring averages for descriptive analyses (out of 11) for m'bahou

4. Discussion

The senescent plantain pulp was used for the production of m'bahou, dish obtained by the incorporation of the cassava flour in the plantain puree.

Proximate composition revealed that this dish contained 92.87% about dry mater and 7.13% moisture. This moisture content is lower than [25], which states that the moisture content must be less than 13.5%. This low humidity indicates that this semolina could be kept for a long time. Moisture plays a very important role in the keeping quality of foods

[26]. Indeed, Moisture content of food or processed product gives an indication of its shelf life, low moisture content is a requirement for long a storage life [27].

As for fat, it enhances the flavor of food and helps improve appearance [28]. But a high fat content could also cause many diseases such as obesity and cause a rancidity of the flavor of the dish during its conservation. However, the fat content of m'bahou was 0.24%. This low level could be explained by the low-fat content of cassava and plantain used for the production of this dish. Since the fat content is low, this dish may be recommended for people following diets. And addition, during its conservation, it would be less exposed to the phenomenon of rancidity.

As concern dietary proteins, they are necessary for the synthesis of endogenous proteins used in the development of new tissues, the repair of depleted cells and damaged tissues of the body [29]. But, given the low protein content recorded (3.07 ± 0.12), it would be important to consume this dish with a rich protein sauce to fill the deficit.

The energy value (364.87 ± 1.07) was higher than those obtained by [30] in couscous enriched with dried spirulina (344 kcal / 100g). The energy value of a food indicated the energy that the body stores during a meal and allows it to maintain its balance. A high energy value of a food indicates a high intake of energy and essential nutrients that can meet the needs of the body and promote growth [31]. As a result, the consumption of this dish could meet the energy needs of the body.

The acid pH obtained (5.55 ± 0.01) was close to that obtained by [32] in boiled plantain dockounou (5.28). This acidity of the pH be explained by the use of anti - browning agents used during the treatment of the plantain puree.

The amounts of reducing sugars (13.21 ± 0.96 g / 100 g) and total (24.87 ± 0.90 g / 100 g) were higher than those of unripe plantain which are respectively 0.45 and 5.13 g / 100 g [33]. As for the starch content (61.15 ± 0.46), it is lower than that recorded in the unripe plantain (80.85 g / 100 g). This variation could be explained by the starch hydrolysis into sugars at the overripe plantain. Indeed, during ripening there is hydrolysis of starch, sucrose giving glucose and fructose [33].

As for the ash content, it was 1.93 ± 0.18%. This value is close to that of the fresh plantain pulp (1.80 g / 100 g) found by [34]. For macro-elements, potassium (120.32 ± 0.21) and calcium (85.50 ± 0.11) are the predominant minerals in the m'bahou, although phosphorus, magnesium and sodium are present. The high level of potassium compared to other minerals would be explained by the presence of plantain in this dish. Indeed, according to [33] potassium is the most abundant mineral in plantain compared to other minerals. As concern the phosphocalcic ratio of this dish (1.91 ± 0.23), it is greater than 1 and is in accordance with the recommendations of [35]. In addition, the sodium / potassium ratio (0.16 ± 0.25) is less than 1, also in accordance with the recommendations of [36]. The phosphocalcic and sodium / potassium ratios comply with the prescribed standards, the consumption of this dish could play an important role in the formation of bones, teeth and protect the body against heart disease [37].

This food is also a source of vitamin A, B1, B2 and C. Vitamins A, B2 and C are the most important. Vitamins are essential compounds provide no calories but play an important role in cellular metabolic reactions. Vitamins are required in small amounts and appropriate for normal growth [38]. Vit B2 content m'bahou was 564.87 ± 4.85 µg/100 g. This vitamin B2 level appeared higher than that of plantain ripe (80 µg/100 g). Vitamin B2 plays a key role in energy metabolism, for the metabolism of fats, ketone bodies, carbohydrates, and proteins [39]. However, it is very sensitive to processing conditions, especially light and heat [40]. Vitamin C is an important water-soluble vitamin. it implicated in most of the life processes but principally function as an antioxidant [41]. M'bahou consumption would not lead to malfunctions of metabolisms that take place in the body.

For the polyphenol contents (109.64 ± 7.40 mg/100 g), they are higher than those obtained by [42] on the flour of the variety Corne 1 (stage 5) used for foufou preparation (844.4 ± 0.4 mg / kg). These high rates could be attributed to the advanced degree of ripening of the bananas used. Indeed, N'goh *et al*. [43] reported that the polyphenol content increases during ripening. M'bahou would therefore be a beneficial dish for health. Polyphenols are natural antioxidants which contribute to the reduction of low-density lipoprotein levels in the blood, thus reducing certain cardiovascular diseases [42]. Tannins (27.01 mg/100 g dm) and phytates (50.42 mg/100 g dm) contents of m'bahou were respectively higher than those reported by [44] for flour plantain (PITA 26): 0.36% and 7.9 $x10^{-5}$ %. Phytates content was low than that of gari (64.38 mg/100 g) produced at 120 h of fermentation [26]. According to [45] an excess of 800 mg of phytate is not recommended for the acceptable daily intake (ADI). So, the consumption of this dish would not be toxic to health.

Sensory quality of food is an essential quality aspect considered by consumers for the acceptability of food [46]. The sensory profile of m'bahou indicated that the color of m'bahou was dark yellow and had a pronounced plantain smell.

This result would be due to the color and smell of the senescent plantain used. The appearance little sticky and soft identified would explain by the high starch content and the low lipid content recorded in m'bahou. The slightly sweet taste perceived by the panelists despite the addition of salt is translated by the increase of sugar in the plantain senescence. Indeed, during ripening there is hydrolysis of starch into sugars such as fructose, which confers this sweet taste.

M'bahou was accepted by the subjects according to the hedonic test. Indeed, the mean scores of the sensory descriptors given by panelists for overall acceptability ranged from 6.40 ± 1.29 to 7.38 ± 1.19 on a 9-point scale. These means are above average (5.00) corresponding to pleasant level, so acceptable. Thus, this dish could be valued in the population.

5. Conclusion

This dried semolina is characterized by relatively high level of carbohydrate and caloric energy. Its low humidity and fat may allow good conservation however, given its low protein content, it would be interesting to consume it always with a high protein diet to fill this deficit. Valorization this dish would be advantageous because it could contribute to reduce plantain post-harvest losses.

Compliance with ethical standards

Acknowledgments

We are grateful to the Biocatalysis and Bioprocesses Laboratory of the Department of Food Science and Technology, Nangui-Abrogoua University for infrastructure and access to scientific instrumentation.

Disclosure of conflict of interest

Authors declare that they have no any conflict of interest.

References

[1] FAOSTAT. Food and Agricultural Organization, Agricultural Data. Crops and products domain; 2014 http://faostat.fao.org/site/339/default.aspx Rome, Italy.

[2] Tuo S, Amari L-NDGE, Camara B, Kassi FM, Ouédraogo SL, Traoré S, Lorng JP, Kouakou AE, Koné D. Effect of the association of different tolerant banana cultivars (*Musa* spp.) on the incidence of black Sigatoka in the susceptible cultivar "orishele" in Ivory Coast. European Scientific Journal. 2015; 11 (24): 70-94.

[3] Kuperminc O. Plantain marketing seasonality in Côte d'Ivoire. Fruit.1985; 43 (6): 359-368.

[4] Tchigossou B, Logbo J, Zandjanakou-tachin M. Study of the agromorphological parameters of plantains (Musa spp.): case of two False-horn type cultivars in southern Benin. Africa science. 2019; 15 (3): 1 – 11.

[5] Atanda SA, Pessu PO, Agoda S, Isong IU, Ikotun I. The concepts and problems of post–harvest food losses in perishable crops. African Journal of Food Science. 2011; 5: 603-613.

[6] Yao AK, Koffi DM, Iri ZB, NIAMKE SL. Effect of partial substitution of wheat flour by mashed plantain banana (Musa AAB) on the quality of pastry products. Journal of Applied Biosciences. 2014; 82: 7436–7448.

[7] Ourega, DA, Koffi LB, N'Guessan KF, Nemlin GJ, Tano K, Dje K M. Physico-chemical characteristics of plantain beers produced from discarded plantains of different varieties from Côte d'Ivoire (Orishele , French 2 and Corne 1) [Physico-chemical characteristics of plantain beers produced from waste plantain varieties of Côte d'Ivoire (Orishele, French Horn 2 and 1)]. International Journal of Innovation and Applied Studies. 2015; 10(2): 666-667.

[8] Kouadio NJ, Koua AYG, Cissé M, Kra KAS, Niamké LS. Nutritional status of baked dockounou formulated with senescent plantain and six sell flours. International journal of food and nutritional sciences. 2015; 4 (5): 17-26.

[9] Emaga TH, Wathelet B, Paquot M. Textural and biochemical changes in banana fruits during ripening. Their influence on the preservation of the quality of the fruit and the control of ripening. Biotechnology, Agronomy, Society and Environment. 2008; 12: 89 - 98.

[10] Dzomeku BM, Osei-Owusu M, Akyeampong E, Ankoma AA, Darkey S. Sensory evaluation of some hybrid cooking bananas in Ghana. African Crop Science conference proceedings. 2005; 7: 631-633.

[11] Akoa EEF, Mégnanou R-M, Kra KAS, Niamké LS. Technical variation in the processing of dockounou, a traditional plantain derivate dish of Côte d'Ivoire. American Journal of Research Communication. 2013; 1(5): 80-97.

[12] N'Guessan AA, Kouadio KO, Gonnety TJ. Effect of Chemical and Thermal Treatments on Browning Inhibition of Senescent Plantain (*Musa paradisiaca*) Puree for Semolinas Preparation. American Journal of Biochemistry 2018; 8(4): 75-84.

[13] Aryee F, Oduro I, Ellis W, Afuakwa J. The physicochemical properties of flour samples from the roots of 31 varieties of cassava. Journal of Food Control. 2006; 17: 916 –922.

[14] AOAC (Association of Official Analytical Chemists). Official Methods of Analysis. AOAC, Washington, 14th Edition. DC. 1990.

[15] FAO (Food and Agriculture Organization). Composition of food in calorigenic nutrients and calculation of useful energy values. FAO Ed, Washington DC. 30. 1947.

[16] Atwater WO, Rosa EB. A new respiratory calorimeter and experiments on the conservation of energy in human body. II. Physical Review (serie I). 1899; 9(4): 214-251.

[17] Bernfeld P. Amylases α and ß. Methods in Enzymology. Colobick, SP, Kalpan NO, 149,158. 1955.

[18] Dubois M, Gilles KA, Hamilton JK, Roben FA, Smith F. Colorimetric method for determination of sugar and related substances. Analytical Chemistry. 1956; 28: 350–356.

[19] Taussky HH, Shorr E. A micro colorimetric method for determination of inorganic phosphorus. Journal of Biology and Chemistry. 1953; 202: 675-875.

[20] Rougereau A. Technical analysis and control in the food industry. Edition Technical and documentation, France, 409.1984.

[21] Singleton VL, Orthofer R, Lamuela-Raventos RM. Analysis of total phenols and other oxydant substrates and antioxydants by means of Folin-ciocalteu reagent. Methods in Enzymology. 1999; 299: 152-178.

[22] Meda A, Lamien E, Romito M, Millogo J, Nacoulma OG. Determination of the total phenolic, flavonoid and proline contents in Burkina Faso honey, as well as their radical scavenging activity. Food and Chemistry. 2005; 91: 571–577.

[23] Bainbridge Z, Tomlins K, Westby A. Analysis of condensed tannins using acidified vanillin. Journal of Food Science and Agriculture. 1996; 29: 77-79.

[24] Latta M, Eskin M. A simple method for phytate determination. Journal of Agricultural and Food Chemistry. 1980; 28: 1313-1315.

[25] CODEX STAN, Codex standard for wheat flour. Codex standard, 152-1985, 1995.

[26] Olaoye OA, Lawrence IG, Cornelius GN, Ihenetu ME. Evaluation of quality attributes of cassava product (gari) produced at varying length of fermentation. American Journal of Agricultural Science. 2015; 2(1): 1-7.

[27] Zakpaa HD, Al-Hassan A, Adubofour J. An investigation into the feasibility of production and characterization of starch from "apantu" plantain (giant horn) grown in Ghana. African Journal of Food Science. 2010; (9): 571–577. Retrieved from www.foodstandards.gov.

[28] Souliac L, Bizet G, Remy S. Reconcile pleasure and nutrition. Work of the PNNS working groups on lipids and on taste. Agronomic Innovations. 2010; 10: 125-136.

[29] Cezard J-P. Dietary proteins: Digestion - Absorption. In Treaty of Pediatric Nutrition. Eds. Maloine., 1993.p. 91-102.

[30] Doumandji A, Boutekrabt L, Saidi NA, Doumandji S, Hamerouch D, Haouari S. Study of the impact of the incorporation of spirulina on the nutritional, technological and organoleptic properties of artisanal couscous. Nature & Technology magazine. 2012; 6: 40-50.

[31] Solomon M. Nutritive Value of three potential complementary foods based on cereals and legumes. In African Journal of Food and Nutritional Sciences. 2015; 5 (2):1-14.

[32] Akoa EEF. Valorization of plantain (*Musa* spp.) in senescence: food formulations of banana dockounou from different types of cereal flours [Single doctoral thesis]. Abidjan, University of Félix Houphouët Boigny; 2014.

[33] Assemand E, Camara F, Kouame F, Konan V, Kouame LP. Biochemical characterization of plantain fruits (*Musa paradisiaca* L.) variety "Agnrin" from Côte d'Ivoire and sensory evaluation of its derived products. Journal of Applied Biosciences. 2012; 60: 4438-4447.

[34] Ojure MA, Quadri JA. Quality evaluation of noodles produced from unripe plantain flour using xanthan gum. International Journal of Research and Reviews in Applied Science, 2012; 13(3): 740-752.

[35] Kemi VE, Karkkainen MUM, Rita HJ, Laaksonen MML, Outila TA, Lamberg-Allardt CJ. Low calcium: phosphorus ratio in habitual diets affects serum parathyroid hormone concentration calcium in health women with adequate calcium. British Journal of Nutrition. 2010; 103: 561 – 568.

[36] FAO (Food and Agriculture Organization). Roots, tubers, plantains and bananas in human nutrition. FAO Nutrition 24 collection, Rome (Italy), 200.1991.

[37] Ijarotimi OS, Oluwalana IB. Chemical Compositions and Nutritional Properties of Popcorn-Based Complementary Foods Supplemented with Moringa oleifera Leaves Flour. Journal of Food Research. 2013; 2(6): 117-132.

[38] Verhoef P, Stampfer MJ, Buring JE, Gaziano JM, Allen RH, Stabler SP, Reynolds RD, Kok FJ, Hennekens CH, Willett WC. Homocysteine metabolism and risk of myocardial infarction relation with vitamins B6, B12 and folate. American Journal of Epidemiology. 1996; 143: 845-859.

[39] Belinda TJ. Significance of riboflavin (vitamin-B2) for health. Journal of Pharmaceutical Sciences and Research.2014; 6(8): 285-287.

[40] Rachmani N, Muller HG. The fate of thiamine and riboflavin during the preparation of couscous. Food Chemistry. 1996; 55: 23–27.

[41] Ogbonna OA, Izundu AI, Okoye NH, Mgbakor MN. Vitamin Compositions of Three Musa Species at Three Stages of Development. Journal of Environmental Science, Toxicology and Food Technology. 2016; 10 (6): 2319-2402.

[42] Gnagne EH, Akely PMT, Petit J, Scher J, Amani G. Physicochemical characterization of 3 cultivated Ivorian plantain commonly used for making local dishes such Foutou and Foufou. Agronomie Africaine. 2017; 29(2): 23-36.

[43] N'goh NG, Brat P, Tomekpe K, Alter P, Fokou E, Etoa FX. Effect of ripening on total polyphenol contents of Musa hybrids and cultivars grown in Cameroon. Acta Horticulturae. 2008; 879: 413 - 418.

[44] Adeniji TA, Sanni OL, Barimalaa SI, Hart DA. Nutritional composition of five new Nigerian Musa hybrid cultivars: implications for adoption in human nutrition. Fruits. 2007; 62 (3): 135 - 142.

[45] Abdoulaye C, Brou K, Jie C. Phytic acid in cereal grains: Structure, healthy or harmful ways to reduce phytic acid in cereal grains and their effects on nutritional quality. American Journal of Plant Nutrition and Fertilization Technology. 2011; 1 (1): 1-22.

[46] Adi DD, Oduro IN, Tortoe C. Consumer Preference and Quality Expectations of Senescent Plantain Products, Journal of Culinary Science & Technology. 2021; 19 (1): 67-82.