Scientific Research Publishing

Open Journal of Applied Sciences, 2022, 12, 964-976
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

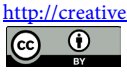
Physicochemical and Microbiological Properties of Bissap (*Hibiscus sabdariffa*) and Ginger (*Zingiber officinale* (L) Rose) Juices Sold in the Western Part of Abidjan (Côte d'Ivoire)

Gnamien Marcel Ahon[1,2*], Gbouhoury Eric-Kévin Bolou[2,3], Mamadou Fofana[2], Kouakou Ernest Amoikon[2]

[1]National Pedagogical Institute for Technical and Professional Education (NPTPE), Abidjan, Côte d'Ivoire
[2]Biology and Health Laboratory, UFR Biosciences, University Félix HOUPHOUËT-BOIGNY, Abidjan, Côte d'Ivoire
[3]National Floristic Center, UFR Biosciences, University Félix HOUPHOUËT-BOIGNY, Abidjan, Côte d'Ivoire
Email: *gnamienmarcel@yahoo.fr

How to cite this paper: Ahon, G.M., Bolou, G.E.-K., Fofana, M. and Amoikon, K.E. (2022) Physicochemical and Microbiological Properties of Bissap (*Hibiscus sabdariffa*) and Ginger (*Zingiber officinale* (L) Rose) Juices Sold in the Western Part of Abidjan (Côte d'Ivoire). *Open Journal of Applied Sciences*, **12**, 964-976.
https://doi.org/10.4236/ojapps.2022.126066

Received: April 20, 2022
Accepted: June 21, 2022
Published: June 24, 2022



Abstract

Juices made from the calyx of *Hibiscus sabdariffa* (Malvaceae), commonly called Bissap, and the rhizome of *Zingiber officinale* (Zingiberaceae), known as Gnamankoudji, are widely consumed in Côte d'Ivoire. The artisanal preparation of these juices often makes their quality problematic. The aim of this study is to determine some physicochemical and microbiological properties of these drinks sold in the city of Abidjan. To do this, samples of Bissap and Gnamankoudji juices were collected near schools in the Mamie Adjoua (Yopougon) and Abobodoumé (Attécoubé) districts. Physico-chemical and microbiological analyses were performed on these collected samples. The results show that the Bissap and Gnamankoudji juices have an acid pH (2.47 and 3.71), a low protein content (0.78% and 2.11%) and a high water content (80.13% and 85.21%), respectively. The reducing sugar content ranged from 1.20% to 3.34%, with high total sugar (695 mg/mL and 812 mg/mL), low ash (0.70 ± 0.07; 0.91 ± 0.01). On the other hand, these juices contain variable concentrations of minerals from one site to another (magnesium, calcium, phosphorus, potassium and iron). Potassium is the most abundant mineral element, followed by phosphorus and magnesium. Moreover, it is observed that the Gnamankoudji juices contain vitamin C (4.67 to 5.58 mg/100mL), contrary to the Bissap juice. The microbiological analysis indicates the presence of aerobic mesophilic germs (AMG) but a total absence of pathogenic germs in all juices. The important presence of nutrients and the total absence of pathogenic germs in these drinks justify their regular consumption by the population.

Keywords

Juice, *Hibiscus sabdariffa*, *Zingiber officinale*, Chemical Composition, Microbiology

1. Introduction

Beverages are an integral part of human nutrition. Those based on *Hibiscus sabdariffa* calyxes and ginger rhizome, which were once intended for family consumption, are now marketed and are experiencing a revival of interest among consumers. *Hibiscus sabdariffa* calyxes are rich in vitamin C, carbohydrate, fructose sucrose, organic acid and antioxidants [1]. Their mineral composition refers mainly to the presence of iron, phosphorus, calcium, sodium, potassium [2], but also trace elements such as copper and chromium. Ginger rhizome extracts contain polyphenolic compounds, a strong antioxidant activity [3], and is a good source of copper. Ginger also contains resin components, proteins, cellulose, pentosans, starch and minerals [4]. It is rich in lipids and vitamin C. It is well known that polyphenols, carotenoids (pro-vitamin A), vitamins C and E present in fruits, have free radical scavenging and antioxidant activities and play an important role in many diseases [5]. In Côte d'Ivoire, the production of *Hibiscus sabdariffa* calyx and *Zingiber officinale* rhizome is mainly carried out in an artisanal way by women's groups. The production process involves several manual steps such as grinding, maceration or decoction, filtration, packaging (sometimes in recycled bottles) and storage The traditional distribution circuit for "juice" is made up of markets, restaurants, places of recreation and also schools. This network is increasingly supplemented by street vendors in the vicinity of hospitals. However, these mass consumption products, made in a traditional way, often escape quality control. The present study aims to determine the physico-chemical properties and microbiological quality of hibiscus calyx and ginger rhizome drinks sold in the vicinity of schools.

2. Materials and Methods

2.1. Biological Material

The biological material used is samples of dry calyx juice of Bissap (*Hibiscus sabdariffa*) and root juice of ginger (*Zingiber officinale* L Rose). This study was conducted during the months of January to February 2020.

2.2. Study Site

The sites where the juice samples were collected were in popular neighborhoods located in the west of the city of Abidjan (**Figure 1**). These are: the Mamie Adjoua neighborhood located in Yopougon and the village of Abobo-Doumé, in the town of Attécoube.

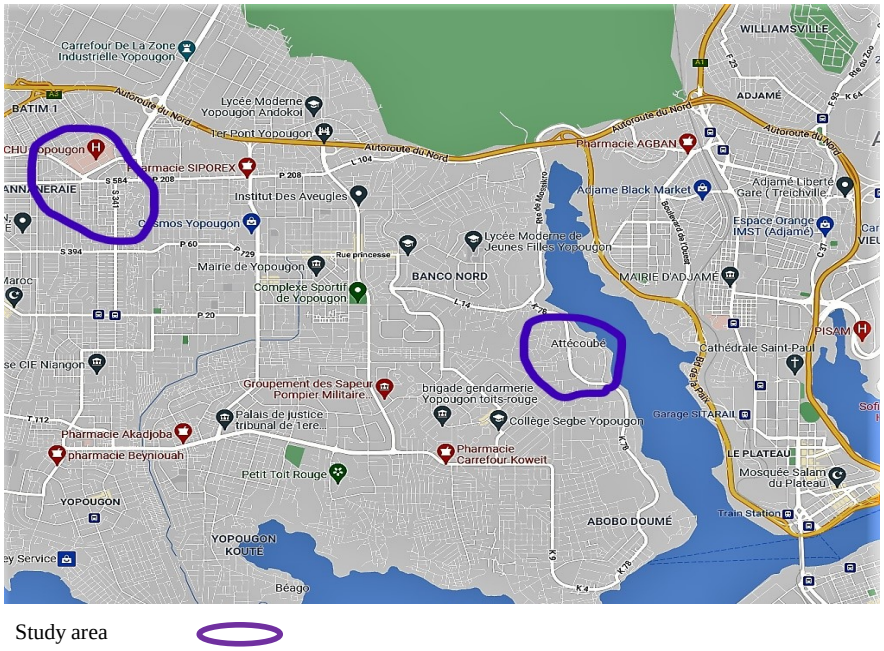


Figure 1. Juice sample collection sites.

2.3. Sampling

The communes of Yopougon and Attécoubé, both rural and urban in the District of Abidjan, were targeted. Samples were taken in the vicinity of the schools. A sample of each type of beverage was taken from each vendor, making two samples from each vendor. After sampling, the samples were labeled and then stored in a cooler containing ice cubes, then transported to the laboratory, packaged and kept at 4˚C in the refrigerator before analysis.

2.4. Sample Processing

The samples were homogenized and weighed in exact quantities for the different analyses. They were refrigerated at 4˚C before analysis. The analyses were carried out on the samples of each type of juice.

2.5. Determination of the Physical and Chemical Characteristics of Beverages

2.5.1. Determination of the Brix Degree

The extractable matter content (Brix degree) was determined using an infrared refractometer, type Abbé AR 200 digital (Leica, USA). The method consists in placing an aliquot in the refractometer mold. After pressing the button of the refractometer, the value is displayed on the screen and the Brix degree was read [6].

2.5.2. Determination of the pH

The pH is determined with a pH-meter Testo 230 type 4 (Testo France). The instrument is calibrated in 2 points, using commercial buffer solutions, at pH = 4 and pH = 7. The electrode of the pH meter is immersed in the solution and the

value is displayed on the screen [6].

2.5.3. Determination of the Titratable Acid Content

The principle consists in measuring the titratable acidity of a product with a titrated solution of sodium hydroxide (0.1 N) in the presence of phenophthalein serving as a colored indicator. Thus, 10 mL of juice were introduced with a pipette into a flask and 25 mL of distilled water were added to a conical flask. 200 mL NaOH, 0.1 N was operated in a burette and was titrated against the sample in the flask using three drops of phenophthalein as indicator. It was titrated until a pink coloration was observed [6].

$$A(\text{meq/100g}) = \frac{V_1 \times N \times 10^4}{V_0 \times m} \quad (1)$$

V_1: volume of the test (mL).

2.5.4. Determination of Moisture Content

The dry matter content was determined according to the method described by [7]. Four 10 g samples (*Mc*) were taken and placed in different previously weighed empty crucibles (*Mcr*) and weighed. The samples were placed in an oven at 105˚C for 24 hours until a constant weight was obtained. They were removed from the oven, cooled in the desiccator for one hour and weighed (*M'*) again. The water content was given by the following expression:

$$\text{Water content}(\%) = 100 - \frac{(M' - Mcr)}{Mc(\text{mL})} \times 100 \quad (2)$$

M': mass of crucible and dried sample (g);
Mcr: mass of the empty crucible (g);
Mc: mass of the sample (g).

2.5.5. Determination of Protein Content

Protein determination was performed by the Kjedjahi method [8]. According to this method, 1 g of the sample was introduced into a mineralizer. 12 mL of concentrated sulfuric acid and 2 pellets were added. The whole was boiled at 400˚C for one hour and cooled to room temperature. The mineralization product was placed in the autodistillator to which 20 mL of soda and 10 mL of water were added automatically. A distillation was done for 10 min and the distillate was collected in an Erlenmeyer flask containing 30 mL of boric acid. The resulting mixture was assayed with a 0.1 N chloridric acid solution in the presence of a color indicator (methyl red + bromocresol green). A blank test was performed under the same conditions. The tests were performed in triplicate.

Total nitrogen percentages and protein content were determined as follows:

$$\text{Percentage of nitrogen}(\%\text{N}) = \frac{(\text{VHCL sample} - \text{VHCL white}) \times \text{NHCL} \times 14.01}{\text{P sample}} \quad (3)$$

$$\text{Protein content } (T) = \%\text{N} \times 6.25$$

with %N: percentage of total nitrogen;

T: protein content;

VHCl sample: volume of HCl solution needed for sample titration (mL);

VHCl blank: volume of HCl solution needed for blank titration (mL);

NHCl: titer of HCl solution; atomic mass of nitrogen = 14.01;

P sample: mass of test sample (g).

2.5.6. Determination of the Ash Content

The ash content is obtained by incineration (or complete combustion) in a furnace. Thus 1 g of sample was introduced into a crucible previously weighed *Mcr*, and placed in the furnace at 525˚C for 6 h [8]. The sample was removed from the furnace and placed in a desiccator for 30 min, then weighed again (*M*). The tests were done in triplicate. The ash content is given by the following relationship:

$$\text{Ash content}(\%C) = \frac{[M - Mcr]}{Me} \times 100 \quad (4)$$

%C: ash content;

M: mass of crucible and ash (g);

Mcr: mass of the empty crucible;

Me: mass of the sample taken (g).

2.5.7. Determination of Reducing Sugar Content

The determination of reducing sugar content was carried out according to the method of [9] using 3,5-dinitro-salicylic acid (DNS). For the determination of reducing sugars, 0.3 and 0.6 of the extract was taken and treated with 1 mL of 3,5-dinitro-salicylic acid (DNS) and heated for 5 min in a boiling water bath. 10 mL of distilled water was added to each tube and the optical density was read with a spectrophotometer at 546 nm under standard conditions for the determination of the calibration line. The assay was performed in triplicate for each assay.

2.5.8. Determination of Total Sugar Content

Determination of total sugar content was carried out according to the method of [10] using phenol and sulfuric acid. For the determination of reducing sugars, 1 mL of the extract was taken and treated with 1 mL of phenol and 5 mL of sulfuric acid, then the optical density was read with a spectrophotometer at 490 nm. The total sugar concentration of the assay was determined from the calibration curve. The assay was performed in triplicate.

2.5.9. Determination of the Mineral Content

The determination of minerals was carried out using an Atomic Absorption spectrometer with air-acetylene flame, AAS 20 type VARIAN. The analytical method used was the International Institute of Tropical Agriculture (IITA, undated) soil and plant sampling method. For the determination of the mineral composition, 0.3 g of the sample was calcined at 600˚C, for 5 h in an oven until a white ash was obtained. After cooling, 5 mL of 1 N nitric acid was added and

evaporated to dryness. 5 mL of 1 N chloridric acid was added to the residue and the whole was put in the oven again for 30 min. The residue was recovered in 10 mL of chloridric acid and placed in a 50 mL volumetric flask. The mineral elements (calcium magnesium, iron, potassium and phosphorus) contained in the sample were determined by Atomic Absorption spectrometry.

2.5.10. Determination of Vitamin C Content

This determination was carried out according to the method described by [11]. The principle of the assay is to oxidize vitamin C in acidic medium by 2,6 dichlorophenol-indolphenol (DCPIP), which is itself reduced (colorless coloration). 5 g of the sample was stabilized with 5 mL of metaphosphoric acid-acetic acid. 1 mL of this mixture was assayed with 2,6-dichlorophenol-indolphenol until a persistent champagne-pink coloration appeared. Vitamin C solutions (1 mg/mL) and metaphosphoric acid-acetic acid were determined under the same conditions. The vitamin C content (mg/100g) was obtained according to the following formula:

$$\text{Vitamin C content} = \frac{\left[1\ \text{mg}\left(Ve - V_0\right) \times 20 \times 100\right]}{\left[1\ \text{mL}\left(Vs - V_0\right) \times 10\right]} \quad (5)$$

V_0: volume of 2,6-dichlorophenol-indolphenol used for the determination of the metaphosphoric acid solution (mL);

Ve: volume of 2,6-dichlorophenol-indolphenol used for the determination of the vitamin C standard solution (mL);

Vs: volume of 2,6-dichlorophenol-indolphenol used for the determination of the sample (mL).

2.6. Determination of Microbiological Characteristics of Beverages

The Mesophilic Aerobic Germs (MAG), Eschericha coli, Salmonella and total coliforms were tested in the samples of Bissap and Gnamankoudji juice.

2.6.1. Sample Dilution

An aliquot of 1 mL of juice was taken under a laminar flow hood near the flame of a Bunsen burner and put into a test tube containing 9 mL of physiological water (9 g of NaCl in 1 L of distilled water). After homogenization, the sample was diluted to the 10th to obtain the 10^{-1} dilution. To obtain the 10^{-2} dilution, 1 mL of the 10^{-1} dilution was taken and homogenized in 9 mL of physiological water. The undiluted sample was the 10^{0}.

2.6.2. Preparation of Culture Media

Plate Count Agar (PCA), Salmonella-Shigella (SS) and VRBL media were prepared according to the manufacturer's prescription. Thus, the prepared media were autoclaved at 121˚C for 15 min. After sterilization, they were cooled and poured into Petri dishes and solidified under aseptic conditions.

2.6.3. Research and Enumeration of Germs

Inoculation was performed on the surface of the agar poured into the Petri dishes. For this purpose 0.1 mL of the raw and diluted juice (10^0, 10^{-1} and 10^{-2}) was plated with a platinum loop. Incubation was done at 30˚C ± 2 for Aerobic Mzsophilic Germs, 37˚C for Salmonella and total coliforms and 44˚C for *Escherichia coli* for 24 h in an incubator. Germ count was done by direct counting with a colony counter for Petri dishes with colony counts between 15 and 300. The number of germs (N) was determined according to the following formula:

$$N = \frac{\sum \text{Colonies}}{V \text{ mL}\left(n_1 + 0.1n_2\right) \times d_1} \tag{6}$$

N: number of germs per mL of product (CFU/mL);
ΣC: sum of colonies counted on all retained Petri dishes (CFU);
V: volume of solution deposited;
n_1: number of Petri dishes considered at the first dilution;
n_2: number of Petri dishes considered at the second dilution;
d_1: dilution factor.

2.7. Statistical Analysis

The results are presented in tables and figures. Statistica version 7.1 software was used for statistical analysis. Analysis of variance (ANOVA) followed by the Newman Keuls multiple comparisons test, at the 5% threshold, was used to rank all means. Means are followed by their standard deviation. Two means are different if the resulting probability is less than 5% ($P < 0.05$). The microbiological analysis of the juices was carried out using the ISO standards NF.

3. Results and Discussion

3.1. Results

3.1.1. Physico-Chemical Parameters of the Samples

The physico-chemical properties of bissap and Gnamankou beverages from the two sites are presented in Table 1. The results show that there is no significant difference between the values obtained ($p > 0.05$) for some of the parameters but a significant difference for others. The extractable matter content of the two types of beverages, expressed in Brix degree, varies from 14.08 to 15.48. It does not differ significantly for each type of drink from one site to the other at the 5% threshold. The analysis of the results indicates only the presence of vitamin C in the Gnamankou juices. The values of vitamin C content are 5.58 ± 1.34 and 4.67 ± 0.81 from site I and site II respectively (Table 1). The values obtained show no significant difference ($p > 0.05$). The pH values of the Bissap juice samples were lower (2.55 ± 0.09) and (2.47 ± 0.07) than those of the Gnamankoudji samples (3.49 ± 0.18) and (3.71 ± 0.85) at the CHU and school spaces respectively. With regard to these values, the Bissap juice is more acidic than the Gnamankoudji. The titratable acid values of Bissap juice (1.14 ± 0.20) and (1.55 ± 0.40) are relatively higher than those of Gnamankoudji juice (1.78 ± 0.22) and (1.66 ± 1.34)

Table 1. Physical and chemical characteristics of beverages.

Parameters	Site I		Site II	
	Bissap	Gnamankou	Bissap	Gnamankou
Brix degree	14.55 ± 4.36[a]	14.23 ± 2.70[a]	15.48 ± 2.21[a]	14.08 ± 4.03
pH	2.55 ± 0.09[a]	3.49 ± 0.18[b]	2.47 ± 0.07[a]	3.71 ± 0.85[b]
Titratable acidity	1.14 ± 0.20[a]	1.78 ± 0.22[a]	1.55 ± 0.40[a]	1.66 ± 1.34[a]
Water content (%)	80.13 ± 0.44[a]	84.93 ± 2.59[b]	83.65 ± 2.59[b]	85.21 ± 4.29[b]
Protein content (%)	0.78 ± 0.10[a]	2.11 ± 0.12[d]	1.15 ± 0.11[c]	0.92 ± 0.09[b]
Ash content (%)	0.70 ± 0.07[a]	0.89 ± 0.05[b]	0.91 ± 0.01[b]	0.75 ± 0.13[a]
Reducing sugars content (mg/mL)	1.20 ± 0.13[a]	3.13 ± 0.44[b]	1.40 ± 0.11[a]	3.34 ± 0.62[b]
Total sugar content (mg/mL)	695.96 ± 151.44[a]	827.78 ± 145.31[a]	812.50 ± 53.64[a]	1050.33 ± 459.75[a]
Vitamin C mg/100mL		5.58 ± 1.34[a]		4.67 ± 0.81[a]

Site I: restaurant in front of the UHC; site II: restaurant in front of the schools. (a, b, c) Values in the same row, assigned the same letter are not significantly different ($p > 0.05$) *Each value is the mean standard deviation of 3 trials.

respectively in the university and school areas. Analysis of the results reveals that total sugars and water are the parameters with high values (695 ± 154.44 to 1050 ± 459.75 mg/mL) and (80.13 ± 0.44 to 85.21 ± 4.29) respectively. The base values were obtained with the parameters of ash (0, 70 ± 0.07 to 0.91 ± 0.01 and protein (0.78 ± 0.10 to 2.11 ± 0.12). However, the content value of the parameters of Gnamankou juice is higher than that of Bissap juice. There is a significant difference between the values of protein, ash and water content ($p < 0.05$). For the other parameters (total and reducing sugars) the values obtained do not show any significant difference.

3.1.2. Mineral Content of Beverages

The results show that there is no significant difference between the values obtained ($p > 0.05$) for some parameters, however a significant difference for others. The analysis of the results of the mineral composition of the juices notes that potassium is the most concentrated mineral in the juices (Table 2). However, this concentration of potassium is higher in Gnamankou juices (17.94 ± 1.20 and 7.08 ± 5.33) in site I and site II respectively than in Bissap juices (9.34 ± 1.00 and 5.14 ± 2.95) in site I and site II respectively. The minerals less concentrated in the juices are calcium (0.01 ± 0.0 and 0.03 ± 0.01) and iron (0.02 ± 0.00 and 0.07 ± 0.02). However, they are relatively more concentrated in Bissap (0.03 ± 0.01) calcium and (0.07 ± 0.02) iron than in Gnamankou (0.01 ± 0.0) calcium and. (0.02 ± 0.00) iron. Minerals such as phosphorus and magnesium have intermediate concentrations between the extremes.

3.1.3. Microbiological Quality of Beverages

Mesophilic Aerobic Germs (MAG), *Eschericha coli*, Salmonella and total coliforms were analyzed in the beverages. The results of the analysis show the presence only of Mesophilic Aerobic Germs in all the samples. This presence is relatively

Table 2. Mineral content of beverages.

Mineral salts	Site I		Site II	
	Bissap	Gnamankou	Bissap	Gnamankou
Magnesium (mg/g)	1.26 ± 0.11^{b}	1.39 ± 0.07^{b}	1.09 ± 0.06^{a}	1.01 ± 0.16^{a}
Calcium (mg/g)	0.03 ± 0.00^{c}	0.02 ± 0.00^{b}	0.03 ± 0.01^{bc}	0.01 ± 0.00^{a}
Phosphorus (mg/g)	1.37 ± 0.48^{a}	1.83 ± 0.12^{b}	1.37 ± 0.06^{b}	1.44 ± 0.12^{a}
Potassium (mg/g)	9.34 ± 1.00^{a}	17.94 ± 1.20^{b}	5.14 ± 2.95^{a}	7.08 ± 5.33^{a}
Iron (mg/g)	0.07 ± 0.02^{c}	0.05 ± 0.01^{b}	0.06 ± 0.01^{bc}	0.02 ± 0.00^{a}

Site I: restaurant in front of the UHC; site II: restaurant in front of the schools. (a, b, c) Values in the same row, assigned the same letter are not significantly different ($p > 0.05$) *Each value is the mean standard deviation of 3 trials.

Table 3. Microbial flora of beverages.

Germes	Site I		Site II	
	Bissap	Gnamankou	Bissap	Gnamankou
Mesophilc Aerobic Germs (ufc/mL)	1.4×10^5	4×10^5	1.5×10^5	2.5×10^5
E. coli (ufc/mL)	Absence	Absence	Absence	Absence
Tidal coliforms (ufc/mL)	Absence	Absence	Absence	Absence
Salmonella ufc/mL	Absence	Absence	Absence	Absence

more important in the Gnamankou juices (4×10^5 and 2.65×10^5) than in the Bissap juices (1.4×10^5 and 1.5×10^5) respectively site I and site II. Other germs (*Eschericha coli*, salmonella and total coliforms) were absent in all samples (Table 3).

3.2. Discussion

Drinks prepared from dry calyxes of Guinea sorrel and rhizome of Ginger, called respectively Bissap and Gnamankou, are commonly consumed by a good part of the Ivorian population. This study wants to contribute to the valorisation of these drinks by determining the notional value and the microbiological quality of them. The results showed that the pH values and titratable acidity of these two beverages are acidic confirming the results of the work of [12]. This acidity allows a good conservation of these drinks which contain added sugar. The pH values are consistent with recommendations for acidic foods with pH values between 3.0 and 4.0 [13]. The Brix values obtained are in the same range as those reported by [14]. The nutritional properties of Bissap and Gnamankou juices were analyzed on the basis of their contents of water, total protein, total and reducing sugars, ash and mineral elements. The water content values of the two juices (80.13% and 85.21%) are consistent with the water content values (80% - 95%) in fruit and vegetable juices reported by [13]. These results and those of these authors, show that water is abundant in beverages. Thus, their consumption allows to satisfy the water needs of the body, whose recommended intake

varies between 1.5 and 2 L/day [15]. In addition, water adds weight to food without providing excess energy. The values of protein content of the juices obtained (0.78 ± 0.10 and 2.11% ± 0.12%) confirm the results of [16] obtained from fresh beet juice but lower than the values obtained by [17] from fruit juice. However, these authors indicated that the value of protein content of fruit juice does not exceed 3.5%. The values of total and reducing sugars contents of the juices ranged from 695.96 to 1050.33 mg/L and 1.20 to 3.34 mg/L respectively Bissap and Gnamankou juice. These results show that the juices have a high sugar content. Regarding the values of total sugar content, the comparison of these values with those of orange juice of the work done by [12] or the value of the content varied between 9.15 and 14.25 mg/L shows that the values of the content (695.96 to 1050.33) of the present study are largely higher than those (9.15 and 14.25) of these authors. Indeed, this difference could be explained by the nature of the ingredients used for the preparation of the juices but also by the addition of a certain amount of sugar. The value of the reducing sugar content obtained indicates that Gnamankou juice contains more reducing sugars than Bissap. These values were comparable to those (2.49 and 4.90 mg/L) that [18] obtained with soybean and carrot juice. The content of reducing sugars in soy and carrot juices and especially in Gnamankou juice may constitute a nutritional risk factor for people who consume them regularly and especially for those who suffer from Diabetes [19]. Indeed, foods rich in reducing sugars, called fast sugars, are also foods with a high glycemic index. The ash content values of the juices (0.07 ± 0.07 and 0.91 ± 0.01) are low. These values of ash content were compared with those of different brands of fruit juices (0.64 to 1.32). From this comparison, it appears that the low ash content is a consequence that they are not an important source of minerals [12]. Bissap and Gnamankou juices contain the mineral elements in varying amounts. Potassium appears to be the most abundant mineral in the juices (5.14 ± 2.95 to 17.94 ± 1.20). The less abundant minerals are calcium (0.01 ± 0.00 to 0.03 ± 0.00) and iron (0.07 ± 0.02 to 0.02 ± 0.00). In general, Gnamankou juice contains more potassium and phosphorus and less magnesium than Bissap. These differences of variations in mineral elements can be explained by the differences of composition of the rhizome and calyxes. The interest of this difference could be used for prevention and treatment for people at risk [20]. The analysis of the vitamin C content showed that Gnamankou juice contains vitamin C with values ranging from 4.67 mg/100mL to 5.58 mg/100mL, whereas Bissap juice does not contain any. However, the presence of vitamin C in the flowers of different varieties of Hibiscus sabdariffa has been reported [21]. The results of these authors seem to indicate that the stability of vitamin C in the flowers used for the preparation of Bissap juice is low. Therefore, the vitamin C would be destroyed during the cooking process applied to the preparation. In the literature, very little work has been done on the microbiological characteristics of Bissap and Gnamankou. There are no specific standards for these two drinks. Consequently, the values obtained will be compared to the quality standards in force for the drinks. Ac-

cording to), there is not a close relationship between a high value of total flora and the presence of pathogenic microorganisms. The values obtained for the growth of germs (aerobic mesophilic germs) are between 1.4×10^5 and 4×10^5 (cfu/mL). These results indicate the growth of aerobic mesophilic germs in all samples and the absence of total coliforms, salmonella and *E. coli*. These results are similar to those of [22] who found mesophilic aerobic germs and the absence of germs such as Salmonella, *E. coli* and total coliforms in juices of two varieties of Bissap. The presence of aerobic mesophilic germs (AMG) could be due to the artisanal conditions, the personnel and the material used for their production. The addition of sugar at the end of juice production could also justify the microbial development observed in the present study. It would be interesting to consider a pasteurization of the juices before their conditioning and their sale. This thermal action could eliminate all this microbial load coming from the environment, the personnel and the material used during the production of these drinks. The absence of pathogenic germs is a good proof that the consumption of the juices does not present any risk for the health of the numerous consumers.

4. Conclusion

The work carried out on the Bissap and Gnamankou juices allowed us to know the nutritional and sanitary quality of these drinks. The nutritional properties studied (water content, titratable acidity, total proteins, total and reducing sugars, ash, mineral elements and vitamin C) vary from one matrix to another. This variation of all the studied parameters brings the nutritional quality of the drinks well appreciated by all the franks of the population. The juices (Bissap and Gnamankou) have a satisfactory microbiological quality because they are free of pathogenic germs. The presence of aerobic mesophilic germs could be linked to the different manipulations and the non-pasteurization of these juices.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Wong, P.K., Yusof, S., Ghazali, H.M. and Man, Y.C. (2002) Physico-Chemical Characteristics of Roselle (*Hibscus sabdariffa L*). *Nutrition & Food Science*, **32**, 68-73. https://doi.org/10.1108/00346650210416994

[2] Cisse, M., Dornier, M., Sakho, M., Ndiaye, A., Rebers, M. and Sock, O. (2009) Le bissap (*Haibiscus sabdariffa* L.): Composition et principales utilizations. *Fruits*, **64**, 179-193. https://doi.org/10.1051/fruits/2009013

[3] Singh, G., Kappoor, I.P.S., Heluani, C.S., Lampasona, M.P. and Catalan, C.A.N. (2008) Chemistry, Antioxidant and Antimicrobial Investigations on Essential Oil Andoleoresins of *Zingiber officinale*. *Food and Chemical Toxicology*, **46**, 3295-3302. https://doi.org/10.1016/j.fct.2008.07.017

[4] Parthasarathy, V.A., Chempakam, B. and Zachariah, T.J. (2008) Chemistry of Spic-

es. CAB International, Wallingford, 70-93.
https://doi.org/10.1079/9781845934057.0000

[5] Prakash, D., Upadhyay, G., Gupta, C., Pushpangadan, P. and Singh, K.K. (2012) Antioxidant and Free Radical Scavenging Activités of Some Promising Wild Edible Fruits. *International Food Research Journal*, **19**, 1109-1116.

[6] AOAC (Association of Official Analytical Chemists) (2004) Official Methods of Analysis. 20th Edition, Association of Official Analytical Chemists, Washington DC, 1058-1059.

[7] AOAC (Association of Official Analytical Chemists) (1980) Official Method of Analysis. 7th Edition, Association of Official Analytical Chemists, Washington DC, 595 p.

[8] BIPEA (Bureau Interprofessionel d'Etudes Analyitiqueq) (1976) Recueil des méthodes d'analyses des communautés européennes. Bureau Interprofessionel d'Etudes Analyitiqueq, Genne-villiers, France, 140.

[9] Bernfeld, P. (1955) Amylase α and β. *Methods in Enzymology*, **1**, 149-158.
https://doi.org/10.1016/0076-6879(55)01021-5

[10] Dubois, M., Gilles, K., Hamilton, J.D., Rebers, A. and Smith, M. (1956) Colorimetric Methods for Determinaiton of Sugars and Related Substance. *Analytical Chemistry*, **28**, 350-356. https://doi.org/10.1021/ac60111a017

[11] AOAC (Association of Official Analytical Chemist) (2005) Official Methods of Analysis. 18th Edition, Washington DC.

[12] Ndife, J., Awogbenja, D. and Zakari, U. (2013) Comparative Evaluation of the Nutritional and Sensory Quality of Different Brands of Orange-Juice in Nigerian Market. *African Journal of Food Science*, **7**, 479-484.
https://doi.org/10.5897/AJFS2013.1060

[13] Kirk, R. and Sawyer, R. (1997) Pearson's Composition and Analysis of Foods. Chemical Polishing, New York, 9-11.

[14] Haque, M.N., Saha, B.K., Karim, M.R. and Bhuiyan, M.N.H. (2009) Evaluation of Nutritional and Physico-Chemical Properties of Several Selected Fruits in Bangladesh. *Bangladesh Journal of Scientific and Industrial Research*, **44**, 353-358.
https://doi.org/10.3329/bjsir.v44i3.4410

[15] EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA) (2010) European Food Safty Authority Scientific Opinion on Dietary Reference values for Water. *EFSA Journal*, **8**, 1459. https://doi.org/10.2903/j.efsa.2010.1459

[16] Emelike, N.J.T., Hart, A.D. and Ebere, C.O. (2015) Influence of Drying Techniqueson the Properties, Lkphydicochemical and Mineral Composition of Beetroot Juice. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, **9**, 20-26.

[17] Jahan, S., Gosh, T., Bigum, M. and Saha, B.K. (2011) Nutritiona Profile of Some Tropical Fruits in Bangladesh: Especially Anti-Oxidant Vitamins and Minerals. *Bangladesh Journal of Medical Science*, **10**, 95-103.
https://doi.org/10.3329/bjms.v10i2.7804

[18] Banigo, E.B., Kiin-Kabari, D.B. and Owuno, F. (2015) Physicochemical Andsensory Evaluation of Soy/Carrot Drinks Flavoured with Beetroot. *African Journal of Food Science and Technology*, **6**, 136-140.

[19] Messing, B, and Billaux, M.S. (1996) Biodisponibilité des glucides des aliments. Arnette Blackwell Publish, Paris, 21-44.

[20] Hinunpanich, V., Utaipat, A., Morales, N.P., Bunyapraphatsara, N., Sato, H., Herunsale, A. and Suthisisang, C. (2006) Hypocholesterolemic and Antioxidant Effects

of Aqueous Extracts from the Dried Calyx of *Hibiscus sabdariffa* L. in Hyperchilesterolemic Rats. *Journal of Ethnopharmacology*, **103**, 252-260. https://doi.org/10.1016/j.jep.2005.08.033

[21] Babalola, S.O., Babalola, A.O. and Aworh, O.C. (2001) Compositional Attrivutes of the Calyces of Roselle (*Hibiscus sabdariffa*). *Journal of Food Technology in Africa*, **6**, 133-134. https://doi.org/10.4314/jfta.v6i4.19306

[22] Ndiaye, N.A., Dieng, M., Kane, A., Cisse, M., Montet, D and Toure, N.C. (2015) Diagnostic et caractérisation microbiologique des procédés artisanaux de fabrication de boissons et de concentrés d'Hibiscus sabdariffa L. au Ssénégal. *Afrique Science*, **11**, 197-210.