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Research Article

PHYSICO-CHEMICAL AND SENSORIAL CHARACTERIZATION OF COCONUT WATER SUGARS FROM COCONUT PALMS (COCOS NUCIFERA L.) VARIETIES IN CÔTE D'IVOIRE

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A B S T R A C T

Sugar quality is related to its composition in certain parameters such as bacteriology, colouring, the granulometrie, the aspect, the ash. Several types of sugar resulting from various sources exist. However, a new sugar find by research which improve the population health is vital. It is within framework that the physicochemical characteristics of sugars extracted from immature coconut water was determined. Another, this study has never been does in Côte d'Ivoire. Thus, pH, acidity, ashes, dry matter, relative density, °Brix, the total and reducing sugars, the proteins and lipids of these sugars were evaluated in this study. Through a descriptive test, sensory analysis was also performed. The results confirmed the poverty in proteins (≤ 1 g / 100 g) and in lipids (1 to 3 g / 100 g) of coconut water sugar. Syrups have similar pHs among the 5 varieties (4. 94 to 5.02). It is the same for white sugars (pH 5.13 to 5.32) unlike with brown sugars (pH 4.05 at 4.92). High ash levels (3 to 7 %) for all sugars, are higher in WAT, MYD and PB121 varieties. In addition, the sugars of the WAT, MYD and EGD varieties contain more Brix (74.02 to 87.56%) than the two hybrids PB121and PB113 (69 to 74.22). The contents in total sugars (21.44 to 32.07 g / 100 g DM) and reducing agents (9.87 to 19.03 g / 100 g DM) are significantly different ($p < 0.05$) among the 5 varieties studied. The highest sugar levels are provided by the dwarf varieties (MYD and EGD). Regarding the sensory profile, all sugars have obtained marks above 5 for overall satisfaction provided the jury. The sugars of EGD and MYD were the most appreciated. 78% of the panelists think that coconut water sugar can substitute ordinary sugar (sucrose) in the preparations and 91% of them are ready to buy in case of sale. This is due to the fact that 95% find these sugars pleasant to eat with a characteristic smell of caramel and copra.

INTRODUCTION

The coconut tree is a plant whose culture is adapted to tertiary and quaternary soils of the littoral. Côte d'Ivoire is the first African country exporter of coconut products with an output of more than 51000 tons of copra per year (CNRA, 2014). This crop can feed more than 20000 families on the coast (Konan *et al.*, 2006). Since the withdrawal of the ivorian state of the entrepreneurial sphere to the private sector (Contamin, 1994), food manufacturing is crucial for improve the primary motivations and farmer benefices. This induces an incomes optimization of the concerned actors. Thus, several research tasks has been done on the transformation of edible parts of the coconut (Assa *et al,* 2007; Konan *et al*, 20 13; Kodjo *et al*, 2015). However, these investigations are still limited to solve the problem of the very low coconut water valorisation in Côte d'Ivoire.

Such as alternative, white sugar, brown sugar and syrup were produced from immature coconut water from 5 cultivars (Lathro *et al*., 2018).

Sugar production is the one of the main links in agribusiness in Côte d'Ivoire and is be made at the artisanal, semi-industrial and industrial level (MINAGRI, 2012 b). However, do the sugars thus produced possess nutritional values and acceptable

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organoleptic parameters? Indeed, no study has reported the biochemical properties of sugars extracted from coconut water from varieties grown in Côte d'Ivoire. This work aims to assess the physico-chemical and organoleptic parameters of brown sugars, white sugar and syrup products with water of five varieties most cultivated in Côte d'Ivoire.

MATERIAL AND METHODS

Plant material

The plant material consists of three categories of sugars including brown sugar, white sugar and syrup extracted to the water of each of the West Africain Tall (WAT), Equatorial Green Dwarf (EGD), Malaysia Yellow Dwarf (MYD), Port-Bouët 121 improved(PB121) and Port-Bouet 113 improved (PB113) previously produced. The coconuts used were all immature (8 and 9 months). After harvest, the coconuts were processed in less than 24 hours for the extraction of water and for the production of sugars. In addition, the cane sugar bought at the supermarket served as a control for the sensory test.

Methods

Physicochemicals analyses

The pH and soluble dry matter (DM-S) were obtained by direct reading respectively with a pH meter (HANNA, Bucharest, Romania) and a refractometer (DIGIT 032 ATC Refractometer). Dry matter (DM) and total ash content were determined by the AOAC (1990) method.

The relative density (RED) was determined by measuring the mass of 1 mL of diluted solution, using a precision electronic balance 0.01 (Sartorius). The solution is obtained by diluting 5 g of syrup/sugar in 10 mL of distilled water. The relative density is given by the relation:

RED = $(M_{syrup} / V_{syrup}.\rho_{water}).fd$ with M and V= mass and volume of syrup or sugar, fd = dilution factor.

The titrable acidity content (TAC) was measured titrimetrically with sodium hydroxid solution (0.1N). Phenolphthalein was taken as a colored indicator and the end of the assay was marked by a persistent pink bend.

TAC = [Nb.Vb/ Va.Ma] with Nb: normality of soda, Vb : versed volume of soda, Va : volume of sugar solution, Ma : sugar mass.

The fat was extracted with Soxhlet (standard NF V03-905) with the fresh material. For the determination of proteins, the colorimetrics methods of Lowry *etal,* (1951) for the syrupsand Sedmak and Grosberg (1977) for white and brown sugars were used. Total carbohydrates, total sugars and reducing sugars contents were determined respectively by the methods of Dubois *et al.* (1956) and Bernfeld (1955).

All the analyses were achived in triplicates

Sensory analyzes

Sensory profile of sugars in immature coconut water

Sensory profile of three sugars categories was tested in 3 sessions during three days with 25 sample group subjects. Six (6) dilutions were made from 5 g of syrup in 1000 mL of mineral water. This action was repeated for the white and brown sugars for all varieties. Also, 5 g of brown cane sugar (control) was prepared under the same conditions. The quantities was set according to the maximum values of sugars, acidity and ash determined in sugars following physicochemical analyzes and taste tests carried out. One sugar category accompanied by the control sugar, was evaluated per session and per day. Each taster, five (5) mL of solution prepared (6 samples = 5 varieties + 1 control) are presented in disposable plastic glasses of white color. The sensory attributes tested were the sweet taste, appearance, color, aroma. The intensity of each attribute was evaluated on a scale of proposed assessment ranging from « 1 = very unpleasant » at «9 = very nice ». For evaluation of the color attribute, subjects were inspired by a sheet with a range of colors enabling connect a specific color to the sample by identification

Tests of consumption, acceptability and purchase of sugars

Its tests were made with a jury of 75 people who were pronounced on consumption, acceptance and purchase agreement of sugar extracted from coconut water. The questionnaire has comport four topics. There are« the substitution of the standard sugar by coconut water sugar », « you accept to integrate in your eating habits the the coconut water sugars »? If coconut water sugar was to commercialize, « would you buy it »? If so, « at what price »? Panelists should check in one of the boxes bearing the words YES and NO to each item.

Solubility of coconut water sugar

The solubility of sugars has been tested according to the principle of Romain et *al*., 2011 based on the fact that 66.7 °B corresponds to 200.5 K_S with K_S corresponding the solubility coefficient.

RESULTS AND DISCUSSION

Results

Physico-chemical parameters of syrups from coconut water

The results presented in table 1 show that relative density (RED) of the syrup is between 2.96 ±0.41 (MYD) and 3.77 ± 0.015 (EGD). These values discriminate varieties in two groups statistically different at 5% threshold. Varieties WAT, EGD and PB121 constituted the first group (3, 65 to 3.77) while the MYD and PB113 form the second group with the lowest density values (2.96 to 3.12). The pH changes very little, from 4.94 ± 0.02 (NJM) to 5.02 ± 0.11 (PB113) (Table1). Titrable acidity content (TAC) vary between 0.54 ± 0.2 and 0.66 % ± 0.02. Dry matter (DM) range from 81.93 % ± 0.017 (PB121) to 85.37 % ± 0.02 (MYD) and subdivises the varieties in two groups (Table 1). The syrups varieties MYD, EGD and PB113 have statistically the same dry matter contents (85.37 % ±0.02, 83.11 % ± 0.02 and 84.24 % ± 0.15). Syrups are not source oflipid with contents ranging from 1.94 ± 0.98 to 3.07 ± 0.26 g / 100 g DS and even less protein source (≤ 1 g / 100 g).

The total sugars content (TSC) and reducing sugars (RS) are all statistically different ($p < 0.05$) at the 5 % threshold. Their values change 21.44 g / 100 g (PB113) to 31.07 g / 100 g (MYD) for total sugars and from 9.87 ± 0.25 (PB113) to 19.03 g / 100 g ± 1.55 (EGD) for reducing sugars for all varieties (Table 1). The ash contents are relatively important and are ranging between 3.65 % ± 0.35 (PB113) and 6.80 % ± 1.15 (WAT) according to the varieties. Finally, at the 5 % probability, the soluble solids content (DM-S) of syrups are all statistically different with significant valuesranging from 69.04 % ± 1.35 (PB113) and 80.64 % ± 0.26 (WAT). Thus, the WAT syrup followed by those of the two dwarves have the highest levels with respectively 80.64 ± 0.26; 78.64 ± 0.33 and 74.02 ± 0.57 g / 100 g of syrup.

The analysis of variance on the physicochemical characteristics of white sugar has indicated a

Table 1 Physicochemical parameters of the syrup of immature coconut water

Variables (SI)	WAT +	MYD	EGD	PB121	PB113	*P-value*
RED	3.65 ± 0.02^{a}	2.96 ± 0.15^{b}	3.77 ± 0.0^{a}	3.67 ± 0.07^{a}	3.12 ± 0.40^{b}	**0,002**
pH	4.95 ± 0.01^{a}	4.94 ± 0.02^{a}	5.01 ±0.02^{ba}	5.01± 0.02^{ba}	5.02 ± 0.11^{ba}	**0,051**
TAC	0.66 ± 0.02^{a}	0.64 ± 0.35^{a}	0.56 ± 0.01^{b}	0.54 ± 0.02^{b}	0.56 ± 0.25^{b}	**0,032**
DM (g/100g)	82.07 ± 0.03^{a}	85.37 ± 0.02^{b}	83.11± 0.02^{c}	81.93±0.17^{da}	84.24 ± 0.15^{e}	**0,042**
Fat (g/100g)	3.07 ± 0.26^{a}	2.12 ± 1.25^{b}	1.94 ± 0.98^{b}	2.85 ± 0.05^{e}	2.82 ± 1.08^{e}	**0,001**
RS (g/100g)	11.18 ± 0.45^{f}	18.47±0.25^{h}	19.03± 0.55^{i}	14.37± 0.25^{d}	9.87 ± 0.27^{p}	**<0,001**
TS(g/100g)	25.85±0.53^{t}	31.07±0.35^{g}	28.04±0.05^{a}	29.05± 0.30^{a}	21.44 ± 0.31^{c}	**0,014**
Pr (g/100g)	0.93 ± 0.02^{a}	0.92 ± 0.35^{a}	0.83 ± 0.41^{b}	0.69 ± 0.18^{c}	0.96 ± 0.28^{a}	**0,022**
Ash (g/100g)	6.80 ± 1.25^{a}	6.21 ± 0.85^{c}	4.77 ± 0.53^{b}	6.25 ± 0.25^{c}	3.65± 0.35^{f}	**0,001**
DM-S (%)	80.64 ± 0.26^{e}	74.02 ± 0.57^{d}	78.64± 0.33^{c}	69.53± 1.05^{b}	69.04 ±1.35^{b}	**0,010**

RED: Relative density, TAC: Titrable acidity, DM: dry matter, TS: Total sugar content, RS: Reducing sugar content, Pr: Protein content, DM-S: Soluble Solids Total
On the same line, averages ± standard deviations having the same small letter in superscript are statistically identical.Different superscript letters indicate a significant difference at the 5% probability level.

Physicochemical parameters of brown and white sugars extract of coconut water

The brown sugar of coconut water is characterized by an acid pH ranging from 4.05 ± 0.5 for MYD to 4.92 ± 0.8 for EGDand significantly differentiates the varieties studied. The titrable acidity content (TAC) is 0.44 ± 0.38 (PB121) and 0.56 acidequivalent g / 100 g ± 0.30 (WAT). The lowest dry matter content (86.37 g / 100 g ± 0.37) is provided by brown sugar of PB121, the highest (92.24 g / 100 g ± 0.15) is provided by PB113and WAT.

There is not more 1% protein in brown sugars. Also, lipid vary between 2 and 3 % (Table 2).

Total sugar content (TSC) of the 5 types of brown sugars are significanty different between varieties with contents of 22.14 ± 0.53 for PB113 and 32.07 ± 0.85 g/100 g for MYD. Nevertheless, the sugars of EGD and PB121 have the same rate of total sugar (30.04 g/100 g ±0.75 and 30.00 g / 100 g ± 0.39 respectively).

Reducing sugars are present in identical or different concentrations between sugars (p> 0.05) (Table 2). The analysis of variance ANOVA showed that the brown sugars of WAT, MYD and PB121 have ash contents statistically identical (p>0.05). Sugars of varieties PB113 and EGD also have, between them, similar ashes rate (5.87 and 4.65 g / 100 g of DM). Soluble solids content (DM-S) is between 71.04 ± 1.55 (PB113) and 82.05 g / 100 g ± 0.24 (WAT). There is no significant difference (p>0.05) between the levels of the two hybrids PB113 and PB121 (71.04 % ± 1.55 and 71.53 % ± 1.02) unlike those of sugar WAT, MYD and EGD (p < 0.05).

density statistically similar between WAT and PB113with respective values 4.58 ± 0.1 0 to 4, 64 ± 1.05. The same is true for white sugars of the MYD and EGD varieties (4.82 ± 0.15 and 4.95 ± 0.28 respectively). The pH of sugars ranging between 5.13 and 5.32 is statistically identical for WAT, EGD and PB121. There is no significant difference between the pH of the sugar of MYDand PB113. Since the pH is directly proportional to the titrable acidity, the values (TAC) range from 0.40 ± 0.01 to 0.47 ± 0.17 acid equivalent g/ 100 g of sugar (Table 3). The dry matter contents (DM) is between 94.46 and 96.00 g / 100 g and are statistically identical to the 5% probabilitythreshold despite the slight differences observed between them (Table 3). White sugar of PB113has the highest dry matter value (96.00 g / 100 g ± 0.02). Protein proportions are lowest in white sugars of immature coconut water followed by lipid proportions with rates ranging from 1.74 (EGD) to 2.16 g / 100 g (PB113). With regard to the reducing sugar content, there is a significant difference (p <0.05) between the varieties. Really, the dwarfs varieties (MYD and EGD) have had the highest rates of total sugars and reducing sugars. The sugars rates vary from 10.51 g / 100g (PB113) to 18.95 g/100g (EGD) for reducing sugars and from 21.76 g / 100 g (PB113) to 30.24 g / 100 g (MYD) for total sugars. White sugars, brown sugars and syrup have a large mineral mass that significantly differentiates the 5 varieties of coconut palms studied. This reflected ashes rates ranging from 4.21 g / 100 g (PB113) to 6.49 g / 100 g (WAT) dry matter (Table 3).

Table 2 Physicochemical parameters of brown sugar fromimmature coconut water

Variables (SI)	WAT	MYD	EGD	PB121	PB113	+*P-value*
RED	4.66 ± 0.35^{a}	3.96 ± 0.50^{b}	4.77 ± 0.15^{a}	4.65 ± 0.57^{a}	4.13 ± 0.15^{c}	**0,032**
pH	4.05 ± 0.11^{a}	4.50 ± 0.40^{c}	4.90 ± 0.35^{b}	4.92 ± 0.29^{b}	4.92 ± 0.81^{b}	**0,045**
TAC	0.56 ± 0.30^{t}	0.54 ± 0.45^{t}	0.46 ± 0.60^{r}	0.44 ± 0,38^{r}	0.46 ± 0.25^{r}	**0,047**
DM (g/100 g)	92.07 ± 0.26^{q}	88.35 ± 0.28^{b}	90.15 ±0.27^{c}	86.37 ±0.37^{d}	92.04 ± 0.15^{q}	**0,025**
Fat (g/100 g)	3.27 ± 0.36^{a}	2.62 ± 1.52^{b}	2.04 ± 0.98^{c}	2.87 ± 0.05^{d}	2.88 ± 1.08^{d}	**0,001**
RS (g/100 g)	15.11 ± 0.45^{y}	18.67 ± 0.20^{t}	19.01 ± 0.20^{t}	15.35 ± 0.15^{y}	10.87 ± 0.25^{g}	**0,031**
TSC(g/100 g)	26.85 ± 0.5 ^{i}	32.07 ± 0.85^{d}	30.04 ±0.75^{k}	30.01±0.35^{k}	22.14 ± 0.3^{l}	**0,040**
Pr (g / 100 g)	0.95 ± 0.20^{a}	0.82 ± 0.30^{b}	0.89 ± 0.41^{b}	0.65 ± 0.18^{c}	0.95 ± 0.08^{a}	**0,012**
Ash (g / 100g)	7.00 ± 1.50^{a}	6.81 ± 0.51^{a}	5.87 ± 0.65^{b}	6.85 ± 0.45^{a}	4.65 ± 0.25^{b}	**0,035**
DM-S (%)	82.54 ± 0.24 ^{a}	75.02 ± 0.50^{b}	78.64 ± 0.33^{c}	71.53 ± 1.02^{d}	71.04 ± 1.55^{d}	**<0,001**

On the same line, averages ± standard deviations having the same small letter in superscript are statistically identical. Different superscript letters indicate a significant difference at the 5% probability level.
RED: Relative Density, TAC: Titrable acidity, DM: Dry matter, RS: Reducing sugar, TSC: Total sugar content, Pr: Protein content, DM-S: Total Soluble solids.

Table 3 Physicochemical parameters of white sugar from immature coconut water

Variables (SI)	WAT	MYD	EGD	PB121 $^{+}$	PB113*P-value*
RED	4.58 ± 0.10^{b}	4.82 ± 0.12^{a}	4.95 ± 0.28^{a}	4.74 ± 0.35^{ab}	4.64 ± 1.05^{b}**0,014**
pH	5.32 ± 0.0^{a}	5.13 ± 0.07^{b}	5.30 ± 0.05^{a}	5.20 ± 0.0 ^{a}	5.14 ± 0.10^{b}**0,021**
TAC	0.43 ± 0.01^{g}	0.47 ± 0.73^{gb}	0.40 ± 0.11^{g}	0.42 ± 0.52^{g}	0.40 ± 0.57^{g}**0,040**
DM (g/100 g)	95.14 ± 0.02^{c}	94.46 ± 0.18^{c}	95.04 ± 0.43^{c}	94.78 ± 0.21^{c}	96.00 ± 0.02^{d}**0,048**
Fat (g/100 g)	2.02 ± 1.25^{a}	1.98 ± 0.25^{a}	1.74 ± 0.45^{b}	2.04 ± 0.62^{a}	2.16 ± 0.34^{a}**0,032**
RS (g/100 g)	11.42 ± 2.54^{h}	18.84 ± 0.30^{e}	18.95 ± 0.02^{e}	14.23 ± 0.53^{i}	10.51 ± 0.02^{d}**0,029**
TSC (g/100g)	25.45 ± 0.37^{a}	30.24 ± 0.04^{b}	27.87 ± 0.34^{c}	23.53 ± 0.50^{d}	21.76 ± 0.30th**0,001**
Pr (g/100g)	0.73 ± 0.25^{g}	0.74 ± 0.28^{g}	0.73 ± 0.20^{g}	0.56 ± 0.15^{h}	0.66 ± 0.38^{d}**0,033**
Ash (g/100 g)	6.49 ± 0.24^{a}	5.65 ± 0.46^{b}	4.61 ± 0.23^{c}	5.31 ± 0.27^{d}	4.21 ± 0.47^{c}**0,045**
DM-S (%)	87.56 ± 0.11^{a}	82.56 ± 0.15^{b}	82.50 ± 0.01^{b}	74.22 ± 0.06^{c}	81.24 ± 0.30^{d}**0,039**

On the same line, averages ± standard deviations having the same small letter in superscript are statistically identical. Different superscript letters indicate a significant difference at the threshold of 5 % of probability.RED: Relative Density, TAC: Titrable acidity, DM: Dry matter,SR: Reducing sugar levels, TSC: Total sugar content, Pr: Protein content, DM-S: Total Soluble solids.

Sensory profile of sugars extracted from the water of 5 coconut cultivars

After post hoc test, the significant differences according to Tukey, the overall satisfaction of panelists has permit to bring the syrups, brown and white sugars into three groups. For syrups, the first group includes EGD and MYD varieties with the highest scores (6.60 and 6.30 respectively). The second group consists syrups WAT, PB121 and MYD with respective gradations of 5.90; 5.90 and 6.30. Finally, syrups of WAT, PB121 and PB113 varieties and cane brown sugar (BCS) taken as control (5.60) form the third group. According to the values and analyzes, the WAT and the PB121 belong to both the second and third groups. According the ANOVA test, one variety can to be in two groups.

In the case of brown sugar of coconut water, overall satisfaction expressed by the jury also divided into three groups. Thus, the EGD sugar with the highest average (8,10) is in itself the first group.The second group consists of WAT and MYD sugars with overall satisfaction ratings of 6.60 and 6.50 respectively. Finally, the third group consists of the sugars of the two hybrids PB121 and PB113 and brown cane sugar with respective scores of 5.70 ; 5.50 and 5.30. In addition, the scores of all sensory attributes are generally greater than 5 (Figure 1).

The white sugar of coconut water has a sweet taste similar to that of brown cane sugar. The first group is formed by a single white sugar of EGD variety (8.00 ± 0.58) whereas the second group consists of two varieties that are WAT and MYD(6.50 ± 0.70 and 6.50 ± 0.75). Finally, the third group is constituted two hybrids (PB121 and PB113) and brown cane sugar (control) with scores overall satisfaction statistically identical (5.70 ± 0.70, 5.50 ± 0.80, 5.30 ± 0.50).

All in all, the brown sugar, white sugar and the syrup from coconut water were differently appreciated by the jury. The satisfactions degree are significantly different at the level of the variety WAT ($p = 0.02$) with notes of 7.10 (brown sugar), 6.50 (white sugar) and 5.90 (syrup). It is the same for the MYD variety ($p = 0.02$) with respective scores of 7.30 ; 6.50 and 6.30 and the variety EGD ($p < 0.001$) which recorded the notes of 7.80 (brown sugar), 8.00 (white sugar) and 6.60 (syrup). However, thethree sugars categories gave the jury the same degree of satisfaction for the varieties PB121 (5,90 ; 5.70 ; 5.90) and PB113 (5.50; 5.50 and 5.60) which is close to the cane brown sugar witness (5.30).

The brown and white sugars of coconut water achieved high scores of « overall degree of satisfaction » compared to syrups (Figure 1).

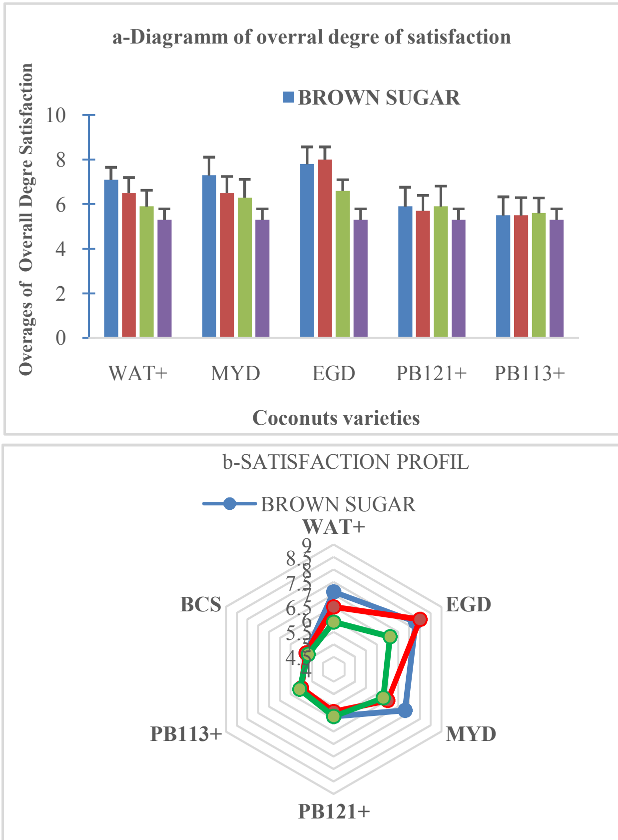

Figure 1 Diagram (a) and sensory profil (b) indicate the overall satisfaction of coconut watersugar

Tests for consumption, acceptability and purchase of coconut sugars

The introduction of coconut water sugar in people's eating habits necessarily involves her acceptance, purchase and consumption by the target populations. For this reason, these aspects were evaluated with the help of a cohort of 75 people. Thus, for the possibility of substitution of regular sugar, 78.26 % of panelists were unanimous in contrast to 14.24 % of those who answered « No ». In addition, 7.5 % answered «Don't know » (Figure 2-a). As for the acceptability of this sugar (Figure 2-b), more than half (56.54 %) found the sugars « very good » while 39.09% among found it « Good ». Less than 5% has shown that this new product is moderately acceptable. Regarding the motivation to buy these sweet products, Figure 2-c shows that about 9/10 of the subjects are ready for this innovation. Another not insignificant aspect is the purchase price of this sugar. On this point, the subjects (panelists) have each opted for one of the three psychological prices proposed. Thus, the first 2 prices, namely 450 FCFA and 500 FCFA for 500 g of sugar, were adopted by all the panelists. The frequency of choice of the purchase price is illustrated in Figure 2-d.

DISCUSSION

Traditionally, table sugars are considered as unimportant nutrients that do not provide much more than a pleasant sweet taste. However, following the analyzes carried out on the coconut water sugar from immature coconut, nutritive substances are distinguished in a variable way. The fats and proteins are the two most poorly represented nutrients in coconut water sugars. These low levels aremodulated simply because coconut water is naturally poor in proteins and lipids according to previous research (Adubofuor *et al.,* 2016 , Prakruthi *et al* ., 2014, Prades *et al* ., 2012). Nevertheless, there was an increase of lipids in the sugars of coconut water compared to the coconut water itself. Tanqueco *et al.* (2007) determined fat contents between 0.135 and 0.866 g/100g of coconut water of Laguna Tall, Sain Ramon Tall and Aromatic Dwarf varieties. These variabilities in protein content are also due to the genotypic differences of the coconut trees studied. There is also the category of sugar namely brown sugar, syrup and white sugar, obtained at different temperatures, which could induce these observed differences.

During the heating process, the latent heat is likely to accelerate the action of enzymes which acidified the middle, which would decrease the pH of the sugar and so will greatly its acidity. Despite somesimilar doses of acidity between the differents coconut water sugars, the analysis of the variance shows significant differences at the 5 % threshold of probability. This difference may, moreover, be attributable to the fact that coconut water sugars contain different doses of acidic compounds such as ascorbic acid, amino acids, fatty acids and carbon dioxide (Jayalekshmy *et al.,* 1988). These components are initially contained in the coconut water used. The pH of coconut water sugars is comparable to that of honey, which is between 3.5 and 5.2 (Pamplona, 2011).

The ratio of reducing sugars to total sugars is an important factor in determining the sweetness of coconut water in coconut (Prades *et al* ., 2012). Also, campos *et al* (1996) in their work assimilated the amount of raw sugar in coconut water to the soluble dry matter. This observation could justify the fact that the ratio of reducing sugars / total sugar is higher in the sugar of water from the two dwarfs (MYD and EGD) followed by the hybrid PB121. This high ratio in the latter case would therefore be due to its female parent (MYD) since its male parent (WAT) is less sweet than the MYD according to most research previously carried out. Digestion is facilite by coconut water consomption which often advisable in constipation case, this justifies that the fibers contained in the coconut water sugars are soluble type which facilitates intestinal transit. The consumption of this sugar can therefore reduce the level of cholesterol and the risk of infarction as highlighted by Pamplona during its investigations in 2011.

In this study, organoleptic characteristics of coconut water sugars was evaluate. Theacidic and salty flavors were neglected, not being perceived by the tasters during the sampling. This would suggest that mineral salts and acid molecules have not been perceived by consumers. In fact, they reflect the maximum values obtained respectively by the titrable acidity and ash contents in the various sugars studied. These mineral elements have been complexed with molecules such as proteins and fatty acids. So, the expression of the aroma of the sugars presented is therefore very little attributable to the acids. This aroma expression is also primarily reserved for esters (Borse *et al*.2007).

In general, the sweet taste was perceived by tasters in the water sugars of PB121 ($p = 0.908$), MYD ($p = 0.196$) and PB113 ($p = 0.447$). Between the three categories of sugars, brown sugars possess the sweet taste most pronounced. This is justified by the highest ratings attributed to them. The same is true for the descriptors « aroma » and « odour » and even at the aspect level. The accentuation of the aroma and the sweet taste is peculiar to the advantages related to the technique of cooking food. This thermal method makes some foods more appetizing and tasty as it enhances their flavor, aroma and texture. The significant differences that exist between white sugar, brown sugar and syrup are attributed to the method of production that induces sugars to a certain number of advantages. However, the three sugar categories provided the same satisfaction degree for varieties PB121 and PB113. For the other three varieties (WAT, MYD and EGD), the scores for the attribute « overall degree of satisfaction » are lower for syrup and higher for brown sugar of varieties WAT, MYD and white sugar of EGD variety. These differences and similarities can still be explained by the varietal origin, the method of obtaining the sugar, the chemical composition of the coconut water used. Also, at the genetic level, the variability of sugar parameters studied appears to be related to heterosis effectin view of differences in sensory characteristics between water sugars derived from PB121 and those of his parents (MYD and WAT).

This result obtained from a panel that knows and consumes frequently coconut by-products shows the good quality and good organoleptic properties of the three sugars categories that need to be improved and standardized. The acceptability test results revealed that 94% of consumers would be willing to buy this sugar if it were to be marketed. The reluctance of the 5% of consumers is related to their dietary habits and the hygroscopic state of this sugar. But it is likely that with the development of its marketability, this new type of sugar will also enter the eating habits of the most reluctant. But a major problem that could be associated with the production and marketing of coconut sugar is the price offered by consumers, namely 450-500 F CFA for 500 g quantity. Indeed, considering the operating account of a small unit of production of 200 fresh coconuts EGD (about 70 liters of coconut water) it will be produced therefore about 62 gx 70 liters = 4340 grams of brown sugar. This production is therefore evaluated at a cost 500 x 8.66 = 4330 FCFA if the purchase price of 500 g quantity of coconut water sugar set at 500 FCFA. This result shows that the low purchasing power of consumers is something that could hinder the development of the coconut sugar market. Also, the 200 coconuts return to 5000 F CFA because of 25 F the coconut. However, the other parts of the coconut namely the fresh almond and the fillings being exploitable, this new technology to its reason to exist and to be put together. In addition, 200 immature coconuts of PB113 provide about 100 liters of coconut water for a production of 57 g / L of white sugar and 51 g / L of brown sugar.

CONCLUSION

At the end of the study, the three sugars were evaluated and the results showing the nutritional character of the coconut water sugar. Unlike cane sugar, coconut water sugars contain some nutritives capable to assure the human metabolism after moderate consomption. In addition, its consumption and its purchase have the approval of the majority of the population. Thus, coconut water sugars can replace other sugars exist such as brown and white cane sugars.

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