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# PHYSICOCHEMICAL COCONUT WATER ASSESSMENT AND OF THE MICROBIOLOGICAL QUALITY OF ITS SUGAR EXTRACTED OF FIVE COCONUT ECOTYPES AT THE MARC DELORME STATION, CÔTE D'IVOIRE

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**ABSTRACT:** The objective of this study was to produce sugar from coconut water of immature nuts aged 8 to 9 months from West African Tall (WAT), Malayan Yellow Dwarf (MYD), Equatorial Guinea Green Dwarf (EGD) ecotypes and two hybrids PB113$^+$ and PB121$^+$ cultivated at Marc Delorme research station, southern Côte d'Ivoire. 12 coconut trees were randomly selected per cultivar on experimental fields. The coconut water from immature nuts of ranks 19 and 20 have undergone the production of 3 different sugars. Syrup and brown sugar were produced by hot and white sugar by freeze-drying. The volume, the Dry Metter content, pH and Brix degree of coconut water and microbiological characteristics of sugars of the latter were assessed. Pearson's correlation at 5% level was tested. The results shown that 2 immature nuts from PB121$^+$ and PB113$^+$ as against 3 from EGD and WAT or 4 from MYD were necessary to obtain one liter of coconut water suggesting that nuts from hybrids are bigger. The samples of coconut water extracted from MYD and EGD nuts contained high soluble solids rates varying from 6.32 to 6.98%. Their sugar content was higher. Thus, EGD produced 66.18 g/liter white sugar by freeze-dried, 61.64 g/liter of semi crystalline brown sugar and 64.84 g/liter sugar syrup. Likewise, from immature water of MYD nuts, extracted sugar yields were 62.62 g/liter for white sugar obtained by freeze-dried, 59.95 g/liter for syrup sugar and 55.90 g/liter for semi crystalline brown sugar. Significant positive correlations exists between immature coconut water's soluble solids content and the sugar yield (r = + 0.93). Sugar obtained offers satisfactory microbiological quality thus, can be integrated in the food practices of the consumers.

**Key words:** Immature coconut's water, sugar, output, microbiological quality, Côte d'Ivoire

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## INTRODUCTION

The coconut is a significant fruit-bearing plant which provides food to million people in the world. The area of total cultivated coconut palms in the world is 11.8 million hectare (FAO & World Oil, 2010) of which the three largest producing countries are, by descending order for production, Indonesia, Philippines and India. In Côte d'Ivoire where more than 20000 families living on the littoral depend mainly on coconut culture, the cultivated area covers 50000 ha for a production of 195.000 tons of nuts per year and annual coprah yield of 45000 tons (Konan *et al.*, 2006). To profit fully from this productivity and this availability, valorization of coconut products proves to be necessary. This valorization is especially possible in the case of the coconut water, considering coconut water multiple uses such us a symbolic religious, a biocatalyst, a natural beverage, a medicine and a growth medium for microorganisms and plants (Prades *et al.,* 2012). These various uses are possible by using the original biochemical composition of the coconut water. Coconut water is different from coconut milk, which is the oily white liquid extracted from fresh kernel (Prades *et al.,* 2012). Coconut water is a sweet refreshing drink taken directly from immature or mature nuts. Likewise sugars extracted from coconut water constitute constancy in the basic food especially for people reached of the diabetes of type 2.

Previously, the physicochemical parameters, food values, microbiological, organoleptic and sensory characteristics of the of immature coconut water are known (Assa *et al.* 2007; Assa *et al.,* 2013; Kodjo *et al.* 2015). Except uses of the immature and mature coconut water, generally like hydrating quality, earlier studies were not undertaken to appreciate the role which could play its sugar in the metabolism in *vivo,* even less to think of the manufacture of sugar from coconut water. Then, the biochemical characters of $PB113^+$ water, a hybrid very vulgarized, are little know.

The purpose of this study is to evaluate some physicochemical characteristics of coconut water and microbiological parameters of reversed at human persons its sugars syrup and solids edible.

## MATERIAL AND METHODS

### Plant material

The material used was constituted of West African Tall (WAT), Malayan Yellow Dwarf (MYD), Equatorial Green Dwarf (EGD), hybrids $PB113^+$ and $PB121^+$ ecotypes. Their nuts were harvested in experimental fields 052, 081 and 092 of Marc Delorme research station (N 5°14.5' - W 3°54.5') at Port-Bouët, of CNRA (Centre National de Recherche Agronomique) Southern Côte d'Ivoire.

### METHODS

### Coconut water sampling

The coconut palms were selected were asymptomatic. Twelve (12) coconut trees were randomly selected per ecotype split up into 3 batches (4 palms per batch). Afterwards, for one palm, 5 nuts were collected from each bunch of ranks 19 (nuts aged 8 months) and 20 (nuts aged 9 months). The physicochemical analyses on coconut water, syrup and sugar extractions were carried out in less than 24 hours after harvest. The study was carried out during three campaigns whose each were used as repetition.

### Determination of the physical coconut water parameters

The volume of the coconut water was obtained using a graduated test-tube. Dry matter content was obtained using a drying oven (Memmert 854 schwabach such 09122/4031) to 105°C during 8 hours according to the method of AFNOR (1991). The pH was obtained by the method of AOAC (1990). The dry extract refractometric (Brix degree) was obtained using a manual refractometer with autocorrecting of 20° C of temperature.

### Production of various coconut sugars

Syrup and brown sugars were produced hot using a hotplate (TRIOMPH, bets, France) provided with a temperature regulator, heat and time. One liter (1L) of coconut water is taken then heated in a frying pan in 3 successive evaporations. The first evaporation wascarried out with 120°C during 45 minutes, the second with 80°C during 20 min then the third with 60°C during 15 min. After these three sequential evaporations, the product was cooled at laboratory temperature (27° C) and is mixed during 10 min. Final sugar obtained is picked off frying pan, emoted then cooled at laboratory temperature (25° C). After cooling, sugar obtained was conditioned in sterile plastic bottles.

For white sugar production by freeze-drying, one (1) liter of coconut water set out again in small quantities (75 to 250 mL) in plates and balloons to be freeze-dried then placed in a freezer with (-80°C). After 24 hours of congelation, the balloons containing frozen water are assembled on the aircraft to freeze-dry (Biobase Biodustry, Shandong, Bk-FD10P). The frozen coconut water undergoes a sublimation of 24 hours vacuum to give white sugar.

Various sugars obtained were quantified and conditioned in bottles then preserved at the refrigerator for the various analyses.

### Microbiological analyses of coconut water sugars

The microbiological analyses were carried out only on sugar syrup and brown sugar. Thus, the enumeration of the enterobacteries was carried out according to the method NF V08-054: avril 2009. Total coliforms and aerobic flora mesophyll were respectively carried out by the standard ISO 4832 and ISO 4833. The staphylococcus aureus as for them were counted by spreading out on selective medium solid Baird Parker (LP) after 48 hours of incubation to 37°C while referring to standard ISO 6888 (2). Lastly, the enumeration of the colonies of *Clostridium* grew on meat medium or Wilson Blair medium during 72 hours at 37°C was carried out according to the standard ISO 7937: 2004.

### Statistical analyses

The means were calculated parameters accompanied by standard deviation. The Student T test was employed to assess the effects of the coconut cultivars and the stage of nut's maturity on the physicochemical properties of coconut water and/or coconut sugars. The one-way ANOVA with only factor "Method of sugars production" was performed to determine the impact of the method of production on the coconut water sugar yield. The differences observed at 5% threshold were classified with post-ANOVA test of SNK (Student Newman Keuls). All statistical analyses were carried out using software IBM SPSS Statistics version 22.

## RESULTS

### Physico-chemicals parameters of the coconut water

The results showed that there is a significant difference between the physical parameters of coconut water (Table 1).
Thus, on the level of the two stages of maturity (8 and 9 months), nuts harvested MYD cultivar contain lowest water respectively 260,06 mL and 262,67 mL at 8 and 9 months old. The highest quantities of coconut water were observed in hybrid nut PB 113$^{+}$. These values were of 553.93 mL (8 months) and 554.53 mL (9 months). The other varieties provided intermediate values of coconut water content.
When the age is taken as determinant, no significant difference exists between volumes of water from nuts of the same cultivar except for WAT which contained approximately 324 mL at 8 months old and 319 mL at 8 months old.
The coconut water from the nuts of MYD and EGD from 8 and 9 month old provided the highest percentage of dry matters.

**Table 1. Means classification of 4 physico-chemicals parameters of coconut water extracted from nuts harvested on bunch of ranks 19 and 20 at Côte d'Ivoire**

| Variables (SI) | Nut old (month) | Coconuts | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cultivars | | | Hybrids | | |
| | | **WAT** | **MYD** | **EGD** | **PB121$^{+}$** | **PB113$^{+}$** | p-value |
| VE/N (mL) | 8 | $323.80 \pm 1.12^{Na}$ | $260.06 \pm 1.10^{Pb}$ | $292.80 \pm 1.61^{Vc}$ | $380.60 \pm 1.40^{Ge}$ | $553.93 \pm 1.83^{Fd}$ | 0.034 |
| | 9 | $319.4 \pm 1.12^{Ma}$ | $262.67 \pm 2.32^{Pb}$ | $293.07 \pm 1.33^{Vc}$ | $378.47 \pm 1.88^{Ge}$ | $554.53 \pm 1.13^{Fd}$ | 0.022 |
| P-value | | 0.021 | 0.063 | 0.082 | 0.131 | 0.922 | |
| MS (%) | 8 | $5.54 \pm 0.01^{Aa}$ | $7.84 \pm 0.01^{Cb}$ | $7.65 \pm 0.02^{Eb}$ | $6.23 \pm 0.16^{Le}$ | $6.24 \pm 0.01^{Pe}$ | <0.001 |
| | 9 | $5.22 \pm 0.01^{Ba}$ | $6.43 \pm 0.40^{Dc}$ | $6.58 \pm 0.01^{Hc}$ | $6.13 \pm 0.01^{Ld}$ | $6.16 \pm 0.26^{Pd}$ | 0.001 |
| P-value | | 0.095 | 0.032 | 0.032 | 0.115 | 0.074 | |
| ESR (%) | 8 | $5.10 \pm 0.08^{Za}$ | $6.32 \pm 0.20^{Rb}$ | $6.94 \pm 0{,}05^{Gc}$ | $4.99 \pm 0.08^{Ta}$ | $5.58 \pm 0.15^{Fd}$ | 0.001 |
| | 9 | $5.25 \pm 0.08^{Ta}$ | $6.93 \pm 0.05^{Eb}$ | $6.98 \pm 0{,}06^{Gb}$ | $5.29 \pm 0.06^{Ua}$ | $5.63 \pm 0.10^{Fe}$ | 0.013 |
| P-value | | 0165 | 0.025 | 0.931 | 0.025 | 0.195 | |
| pH | 8 | $5.10 \pm 0.01^{Fa}$ | $5.26 \pm 0.50^{Bb}$ | $5.37 \pm 0.24^{Gc}$ | $5.10 \pm 0.01^{Ya}$ | $5.15 \pm 0.07^{Na}$ | <0.001 |
| | 9 | $4.99 \pm 0.04^{Ka}$ | $5.05 \pm 0.05^{Eb}$ | $4.99 \pm 0.05^{Fa}$ | $4.97 \pm 0.01^{Sa}$ | $5.20 \pm 0.01^{Nd}$ | 0.002 |
| p-value | | <0.001 | 0.012 | <0.001 | <0.001 | 0.061 | |

On the same raw, the means ± standard deviation which carry the same small letter while exposing are statistically identical to the threshold of 5%. In the same column and for the same parameter, the means ± standard deviations which is accompanied by the same capital letter while exposing are statistically identical to the threshold of 5 %. **VE/N:** volume of water per nut; **MS:** matter dries; **ESR:** Dry Extract Refractometric; **pH:** potential of hydrogen; **P:** value of the probability of the ANOVA test.

WAT provided the lowest contents of dry matters (5.54 %) and (5.22 %) respectively for nuts of 8 and 9 months old. These values obtained at the 2 stages of nut maturities were identical statistically.

As for the hybrids PB 121$^+$ and PB 113$^+$, the values obtained were intermediate on the level of the 2 stages of maturity and statistically identical to the level of each stage.

The dry extract refractometric (ESR) of nuts from 8 and 9 months old of WAT cultivar and the hybrid PB121$^+$ were lowest statistically. On the level of each stage of nut maturity, ESR values from these two cultivars were identical statistically.

## Production output of coconut water sugars

The two methods of sugars production were given significant differences between white sugar, syrup and crystallized brown sugar output (table 2).

Thus, with freeze-drying, higher quantity of white sugar was obtained for the same volume of water and cultivar used compared to the ones obtained when heat method was used. By freeze-drying, the EGD gives 66.18 g/L white sugar as against 61.64 g/L brown sugar obtained by the heat. On the other hand, PB121$^+$ statistically gives the same quantities of white sugar and syrup.

With 1 liter of coconut water resulting from all cultivar's immature nuts at 8 month old sugar syrup quantities ranging from 47.59 g/L to 64.59 g/L were produced. When evaporation is continued, the brown sugar is obtained in lower quantities than those of syrup and varying from 43.27 g/L to 61.64 g/L. When sugar production is done with lyophilisator, the quantities of white sugar obtained were slightly raised and varied from 47.88 g/100 g to g/100 g for the water of nuts from bunch of rank 20 (9 months old), the production is fairly high. At 9 month old the level of extracted white sugar, the increase in the output is 3 % for all cultivars except for the hybrid PB121$^+$ which is lower than 3 %.

**Table 2: Outputs out of syrup and granulated sugar extracted from water of nut harvested on bunch of ranks 19 and 20 at Côte d'Ivoire**

| Variables (SI) | Nut old (month) | Coconuts | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cultivars | | | Hybrids | | p-value |
| | | WAT | MYD | EGD | PB121$^+$ | PB113$^+$ | |
| R. Syrup (%) | 8 | $49.64 \pm 0.04^{Aa}$ | $59.95 \pm 0.01^{Bb}$ | $64.59 \pm 0.36^{Cz}$ | $47.59 \pm 0.47^{Ra}$ | $52.61 \pm 0.27^{Fe}$ | 0.002 |
| | 9 | $50.65 \pm 0.72^{At}$ | $59.95 \pm 0 .01^{Bb}$ | $64.94 \pm 0.02^{Cc}$ | $46.56 \pm 0.02^{Rd}$ | $54.51 \pm 0.08^{Pe}$ | 0.045 |
| P | | 0.059 | 0.135 | 0.241 | 0.146 | 0.001 | |
| R Brown sugar (%) | 8 | $45.54 \pm 0.35^{Ta}$ | $55.90 \pm 0.58^{Gb}$ | $61.64 \pm 0.02^{Kc}$ | $43.27 \pm 0.41^{Kd}$ | $50.87 \pm 0.65^{Wt}$ | 0.002 |
| | 9 | $48.47 \pm 0.03^{Ba}$ | $58.95 \pm 0.03^{Eb}$ | $61.58 \pm 0.52^{Kg}$ | $45.57 \pm 0.01^{Ld}$ | $51.00 \pm 0.50^{Wd}$ | 0.001 |
| P | | 0.021 | <0.001 | 0.413 | 0.002 | 0.089 | |
| R. White sugar (%) | 8 | $50.54 \pm 0.04^{Ua}$ | $62.62 \pm 0.05^{Bb}$ | $66.18 \pm 0.04^{Yc}$ | $47.88 \pm 0.06^{Md}$ | $55.22 \pm 0.09^{Je}$ | 0.003 |
| | 9 | $52.74 \pm 0.14^{Va}$ | $64.79 \pm 0,15^{Db}$ | $68.21 \pm 0.34^{Rc}$ | $48.58 \pm 0.26^{Md}$ | $57.59 \pm 0.49^{Me}$ | 0.025 |
| P-value | | 0.007 | 0.004 | 0.024 | 0.037 | 0.001 | |

On the same raw, the mean ± standard deviation which carry the same small letter while exposing are statistically identical to the threshold of 5%. In the same column and for the same variable, the averages ± standard deviations which carry the same capital letter while exposing are statistically identical to the threshold of 5 %.

## Aspect of coconut water sugars

At the end of three evaporations, sugar syrup (figure 1-a) and a crystalline brown sugar presented as slightly compact grains and fairly hygroscopic grains (figure 1-b) were obtained. The crystalline sugar of white color was obtained following a direct freeze-drying of the coconut water (figure 1-c). The texture of the sugar obtained by heating although granulous was not friable as conventional sugar. On the other hand, white sugar produces has a friable but very hygroscopic texture.

a b c

**Figures 1: various types of sugars obtained: syrup sugar (a), brown sugar (b) and white sugar (c)**

## Microbiological quality of the coconut water sugars

## Microbiological quality of syrup and brown sugar

The sugar syrup obtained by heating has a satisfactory of microbiological quality. Indeed, it was characterized by a total absence of coliforms, clostridium and staphylococcus aurous. Sirup and brown sugar are also free to yeasts and moulds with less than one UFC/g of counted germ. Total flora aerophyl mesophyll is also absent but only in sugars of WAT and $PB113^{+}$ On the other hand, $3.10^{1}$ UFC/g of FAMT were counted in syrup and brown sugars of MYD and EGD and $11.10^{1}$ UFC/g of FAMT in the ones of $PB121^{+}$. The syrups resulting from the coconut water contain very low microbial loads varying from 0 to $11.10^{1}$ UFC/g of sugar (Table 3).

Just as sugar syrup, the brown sugar is deprived of all the germs studied except the FAMT. The latter is counted in loads lower than those counted in syrup in the same varieties (Table 3). The microbial loads lie between 0 and $3.010^{1}$ UFC/g brown sugar.

**Table 3: Germs counted in brown and syrup sugar of immature coconut water**

| Germs (UFC/g) | Type of Sugars | VARIETIES | | | | |
|---|---|---|---|---|---|---|
| | | **WAT** | **MYD** | **EGD** | **$PB121^{+}$** | **$PB113^{+}$** |
| FAMT | Syrup | < 1 | $3.0 \pm 2.5.10^{1}$ | $3.5 \pm 1.5.10^{1}$ | $1.1 \pm 1.2.10^{2}$ | < 1 |
| | Brown | < 1 | $2.1 \pm 1.8.10^{1}$ | $3.0 \pm 2.1.10^{1}$ | $0.5 \pm 0.9.10^{1}$ | < 1 |
| YEASTS | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |
| MOULD | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |
| CT | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |
| CLOS | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |
| ENT | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |
| ST-aureus | Syrup | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Brown | < 1 | < 1 | < 1 | < 1 | < 1 |

**AFMT:** Aerobic flora mesophile total; **CT :**Coliformes totals; **ST-aureus** Staphylococcus aureus; **ENT :**Enterobacteries; **CLOS** :Clostridium

**Frequencies of total microbiological satisfaction of sugar syrup**

The results in frequency of samples satisfactory, acceptable and unsatisfactory of sugar syrup were presented in figure 3. These results are obtained by considering each category of micro-organism taken individually on the one hand and the whole of the studied germs on the other hand. These results take into account only the sugar syrup which has little more germs than the brown sugar. The various percentages of the frequency of total satisfaction of sugars syrups were 97 % ($PB121^+$), 99 % (EGD and MYD) and 100 % ($PB113^+$ and WAT) (figure-2).

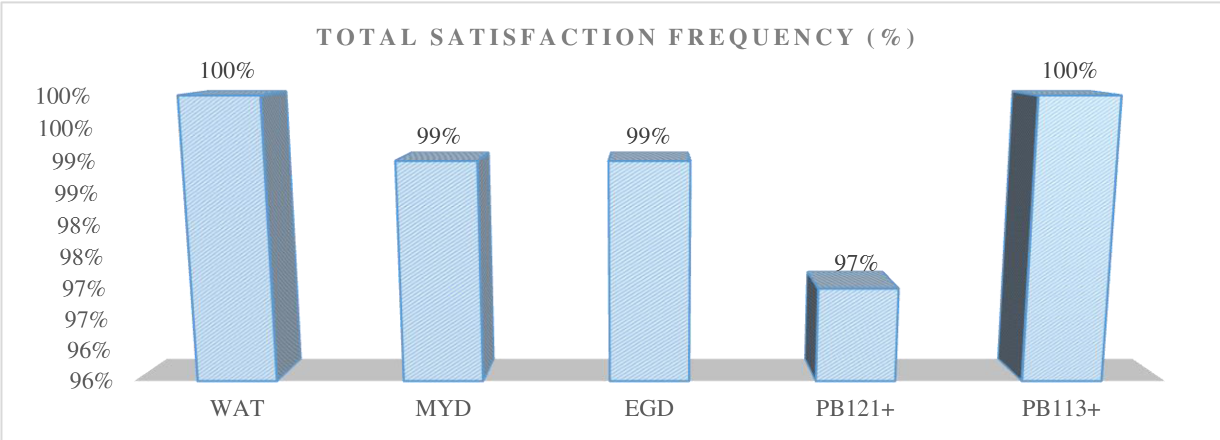


**Figure 2: Total satisfaction of sugars syrup for all the micro-organisms counted**

## DISCUSSION

One nut of $PB113^+$ contained an average of 554 mL of water, thus 2 nuts of 9 months old are needed to obtain 1 liter of coconut water and to produce approximately 54 g of syrup, 51 g of brown sugar and 57 g of white sugar. On the other hand, the double is needed, i.e. 4 nuts of the cultivar Malayan Yellow Dwarf (MYD) to obtain 1 liter of coconut water and to roughly produce 60 g of syrup, 59 g of brown sugar and 65 g of white sugar. For the three other varieties of coconut, 3 nuts are needed to produce 1 liter of water because only one nut gives 380 mL, 323 mL and 293 mL of water respectively for $PB121^+$, WAT and EGD. The higher volume of water in nut of $PB113^+$ and $PB121^+$ is due to the fact that their male parents, Rennel Island Tall (RIT) and WAT respectively, produce very large nuts according to the study of Assa *et al.* (2007).

The pH of the water of all studied cultivars is lower than 7 thus acid. The values are included between 5.10 and 5.37 for the nuts of 8 month old. There is a reduction of pH of coconut water in the 9th month with values varying from 4.97 to 5.20. This reduction could be allotted to the increase in the age and or in the contents of water component such as residues of the strong and weak acids to knowing the amino acids, the fatty acids, the ascorbic acid or vitamin C and the dissolved carbon dioxide (Jayalekshmy et a*l,* 1988). In addition, there are periods when the selected coconut palms are " in rest " and do not receive any more sap on the level of the crown, which entrained at them, an early maturity causing an increase in acidity in water from where the pH decrease.

The values of pH do not corroborate those reported by Kodjo *et al.* (2015) and of Assa *et al.* (2007) who found that the coconut water's pH tends towards neutrality. However, pH values of coconut water found in our study close to those found by Adubofuor *et al.* (2016) which are 4.67 and 4.78 respectively for the coconut water of Green and Yellow Malayan Dwarf.

The contents of soluble solids of the water of the MYD and that of the EGD obtained in our work are higher than those obtained by Adubofuor *et al.* (2016). These differences can be explained by the composition of the total sugar and reducing sugars contents of studied coconut water samples. Before this study, Jean *et al.* (2009) paid contents of soluble dry matters of the coconut water ranging between 4.5 and 6.5° Brix thus very close to current values obtained in our study. The quantity of sugar produced is proportional to the rate of soluble dry matter of coconut water. Indeed, the most sweetened cultivars that are the MYD and EGD (Assa *et al.* 2013) have their water which produces more quantities sugars compared to the three other studied cultivars. That is explained by the variety and coconut origin since the water of all nuts of dwarf coconut of yellow or green color is not always sweetened. In addition, both studied dwarf cultivars have a high quantity of soluble dry matter which roughly represents the quantity of sugar present in the water of coconut according to the study of Campos *et al.* (1996).

The rates of granulation of the amorphous sugars are controlled by the moisture, the relative humidity (HR) and the temperature of storage higher than the temperature of vitreous transition (Fan & Roos, 2016). Thus, the difficult control of the sugars's granulation of coconut water would be justified by their composition in various limiting factors. The complex glucides such as starch (Iglesias & Chirifie, 1978), the proteins (Fan & Roos, 2016) and the carbohydrates (Sillick & Gregson, 2010) are the components of sugar which delay its crystallization. Our results highlight this phenomenon of crystallization because it is about a raw sugar containing several nutriments resulting from the raw material to knowing of immature coconut water. In addition to the above mentioned authors in the last case, our results corroborate the work of Kerry & Roos**,** (2012).
In comparison with the principal counted germs, syrup and brown sugars do not present a microbiological risk. Indeed, except the AFMT which are present in the sugars of MYD, EGD and PB121$^+$, there are a total absence of other germs in the sugars. The presence of the AFMT in syrups and brown sugar of varieties MYD, EGD and PB121$^+$ would be due to a contamination cross of the coconut water during its process of extraction after harvest of nuts. This contamination could also come from the instruments used for the production and the ambient air during the cooling of the product on the straw mattress. However the level of contamination is largely lower than the threshold of criterion (m) (AFSSA, seized 2007-SA-0174, March 2008). Better still, the last version of the microbiological criteria applicable to the foods, of the ministry for the health of the Grand Duchy of Luxembourg, considers sugar, the honey and jams of satisfactory microbiological quality, when all the actual values are lower than 100 UFC/g. Moreover, the sum of the frequencies of satisfaction per counted germ vary from 97 % to 100 % thus of a microbiological quality. This low microbiological load in sugars of the coconut water could be also allotted to the technique of evaporation by heating used. This technique included sterilization (120°C during 45 min) allowing the denaturation of the proteins (Boekhout & Robert, 2003) [23] causing the destruction of the micro-organisms. Adubofuor *et al.* (2016) reduced to 60 UFC/g yeasts and moulds which were 840 UFC/g in the MYD coconut water, after only 15 minutes of pasteurization to 80°C the good practices of hygiene and the heat thus justifies the microbiological quality of the sugars produced in the case of this work. Thus, analyzed sugars complying with the regulations of the standards described by Jouve (1996) can be consumed without any risk of contamination for the consumer.

## CONCLUSION

This study was conducted at Marc Delorme Research station to set up a reliable method for sugar production from immature water of coconut, to quantify the sugar production per variety and bunch then to evaluate the sugar's microbiological quality. Two methods of coconut sugar production from water extracted in immature nuts were know, heating and freeze-drying methods. Three sugar types were produced. There are semi crystalline sugar and sugar syrup by heating and the white sugar obtained by freeze-drying. The results revealed that the method with the cold gives more sugar than the heating. MYD and EGD cultivars gave the most sugar whatever the method. More one variety of coconut is sweetened, more its water produces a significant quantity of sugar. All the syrups and the brown sugars obtained are satisfactory microbiological quality within sight of the units forming colonies which are much lower than the standards in strengths. Thus, these sugars which must enter in the food practices of populations in Côte d'Ivoire and besides. However, these sugars would be suitable for regulate the problem of diabetes in these last.

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