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Physico-chemical properties of palmyra palm *(Borassus aethiopum* Mart.*)* fruits from Northern Cameroon

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Palmyra palm (*Borassus aethiopum* Mart.) is a priority socio economic ligneous tree species naturally widespread in Cameroons Savannah regions. Its fruits are consumed as food and or food supplements especially during famine periods. Unfortunately, over 60% of the annual fruit yield is often lost within ten days after harvesting due to rot in storage. In the current study, we examined palmyra palm tree cultivars fruit nutritional and morphological attributes from agro - climatic zones of Cameroon. Significant differences in fruit morphology and similarity in nutritional composition per 100 g of fresh matter was observed (> 4.47 g sugars, 5.18 g fiber, >26 mg of provitamin A and >134.82 mg vitamin C. The pulp constituted 35% of the total mass of the fruit.

Key words: Cameroon, *Borassus aethiopum*, fruit nutrition attributes, morphology.

INTRODUCTION

Among species of agroforest landscape of sahelian and soudano - sahelian parks, there is palmyra palm (*B. aethiopum* Mart.), date palm of the desert (*Balanites aegyptiaca* (L.) Delile), tamarind (*Tamarindus indica* L.), jujube tree (*Zizyphus jujube* Mill.), fig - tree (*Ficus sycomorus* Miq. and *Ficus platyphilla* Delile.), nere tree (*Parkia biglobosa*) (Jacq.) R.Br. ex G.Don), shea (*Butyrospermum parkii* (G.Don), Kotschy) and doum palm (*Hyphaene thebaic* (L.)Mart.). The non woody forest products of these plants were often collected and rarely constitute basic food commodities (Grivetti, 1978; Campbell, 1978). Concerning Palmyra palm, it grows naturally through out the semi arid to subhumid regions of Africa, from Senegal to the Central African Republic (Leakeys, 1996; Cretenet et al., 2002). In Cameroon, Lake Chad region and northern part of Mount Cameroon, palmyra palm growth densities is 60 to 120 trees and fruit production of 15 to 40 tons per hectare (Djibrilla, 2004). However, most of the fruits are lost due to rot in storage and hence there is need for fruit preservation technologies (Lamien and Bayala, 1996; Nikiéma, 1997; Nikiema et al., 2003). Additionally, wine production from the Palmyra tree sap also threatens the sustainability of the species population (Cassou and Dupommier., 1997). In the current study, we evaluated Palmyra palm fruit nutritional and morphological attributes in order to identify technological options for its processing and storage. The hypothesis investigated in this study was that agro climatic area affected the physico - chemical composition and morphological properties.

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MATERIAL AND METHODS

Data collection

Twenty fruits were harvested from 5 different trees in each of two study areas, making a total of 100 fruits per zone. The fruits were then immediately transported in jute bags to the laboratory.

Study areas

Zone 1: Extending from the north of Maroua (10°30' North) till the Lake Chad region (13°10' North); the locality of Kousseri (Logone and Chari division - Cameroonian Far - North region) situated in the sahelo - soudanian agro - climatic zone. This area is characterized by a rainfall lower than 800 mm and dominated by vertisols and alluvial soils (Bardinet et Monget., 1983).

Zone 2: Extending from the north of the Adamawa region to Touboro (7°30' North) to Garoua (9°20' North); the locality of Wakwa neighbouring Ngaoundere (Vina division - Cameroonian Adamawa region) situated in the soudanian agro - climatic zone. This area is characterized by annual rainfall ranges from 1000 and 1300 mm and is dominated by ferruginous soils. These two agro - climatic zones encampass the semi - arid and subhumid regions of Cameroon (7°30' and 13° North and 9° and 15° East) and were chosen for their diversity in cultural, social, climatic and vegetation settings (Garine and Koppert 1988; Garine 1993 a and b).

Methods of analysis

Physical characterization

As soon as they arrived the laboratory, the fruits were sorted out in order to remove damaged ones and then 30 fruits from the two different areas were selected on the basis of the state of ripness, similarity in shape and size. The fruits were then washed, weighted, peeled and pulped. The pulp, the kernel and the peelings were weighed using an electronic balance (Precisa, France). The thickness of the pulp and the mean diameter were measured using a penetrometer (Vasse, PNR 10, Germany) and a measuring tape respectively.

Chemical characterization

The water content (WC) and the total ashe (TA) were determined using UICPA (1979) methods. Total ashe was obtained by incineration of defatted flour and Fe, Ca, Mg and P were determined according to Maynard (1970). Total lipids (TL) were extracted using hexane (UICPA (1979) methods). Soluble sugars (SS) were extracted with water and total sugars (TS) were obtained after hydrolysis with HCl, and their contents were analyzed according to Fisher and Stein method (1961). Total proteins were mineralized by the method of Kjeldhal (AFNOR, 1981) and the total nitrogen determined according to Devani et al., (1989). Nitrogen was converted into proteins by the factor of 6.25. Total fibers contents were determined by the method of Weende (cited by Wolff, 1968). The contents in total carotenoids were assessed according to Wolff (1968). Vitamin C was extracted according to Harris and Ray (1935) technique and measured according to Evered (1960). Total phenolic compounds were extracted with ethanol (70%) and measured by the reagent of Folin - Ciocalteu (Marigo, 1973).

Three replicates were carried out for each parameter and means were obtained from the replicates. These means were compared by analysis of variance and where significant differences existed, values were classified by the Duncan multiple range test. The statistical analyses were performed using SPSS software (Statistical Package Social Science, 1993) to group the samples according to similar features.

RESULTS AND DISCUSSION

Morphological characteristics of the fruits

The morphological characteristics were determined for each of the 30 fruits harvested in the two agroclimatic zones (Kousseri and Ngaoundere). The means of triplicate analyses are reported in Table 1. Independently of the zone, the fruits had a mean diameter higher than 13 cm, a pulp of 8 mm of thickness, for a weight higher than 1250 g. The kernel and the peelings represent 50 to 52% and 11.50 to 12% of the total weight respectively. The standard deviation showed variability of the physical properties between the fruits of the same origin, the weight of whole fruit was 1324.55 ± 85.99g for Kousseri and 1270.04 ± 116.69g for Ngaoundere. The thickness of the pulp was constant from a fruit to another regardless of the agro -climatic zone: 0.82 ± 0.03 cm for Kousseri and 0.82 ± 0.05 cm for Ngaoundere.

Based on ANOVA, the percentage of pulp in relation to the total weight of fruits significantly differed between agro - climatic zones ($p < 0.05$, Table 1). The correlation coefficients between some measured parameters (Thickness of pulp, Weight of fruit, Weight of kernels, Weight of pulp, % of pulp) are presented in Table 2. There was positive correlation ($p < 0.05$), between the weight of the fruit and the weights of the kernel in all the agro - climatic zones ($r = 0.95$ and $r = 0.96$ for Kousseri and Ngaoundere respectively, Table 2). There was a correlation between the diameter of the fruit and the weights of the fruit, the pulp and the kernel (Table 2).

It should be noticed that the output in pulp of the fruit of the Palmyra palm is near to that of the mangoes which are pulpy drupes with 30 to 50% of the pulp according to the variety (Traore, 1997). Based on the correlations between the different parameters, one could chose fruits with interesting technological potential. Thus, for the fleshy fruits, the weight parameter must be taken into account.

Physico-chemical attributes

The physico - chemical analyses were carried out on the pulp of 30 fruits from each agroclimatic zone, and the results are reported on Table 3. The water contents of the fruits of the Palmyra palm (*B. aethiopum*) were between 79.13 ± 0.64 to 81.38 ± 1.94 g/100 FM. The total sugar contents of fruits from Kousseri and Ngaoundere were 5.62 ± 1.13 g/100g FM and 4.47 ± 1.07 g/100 g FM respectively. The soluble sugars were 81.00 to 84.11% of the total sugars. The proteins contents were 0.85 g/100g FM. The total lipids contents were less than 0.20 g/100gFM. The crude fibers contents varied from 5.72 to 7.89 g/100g FM. The total carotenoids contents of the pulp were between 26 and 28 mg/100g FM. The total carotenoids was more than 26 mg/100g FM while Vitamin C was 134.82 ± 3.94 to 171.33 ± 2.62 mg/100g FM. The total ash contents varied around 0.74 ± 0.01g/100g FM. The analysis of the ash revealed that 100g FM contains 108 mg of calcium, 21 mg of magnesium, 567 mg of phosphorus and > 2 mg of iron. There was a significant difference ($p < 0.05$) between the ash and the vitamin C

Table 1. Some morphological characteristics of fruits from Kousseri and Ngaoundere.

	Source	
Parameters	**Zone 1 (Kousseri)**	**Zone 2 (Ngaoundere)**
Mean diameter (md) (cm)	13.85 ± 0.32 [a]	13.56 ± 0.49 [a]
Thickness of pulp (tp) (cm)	0.82 ± 0.03 [a]	0.82 ± 0.05 [a]
Weight of whole fruit (wf) (g)	1324.55 ± 85.99 [a]	1270.04 ± 116.69 [a]
Weight of pulp (wp) (g)	511.88 ± 36.91 [b]	449.19 ± 46.91 [a]
Weight of kernels (wk) (g)	658.83 ± 47.57 [a]	659.76 ± 71.40 [a]
Percentage of pulp (%p)	38.60 ± 1.07 [b]	35.22 ± 1.19 [a]
Weight of peelings (g)	158.32 ± 32.74	154.72± 30.32
Weight of cockle (g)	291. 40 ± 12.32	270.36 ± 9.26
Weight of almond (g)	395.77 ± 20.45	379.48 ± 16.12

Values on the same line with the same letter as superscripts are not significantly different at the level of 5%. Results are mean ± SD.

Table 2. Correlations between physical parameters of the fruits.

	Source	r				
Thickness of pulp	1 Kousseri	0.62* (0.00)				
	2 Ngaoundere	0.43* (0.02)				
Weight of fruit	1 Kousseri	0.90* (0.00)	0.77* (0.00)			
	2 Ngaoundere	0.81* (0.00)	0.13 [ns] (0.48)			
Weight of kernels	1 Kousseri	0.83* (0.00)	0.71* (0.00)	0.95* (0.00)		
	2 Ngaoundere	0.74* (0.00)	0.03 [ns] (0.90)	0.96* (0.00)		
Weight of pulp	1 Kousseri	0.86* (0.00)	0.73* (0.00)	0.93* (0.00)	0.78* (0.00)	
	2 Ngaoundere	0.83* (0.00)	0.24 [ns] (0.19)	0.93* (0.00)	0.80* (0.00)	
% of pulp	1 Kousseri	0.14[ns] (0.48)	0.08 [ns] (0.67)	0.07 [ns] (0.70)	-0.20 [ns] (0.28)	0.44* (0.02)
	2 Ngaoundere	0.38* (0.04)	0.38* (0.04)	0.19 [ns] (0.31)	-0.06 [ns] (0.74)	0.53* (0.01)
		Diameter of fruit	Thickness of pulp	Weight of fruit	Weight of kernels	Weight of pulp

* = significant at a probability P ≤ 0.05; ns = not significant; Numbers in brackets represent different levels of probability.
Source : 1- Kousseri (sahelo-soudanian zone) and 2- Ngaoundere (soudanian zone).

contents of the fruits in regard to the localities (Table 3).

The results in Table 3 were compared to the composition of other currently consummed fruits. The pulp of the fruits of the Palmyra palm (*B. aethiopum*) presented high water content (79.13 ± 0.64 to 81.38 ± 1.94 g/100 FM, with respect to the origin). Its water content was higher than that of sweet banana (72 - 75%) and lower than that of mango and pineapple (83 - 85 g/100g FM) (Toure and Kibangou-Nkembo, 2000). This figure of water content is an exception as compared to the fruits of the other under - exploited species of the arid zones; as a consequence, it predisposes these fruits to a rapid change after harvesting, this justifies the currently recorded losses of 60% of the total production after 10 days. The total sugar contents of fruits from Kousseri and Ngaoundere were 5.62 ± 1.13 g/100g FM and 4.47 ± 1.07 g/100g FM respectively. Compared to that of the other species of the same region, these values is close to that

Table 3. Physico - chemical composition of the pulp of *B. aethiopum* fruits from Kousseri and Ngaoundere.

	Sources	
Parameters	**Kousseri**	**Ngaoundere**
Water content (%)	79.13 ± 0.64[a]	81.38 ± 1.94[a]
Total ash (%)	0.73 ± 0.12 [a]	0.74 ± 0.01 [b]
Total sugar (%)	5.62 ± 1.13[a]	4.47 ± 1.07[a]
Soluble sugar (%)	4.58 ± 1.12[a]	3.76 ± 1.03[a]
Total proteins (%)	0.85 ± 0.13[a]	0.73 ± 0.10[a]
Crude fibers (%)	5.72 ± 0.39[a]	5.18 ± 0.23[a]
Total lipid (%)	0.16 ± 0.001[a]	0.15 ± 0.002[a]
Carotenoïds (mg/100gFM)	27.42 ± 0.90[a]	26.61 ± 0.83[a]
Vitamin C (mg/100gFM)	134.82 ± 3.94[a]	171.33 ± 2.62[b]
Iron (mg/100gFM)	2.05 ± 0.15	2.15 ± 0.20
Magnesium (mg/100gFM)	20.61 ± 0.25	21.01 ± 0.31
Phosphorous (mg/100gFM)	567.40 ± 0.42	567.01 ± 0.43
Calcium (mg/100gFM)	107.61 ± 0.20	108.25 ± 0.24
Total phenolic compounds (mg/100gFM)	274.20 ± 0.19	274.56 ± 0.20

(%) represents the content (g) per 100 g of fresh consumable product.

of the fruits of (Areca cathecu Linnaeus.) 3.38 - 4.88 g/100g FM (Bavappa et al., 1982) and lower than that of the fruits of the date palm (*Phoenix dactylifera* L.) 64.71 g/100g FM (Watt and Merrill, 1963). The soluble sugars were 81.00 to 84.11% of the total sugars. This high soluble sugar contents is unfavourable for a long preservation due to fermentation and browning reactions. The proteins contents were very low (0.85 g/100g FM). This value is comparable to that of dates (*P. dactylifera,* 0.71 g/100g FM) (Watt and Merrill, 1963), and of the fruits of the Doum palm of Africa (*Hyphaene compressa* H.Wendl.), 0.80 g/100 g FM (Hebeke, 1989). The total lipids contents were less than 0.20 g/100g FM. This value is higher than that of the dates (*P. dactylifera*), (0.14 g/100g FM) and lower than that of the Doum palm from Africa (*H. compressa*) (0.84 g/100g FM) (Hoebeke, 1989). The crude fibers contents varied from 5.72 to 7.89 g/100g FM. The total carotenoids contents of the pulp were between 26 and 28 mg/100g FM. These values were lower than those of the fruits of the palm oil tree (*Elaeis guineensis* Jacq.) (50.68 FM mg/100g) (Atchley, 1984), and similar to those of the fruits of the date palm (*P. dactylifera*) (25 FM mg/100g) (Watt and Merrill, 1963). The total carotenoïds represent more than 26 mg/100g FM, thus making the Palmyra palm fruit an important source of vitamin A. Vitamin C contents were 134.82 ± 3.94 to 171.33 ± 2.62 mg/100g FM. The total ash contents varied around 0.74 ± 0.01 g/100g fresh matter (FM), they were higher than those of *Cocos nucifera* (0,33 g/100gFM) (OHLER, 1984), *E. guineensis* (0.52g/100gFM) (Atchley, 1984), *P. dactylifera* (0.61g/100g FM) (Watt and Merrill, 1963), *A. cathecu* (0.47 - 0.58 g/100g FM) (BAVAPPA *et al.,* 1982) and lower than those of *H. compressa* (2.03 g/100g FM) (Hoebeke, 1989). The analysis of the ash revealed interesting amount of minerals. Reported to 100 g FM, it contains about 108 mg calcium, 21 mg of magnesium, 567 mg of phosphorus and more than 2 mg of iron. The significant difference between ash and vitamin C contents of the fruits in regard to the localities could be justified by ecological factors bound to the nature of soils, of the degree of sunshine and the rainfall in the two concerned agroclimatic zones.

Conclusion

The fruit of the Palmyra palm (*Borassus aethiopum* Mart.) can be classified amongst semi - arid zone resources with important water content and with the particularity to be the good sources of sugars, of vitamin C, of provitamin A, of minerals and fibers. Its output in flesh added to its biochemical features, destine it to several potential technological transformations in the domain of food science, as: the moderate drying or the lyophilisation in view to produce an enriched flours, the extraction pulp in view to produce mash or bracing refreshing drinks, the fermentation of the juice in view of the production of wine or vinegar, and finally the treatment of the pulp in order to produce jam and other candy products. These perspectives allow foreseeing the obtention of a range of natural products of good nutritional value. At the same time a rational treatment of this production should reduce the post - harvest losses and should increase producer's resources.

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