ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 03, Issue 08, pp.1713-1719, August, 2016

RESEARCH ARTICLE

MINERAL COMPOSITION AND VITAMIN A OF TEN WILD FRUITS CONSUMED IN TREE DEPARTMENTS OF CHAD

***Marceline Mouti, Makalao, Aly, Savadogo and Alfred S, Traore**

[1]Department of Biochemistry and Biotechnology, Research Center in Biological, Food and Nutritional Sciences (CRSBAN), Unit of Formation and Research in Life and Ground Sciences, University Ouaga, BP: 7021, Ouagadougou, Burkina Faso

ARTICLE INFO

Article History:
Received 02nd May, 2016
Received in revised form
20th June, 2016
Accepted 26th July, 2016
Published online 30th August, 2016

Keywords:
Wild fruit,
Minerals,
Vitamin A,
Chad.

ABSTRACT

The composition of minerals and vitamin A of *Ziziphus mauritiana* Lam. ; *Detarium microcarpum* (Guill. & Perr.); *Balanites aegyptiaca* (L.) Del.; *Vitellaria paradoxa* Gaertn. F.; *Tamarindus indica* L. ; *Hyphaene thebaïca* Mart. ; *Borassus aethiopum* Mart. ; *Adansonia digitata* L. ; *Vitex donania* Sweet. ; *Parkia biglobosa* (Jacq.) Benth. was studied and quantified in tree Departments of Chad. The minerals were determined by spectrometry and photometry and vitamin A was determined by HPLC. The results showed that the copper content were ranged from 117±3,25 to 298,1±1,27mg/100g, manganese content were ranged from 273,5±3,53 to 11052,5±4,94mg/100g, sulfur content were varied from 25±2,82 to 16918±2,82mg/100g and vitamin A varied from 16,03 to 191,91mg/100g . These results show that wild fruits are a good source of minerals and vitamin A.

INTRODUCTION

The vegetation of the Sahelian zones allow to have the necessary resources such as pasture for flocks coming from the Sahara and Sahel regions during the rainy season and also trees and fruits consumed by the population of this area (Blench, 2002; Bastide et Ouedraogo, 2008 ; Gning *et al*., 2013; Kouyaté, 2005). In Sudano-Sahelian Africa, about 90% of wood energy needs are assured by the forestry training for urban and rural populations (Gning *et al*., 2013). Thus, the vegetation in this area is not spared from illegal woodcutting and the presence of most fruit trees scattered in the savannah are not spared by this degrading environment practice (Ambé, 2001; Makumbelo *et al*., 2007). These berries are met at the weekly markets of villages and almost every day in the city markets. These fruits appear seasonally and are sold in markets. But some of them are preserved and consumed even during the lean period by villagers (Tchago et Moupeng, 2002). These small business operations are performed mainly by women and children the most vulnerable segments of society that perform themselves gathering and collecting in small savanna forests that surround the towns and villages (Ake *et al*., 2006). Among these fruits, we can quote the best known are among other fruits like *Ziziphus mauritiana* Lam. ; *Parkia biglobosa* (Jacq.) Benth. ; *Balanites aegyptiaca* (L.) Del.; *Vitellaria paradoxa* Gaertn. F. and many others. Yet nutritionally, fruits in general are a necessary complement the basic plans consist of cereals and starchy foods, particularly poor in minerals and vitamins (Kouyaté *et al*., 2009; Krishnamurthy et Sarala, 2012). They are rich in minerals and vitamins and are consumed during the lean season and by the people (Compaoré *et al*., 2011; Kouebou *et al*., 2013). The aim of our study is to identify wild fruits of economic importance present in our markets and identify some of these mineral compositions of fruits and vitamins.

Corresponding author: Marceline Mouti, Makalao,
Department of Biochemistry and Biotechnology, Research Center in Biological, Food and Nutritional Sciences (CRSBAN), Unit of Formation and Research in Life and Ground Sciences, University of Ouagadougou; BP: 7021, Ouagadougou, Burkina Faso

MATERIALS AND METHODS

Choice of species

According to the Food Resources Program (Eyog *et al*., 2002), the Sudano-Sahelian zone of Niger, who did not have data on Chad, the following species have been classified in relation with their distribution density in nature reserves and around the town the socio-economic value, timber production and nutritious food products: *Balanites aegyptiaca* (L.) Del.; *Ziziphus spina christi* (L.) Desf. ; *Boscia senegalensis*; *Tamarindus indica* L. ; *Hyphaene thebaïca* Mart. ; *Borassus aethiopum* Mart. ; *Adansonia digitata* L. ; *Vitex donania* Sweet. ; *Parkia biglobosa* (Jacq.) Benth.; *Boscia senegalensis. Boscia senegalensis*, *Ziziphus spina christi* (L.) Desf.and *Sclerocarya birrea*, which is not found in the market, have been replaced by *Detarium microcarpum* (Guill & Perr.), *Balanites aegyptiaca* (L.) Del. And *Vitellaria paradoxa* C.F.Gaertn.

Selection of the study areas

Chad is located in the 8th and 24th degrees latitude North and the 13th and 24th degrees East longitude (Oumkalsoum, 2004). Three departments were selected for the study. They were chosen because of the geographical position because they are in the Sudan region: 7th and 11th degrees latitude North and 14th and 24th degrees East longitude, located in the deep South of the country, have the same climate and therefore almost the same vegetation (Baohoutou-Laohote, 2007). We have the Department of Mayo-Kebbi Est Region headed Bongor place, is located 253 km south of N'Djamena, is in the Sudano-Sahelian zone: 10th and 31st North latitude and 15th and 37th East longitude (INSEED, 2009), with annual rainfall of 800 mm and vegetation is wooded savannah dominated with acacia presence Combretaceae. The Department of Tandjilé headed instead Lai, is located 400 km South of N'Djamena: 9th and 37th and 16th latitude North and 32 East longitude. The Department of Kabbia headed Gaya place is located 350 km from N'Djamena: 9th and 62nd and 15th North latitude and East longitude 5th (INSEED, 2009). These two regions are in the Sudanese region with annual rainfall of 1000 mm and vegetation are clear Combretaceae forests and savannas with mixture of legumes such as shea butter, African locust and Combretaceae (Baohoutou-Laohote, 2007).

Field investigations

Samples collection and pre-treatment

The fruits are purchased in urban markets and fees are transported in coolers (equipped with ice packs or icebox). Sudanese region is rather Region Sudan. Transport of samples of N'djamena in Ouagadougou was done in refrigerated conditions. The ten fruits were identified at the Department of Botany, University of Ouagadougou. Each of the fruits mesocarp was scooped with knife and stored in clean plastic containers prior analysis. The endocarps of fruits were removed and pulp of fresh fruit and dried fruit such than *Adansonia digitata* L., *Balanites aegyptiaca* (L.) Del., *Detarium microcarpum* (Guill. & Perr.), *Hyphaene thebaïca* Mart., *Tamarindus indica* L. and *Parkia biglobosa* (Jacq.) Benth. were picked for analysis of possible. The fruits of *Ziziphus mauritiana* Lam. were ground, sieved with a sieve Analysensieb. AFNOR-ASIM W: 500; Nr: 152014. Rahmen Edelsdahl to remove the kernels. All analyzes were repeated 2 times.

Determination of metal ions in the mesocarp fruits

Mineralization was achieved through dry ashing. The ash obtained contains (Cu, Mn, Na, S).

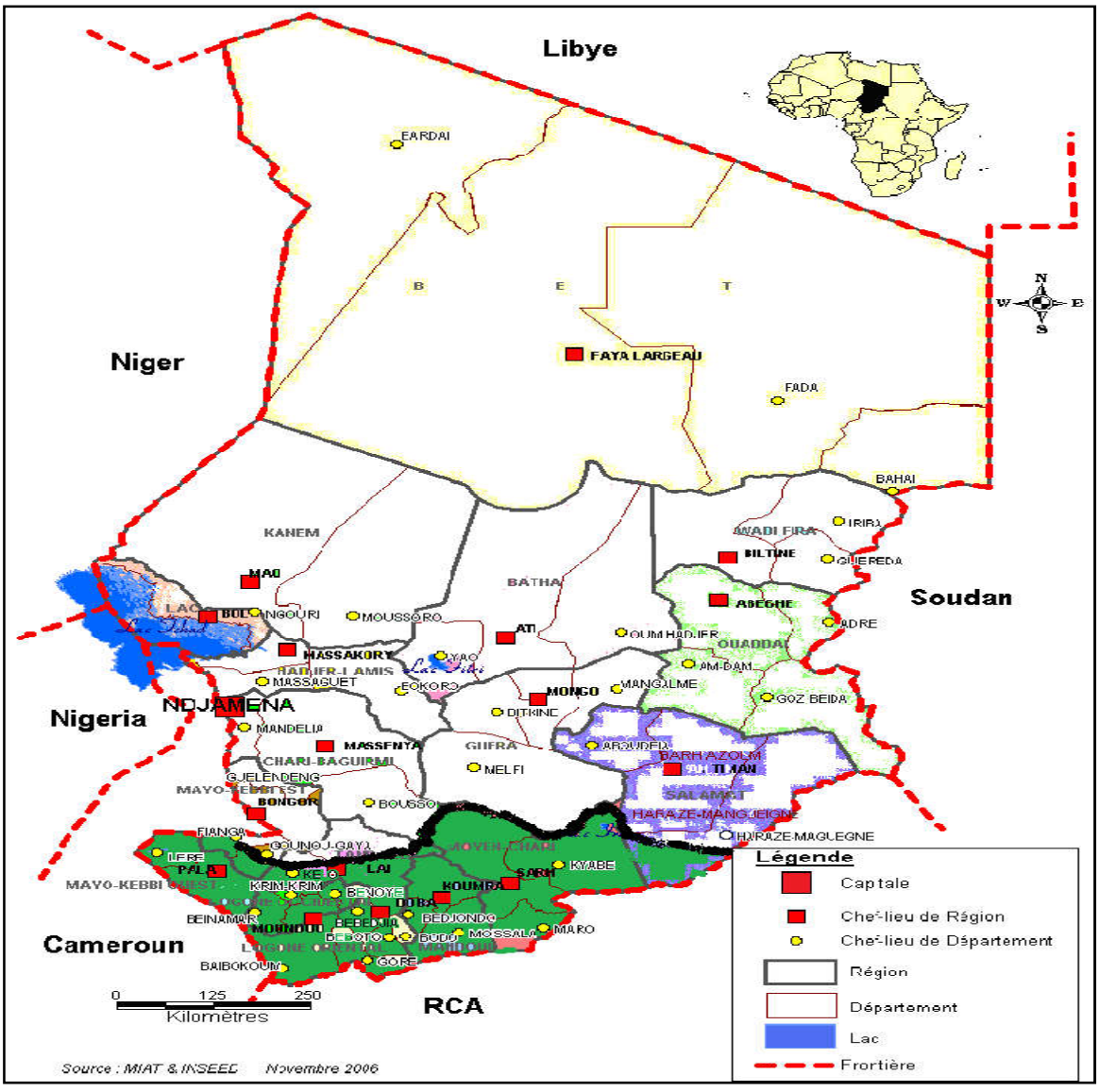

Figure 1. Samples sites (Source: TCHAD ORCE, 2009)

These minerals were determined by Atomic Absorption Spectrometry (with a PELKIN Elmer model 3110 device, Connecticut, USA). A hollow Al-Ca-Cu-Fe-Mg-Si-Zn cathode lamp was used. Potassium was measured using a flame photometer (Corning 400, Essex, England); phosphorus was determined with Skalar auto analyser (Skalar, Breda, The Netherlands). (Pinta, 1973).

Determination of Sulfur

The essay was done according to the method of (Chaudry *et al.,* 1966). Mineralization was made from a fruit pulp gram. 6 ml were taken from the mineral deposit which 0.36 g was added $BaCl_2$. After stirring, allowed to stand for 30 minutes and then was added 4 ml of the compound of polyvynil alcohol 2.5ml stabilizing solution 1%, 25ml glycerol and 72,5ml distilled water. The absorbance of the solution was then measured in a spectrophotometer at 440 nm.

Determination of Vitamin A

The HPLC system that was used for the analysis of the Beta carotene consists of a pump model JASCO PU 980, a UV / Visible JASCO 975 a chromatographic column Nucleosil C18, SUPELCOLC18 model to 25 mm long, 4.6 mm in diameter with particles of size 5µm. The system was connected to a computer with software (Galaxy Work Station) integration and data processing. The test sample through a column filled with a stationary phase and is driven by a carrier solvent called the mobile phase. The active ingredients of the sample migrate differentially according to their polarity and their density. On leaving the column, each active ingredient is quantified by a detector. On the chromatogram, the active ingredient is represented by a curve that is characterized by its area and retention time. For the content, so it is necessary to have a standard of beta-carotene.

RESULTS

Table 1. Composition of copper of different fruits in tree sites

Fruits	Sites		
	Bongor	**Gaya**	**Laï**
Adansonia digitata L.[1]	136±1,27[a]	130,4±1,97[a]	143,77±2,86[b]
Balanites aegyptiaca (L.) Del.[1]	271,8±3,53[e]	263,62±1,3[e]	260,85±5,86[e]
Detarium microcarpum (Guill. & Perr.)[1]	236,55±6,85[f]	232,65±1,76[e]	248,35±0,63[f]
Hyphaene thebaïca Mart.[1]	159,57±1,66[d]	206,65±6,71[f]	223,35±1,9[f]
Parkia biglobosa (Jacq.) Benth.[1]	260,4±3,25[f]	240,95±4,87[f]	245,4±6,22[e]
Tamarindus indica L.[1]	297,95±1,2[f]	280,85±1,48[e]	297,65±2,72[f]
Ziziphus mauritiana Lam.[1]	130,35±0,35[d]	117±3,25[b]	139±0,28[a]
Borassus aethiopum Mart.[2]	292,55±8,13[e]	160,47±0,67[c]	288,05±2,75[f]
Vitex donania Sweet.[2]	292,1±0,98[e]	286,05±3,7[d]	298,1±0,28[f]
Vitellaria paradoxa Gaertn. F.[2]	276,75±3,04[e]	267,25±2,47[e]	236,8±1,27[e]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 2. Composition of manganese of different fruits in tree sites

Fruits	Sites		
	Bongor	Gaya	Laï
Adansonia digitata L.[1]	4124±1,41[ab]	3204,5±4,94[a]	1632±5,65[a]
Balanites aegyptiaca (L.) Del.[1]	7476,5±0,7[ab]	201,5±0,7[b]	471,5±0,7[c]
Detarium microcarpum (Guill. & Perr.)[1]	5727,5±3,53[c]	8450,5±2,12[c]	6991,5±4,94[b]
Hyphaene thebaïca Mart.[1]	502±1,41[d]	273,5±3,53[d]	1930±4,24[c]
Parkia biglobosa (Jacq.) Benth.[1]	8682,5±2,12[e]	10448,5±2,12[e]	11052,5±4,94[d]
Tamarindus indica L.[1]	991±1,41[f]	3250,5±2,12[a]	2018,5±2,12[e]
Ziziphus mauritiana Lam.[1]	2047,5±0,7[g]	2075,5±2,12[f]	1322,5±2,12[f]
Borassus aethiopum Mart.[2]	2432±5,65[h]	3179,5±2,21[a]	3210±1,41[g]
Vitex donania Sweet.[2]	3248,5±4,94[i]	3248,5±1,41[g]	3742,5±3,53[h]
Vitellaria paradoxa Gaertn. F.[2]	2848,5±2,21[j]	2837,5±3,53[ab]	2937±4,24[i]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 3. Composition of phosphorus of different fruits in tree sites

Fruits	Sites		
	Bongor	**Gaya**	**Laï**
Adansonia digitata L.[1]	74±2,82[a]	62,5±3,53[a]	58,5±2,12[a]
Balanites aegyptiaca (L.) Del.[1]	33±1,41[b]	31±5,65[b]	5,5±2,12[d]
Detarium microcarpum (Guill. & Perr.)[1]	45,5±2,12[b]	44±5,65[a]	30±5,65[a]
Hyphaene thebaïca Mart.[1]	90,5±3,53[ab]	75±4,24[c]	73,5±4,94[ab]
Parkia biglobosa (Jacq.) Benth.[1]	46±1,41[b]	61±2,82[a]	46±2,82[ab]
Tamarindus indica L.[1]	46,5±0,7[b]	60±1,41[ab]	51±4,24[c]
Ziziphus mauritiana Lam.[1]	74,5±0,7[a]	58±1,41[a]	45±7,07[c]
Borassus aethiopum Mart.[2]	46,5±2,12[b]	50,5±4,94[ab]	46,5±4,94[ab]
Vitex donania Sweet.[2]	77,5±0,7[b]	89±1,41[ab]	78±1,41[a]
Vitellaria paradoxa Gaertn. F.[2]	45,5±2,12[b]	30,5±0,7[c]	30,5±6,36[ab]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 4. Composition of potassium of different fruits in tree sites

Fruits	Sites		
	Bongor	Gaya	Laï
Adansonia digitata L.[1]	1945,5±2,12[d]	2123±4,24[i]	1954,5±4,94[a]
Balanites aegyptiaca (L.) Del.[1]	2347±4,24[d]	3021,5±0,7[i]	3131,5±2,12[b]
Detarium microcarpum (Guill. & Perr.)[1]	1608,5±0,7[e]	1901±1,41[h]	1183±4,24[c]
Hyphaene thebaïca Mart.[1]	2524,5±6,36[d]	4092,5±3,53[i]	465±7,07[d]
Parkia biglobosa (Jacq.) Benth.[1]	1605,5±7,77[e]	1653±4,24[i]	1722,5±3,53[e]
Tamarindus indica L.[1]	2102±1,41[e]	1252±1,41[g]	1383,5±4,94[b]
Ziziphus mauritiana Lam.[1]	1943,5±4,94[d]	2001±2,82[g]	1989,5±3,53[f]
Borassus aethiopum Mart.[2]	2014,5±0,7[d]	2572±2,82[g]	2417±0,7[b]
Vitex donania Sweet.[2]	1991±1,41[d]	2413,5±4,94[g]	2281,5±2,12[b]
Vitellaria paradoxa Gaertn. F.[2]	2123±4,24[d]	1774,5±6,36[h]	1811±1,41[b]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 5. Composition of sodium of different fruits in tree sites

Fruits	Sites		
	Bongor	Gaya	Laï
Adansonia digitata L.[1]	1,35±0,49[a]	1,45±0,49[a]	1,9±1,13[a]
Balanites aegyptiaca (L.) Del.[1]	2,25±0,91[a]	2,35±0,63[a]	2,2±0,7[a]
Detarium microcarpum (Guill. & Perr.)[1]	1,35±0,63[a]	1,35±0,35[a]	1,35±0,49[a]
Hyphaene thebaïca Mart.[1]	2,4±0,98[a]	2,35±0,63[a]	1,65±0,21[a]
Parkia biglobosa (Jacq.) Benth.[1]	1,35±0,49[a]	1,3±0,28[a]	1,75±1,2[a]
Tamarindus indica L.[1]	0,8±0,28[a]	1,3±0,42[a]	0,8±0,28[a]
Ziziphus mauritiana Lam.[1]	1,55±0,49[a]	1±0,28[a]	1,55±0,49[a]
Borassus aethiopum Mart.[2]	1,85±0,63[a]	1,9±0,56[a]	3,8±0,7[a]
Vitex donania Sweet.[2]	1,8±0,7[a]	1,75±0,63[a]	1,35±0,07[a]
Vitellaria paradoxa Gaertn. F.[2]	1,45±0,49[a]	1,4±0,56[a]	1,35±0,49[a]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 6. Composition of sulfur of different fruits in tree sites

Fruits	**Sites**		
	Bongor	**Gaya**	**Laï**
Adansonia digitata L.[1]	59,5±0,7[a]	65,5±6,36[a]	25,5±0,7[a]
Balanites aegyptiaca (L.) Del.[1]	38,5±2,12[a]	76,5±4,94[a]	37,5±3,53[a]
Detarium microcarpum (Guill. & Perr.)[1]	59±1,41[a]	49,5±6,36[a]	87,5±0,7[a]
Hyphaene thebaïca Mart.[1]	236±5,65[e]	318±2,82[b]	477±1,41[b]
Parkia biglobosa (Jacq.) Benth.[1]	54±1,41[ab]	39±1,41[a]	39,5±0,7[a]
Tamarindus indica L.[1]	39±1,41[ab]	5643±4,24[c]	11265±7,07[c]
Ziziphus mauritiana Lam.[1]	30,5±0,7[e]	71±1,41[a]	25±2,82[c]
Borassus aethiopum Mart.[2]	12072,5±3,53[b]	10491,5±2,12[d]	16918±2,82[d]
Vitex donania Sweet.[2]	6449±2,82[c]	7251,5±2,12[e]	7244±1,41[e]
Vitellaria paradoxa Gaertn. F.[2]	17712±4,24[d]	7250,5±0,7[e]	7252,5±3,53[e]

[1] : mg / 100 g of dry matter (DM). [2] : mg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Table 7. Composition of vitamin A of different fruits in tree sites

Fruits	**Sites**		
	Bongor	**Gaya**	**Laï**
Adansonia digitata L.[1]	20,23±0,58[a]	22,95±0,65[a]	26,56±0,02[a]
Balanites aegyptiaca (L.) Del.[1]	44,3±0,65[b]	48,42±0,42[b]	41,12±0,43[a]
Detarium microcarpum (Guill. & Perr.)[1]	34,6±0,61[ab]	39,16±0,67[c]	35,2±0,37[a]
Hyphaene thebaïca Mart.[1]	60,94±0,16[d]	65,33±0,43[a]	58,27±0,48[b]
Parkia biglobosa (Jacq.) Benth.[1]	191,91±0,1[c]	184,94±0,16[c]	182,11±0,08[a]
Tamarindus indica L.[1]	39,01±0,14[ab]	32,92±0,1[c]	35,76±0,56[ab]
Ziziphus mauritiana Lam.[1]	28,03±0,28[d]	36,9±0,35[c]	38,67±0,73[ab]
Borassus aethiopum Mart.[2]	19,55±0,67[a]	24,94±0,18[ab]	21,87±0,17[a]
Vitex donania Sweet.[2]	24,89±0,49[c]	17,99±0,33[a]	16,03±0,41[ab]
Vitellaria paradoxa Gaertn. F.[2]	45,82±0,5[a]	26,37±0,34[ab]	32,99±0,73[a]

[1] : µg / 100 g of dry matter (DM). [2] : µg / 100 g of fresh matter (FM).

Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.

Analysis and processing of data

Means, standard deviations were calculated based on the Microsoft Office software Excel 2007 and the means were compared by mean comparison analysis by T test for paired samples for each element studied, taking into account the types of fruits per site, and every kind of fruit for the three study sites based SPSS Statistics 20.0 software. The significance of the results was calculated at 5% level.

DISCUSSION

Mineral content of fruits

In general, variability in the chemical content are reported to be dependent on soil, climatic variations, genetic factors and maturity and the storage conditions of fruits (Edwige *et al*., 2014). Our fruits generally have high levels of copper and manganese compared to the work of other researchers. Pulp of *Vitex doniana* Sweet. contains the highest copper (298.1mg / 100g DM) in Gaya. The content of *Adansonia digitata* L. fruits (136 mg / 100g MS) in Bongor is also far higher than 1,6mg / MS 100g found in Saudi Arabia (Magdi, 2004) and 1.5 mg / 100 g DM found in Madagascar (Ibrahim *et al*., 2013). The same is done for fruit of *Balanites aegyptiaca* (L.) Del. with the highest content (271.8mg / MS 100g) in Bongor greater than 0.39 mg / 100 g DM found in Senegal (Sagna *et al*., 2014); and also to *Hyphaene thebaica* Mart. with the highest content (223.35 mg / 100 g DM) in Lai is greater than 0,102mg / 100g DM found in Nigeria (Nwosu *et al*., 2008). The highest manganese content is noted for those fruits of *Parkia biglobosa* (Jacq.) Benth. in Lai (11052mg / 100g DM) which is well above 78.53mg / MS 100g found in Burkina Faso (Compaoré *et al*., 2011); and for those of *Balanites aegyptiaca* (L.) Del. (201.5 mg / 100 g DM) which is also greater than 0,33mg / MS 100g found in Senegal (Sagna *et al*., 2014). The fruits of *Adansonia digitata* L. whose contents range from 1632-4124mg / 100 MS are greatly superior to 0.6-2,2mg / 100g DM found in Madagascar in different sites (Ibrahima *et al*., 2013). The fruits of *Tamarindus indica* L. whose contents range from 991-3250.5mg / 100 MS are also greatly superior to 0,06-21,5mg / MS 100g found in cities in Africa (Emmy *et al*., 2010).

When the phosphorus content, the following fruits have lower levels to the results of some researchers. Those of *Balanites aegyptiaca* (L.) Del. ranging from 5.5-33mg / 100 MS are less than 48mg / 100g MS found in Senegal (Sagna *et al*., 2014).The fruits of *Adansonia digitata* L. with values ranging from 58.5-74mg / DM 100g are below to 105.2mg / 100 MS found in Nigeria (Oyeleke *et al*., 2012). The fruits of *Borassus aethiopum* Mart. the results vary from 46.5-50.5mg / FM 100g are much lower than 567mg / 100g FM found in Cameroon (Ali *et al*., 2010). As for *Tamarindus indica* L. fruit, results ranging from 46.5-60mg / MS 100g are in same results between 34-78mg / MS 100g found in several of Senegal (El-Siddig *et al*., 2006) and that of 0.12 to 113 mg / 100 g DM found in several cities in Africa (Emmy *et al*., 2010). The potassium content of our fruits is variable. Those of *Adansonia digitata* L. whose contents range from 1945-2123mg / MS 100g are similar to 2221-3054mg / 100g found in several sites in Madagascar (Ibrahim al., 2013), above 1240 mg / 100g MS found in Saudi Arabia (Magdi, 2004) and 1410,35mg / 100g MS found Nigeria (Oyeleke *et al*., 2012). The fruit of *Balanites aegyptiaca* (L.) Del. Whose contents range from 2347-3131.5mg / DM 100g exceed 2220mg / 100g of MS found in Senegal (Sagna *et al*., 2014). The fruits of *Parkia biglobosa* (Jacq.) Benth. The results vary from 1605.5-1722.5mg / MS 100g are much higher than 441.36mg / MS 100g found in Burkina Faso (Compaoré *et al*., 2011). The sodium content of our fruits is lower compared to those found by other researchers. Thus the fruits of *Adansonia digitata* L. Whose values ranging from 1.35-1.9mg / 100 MS are much lower 27.9mg / 100 MS found in Saudi Arabia (Magdi, 2004) and 35.1 mg / 100 g DM found in Nigeria (Oyeleke *et al*., 2012); The fruit of *Balanites aegyptiaca* (L.) Del. The results vary from 2.2-2.35mg / 100 MS are lower than 48mg / 100g MS found in Senegal (Sagna *et al*., 2014). Those of *Parkia biglobosa* (Jacq.) Benth. The results vary from 1.3-1.75mg / MS are less than 100g 31.22mg / MS 100g found in Burkina Faso (Compaoré *et al*., 2011). The highest sulfur content is noted for fruit of *Vitellaria paradoxa* Gaertn. F. (17712mg / 100g MF) and lowest for those of *Ziziphus mauritiana* Lam. (25mg / 100g DM) both to Lai. Compared with dried fruits, sulfur contents fresh fruit are higher. This is explained by the condition of the fruit because the evaporation of water could reduce the sulfur content.

Vitamin A

The levels of vitamin A in our fruits are variable. The highest is noted for those of *Parkia biglobosa* (Jacq.) Benth. In Bongor (191,91µg / 100g DM) and the lowest grade is noted for those *Vitex donania* Sweet. In Lai (16,09µg / 100g DM). Fruit of *Detarium microcarpum* (Guill & Perr) present the following results (Bongor: 34,6µg / MS 100g, Gaya 39,16µg / MS 100g, Lai: 35,2µg / 100g MS) that are below 312µg / MS 100g and *Vitex doniana* Sweet fruit. Present the following results (Bongor: 24,89µg / 100 MS, Gaya 17,99µg / MS 100g, Lai: 16,03µg / 100g DM) which are higher than 11µg / 100g MF both found in Burkina Faso (Kini *et al*., 2008). Vitamin A acts as absorbing visual pigment light. The vitamin A deficiency compromises the formation of rhodopsin, pigment mediator of twilight vision. The systematic function of vitamin A is to ensure growth, general health and life itself (FAO / WHO, 1989).

Conclusion

Of the 10 studied fruit, we see that the fruits of *Parkia biglobosa* (Jacq.) Benth. Have highest levels of manganese contents and vitamin A than 9 other fruits in all 3 sites. The fruits of *Vitex doniana* Sweet. Have the higher level of copper, those of *Hyphaene thebaica* Mart. Have the highest levels of phosphorus and potassium and those of *Borassus aethiopum* Mart. Have the highest levels of sodium and sulfur. These results show that the fruits are good source of minerals and vitamin A.

Conflict of Interests

The author(s) have not declared any conflict of interests.

Acknowledgements

The authors gratefully thank the French embassy in Chad, through the Cooperation and Cultural Action Service (SCAC)

at N'Djaména and Ouagadougou for their financial support. Our thanks also go to Mr. Bénoît Sa TRAORE, laboratory technician at CRSBAN, for his cooperation and availability on his days-off.

REFERENCES

Ake, C.B., Koné, M.W., Kamanzi, A., et Aké. M. 2006. Evaluation de quelques propriétés biologiques de produits de cueillette non ligneux vendus sur les marchés d'Abidjan et ses environs. *Pharm. Med. Trad. Afr*. 14: 1-17.

Ali, A., Alhadji, D., Tchiegang, C. and Saïdou, C. 2010. Physico-chemical properties of Palmyra palm (*Borassus aethiopum* Mart.) fruits from Northern Cameroon. *African Journal of Food Science.* 4(3): 115-119.

Ambé , G. 2001. Les fruits comestibles des savanes guinéennes de Côte-d'Ivoire : état de la connaissance par une population locale, les Malinké. *Biotechnocol. Agron. Soc. Environn. 2001* (*1),* 43-58.

Baohoutou L. 2007. Les précipitations en zone soudanienne Durant les quatre dernières décennies (1960-1999) : variabilités et impacts. Thèse de Doctorat de Géographie. Université de Nice Sophia Antipolis, France. P 1-230.

Bastide, B., et Ouedraogo, S.J. 2008. Rejets de *Detarium microcarpum* et feux précoces. Bois et Forêts des Tropiques. 296 : 2.

Blench R. 2002. Arbres fruitiers sauvages protégés en préfecture du Logone oriental. Projet Exxon/Mobil/Esso-Tchad. Institute Overseas Development à Londres. MEGA-TCHAD 2002.

Chaudry, I.A., Massoumi, A., Cornfield, A.H. 1966. Bulletin Technique n° 14. The Sulfur Institute Washington.

Compaore, W. R., Nikièma, P.A., Bassolé, H. I. N., Savadogo, A., Mouecoucou, J., Hounhouigan, and Traore, S.A. 2011. Chemical composition and antioxidative properties of seeds of *Moringa oleifera* and pulps of *Parkia biglobosa* and *Adansonia digitata* commonly used in food fortification in Burkina Faso. *Current Research Journal of Biological Science.* 3(1): 64-72.

Edwige, T.D.N., Charles, P., Niéyidouba, L., Aminata, S., Margarida, C.E.A., Joseph, B.I. 2014. Nutritional composition of five food tree species products used in human diet during food shortage period in Burkina Faso. *African Journal of Biotechnology*. 13(17): 1807-1812.

El-Siddig, K., Gunasena, H., Prasad, B., Pushpakumara, D., Ramana, K., Vijayand, P., and Williams, J. 2006. Tamarind (*Tamarindus indica* L.), British Library Southampt, Southampton Centre for Underutilized Crops, UK. 210p.

Emmy, D. C., Katerina, H., Patrick, V.D. 2010. *Tamarindus indica*.- a review of traditional uses, Phytochemistry and pharmacology. Africa Focus 23: 53-83.

Eyog, M.O., Gaoué, O.G., Dossou. B. 2002. « Espèces ligneuses Alimentaires ». IPGRI: International Plant Genetic Resources Institute. Réseau "Espèces ligneuses alimentaires". Compte rendu de la première réunion du réseau 11-13 décembre 2000, CNFS Ouagadougou, Burkina-Faso.

FAO/WHO. 1989. Codex Alimentarius Commission. Report of the sixteenth session of the Codex Committee of The Nutrition And Foods Fof Special Dietary Uses Bonn-Bad Godesberg, Federal Republic of Germany, 29 september- 7 october.

Gning, O.N., Sarr, O., Gueye, M., Akpo, L.E., Ndiaye, P.M. 2013. Valeur socio-économique de l'arbre en milieu malinké (Khossanto, Sénégal). *Journal of Applied Biosciences*, 70 : 5617-5631. ISSN 1997-5902 ;

Ibrahima, C., Didier, M., Max, R., Pascal, D., Benjamin, Y., and Renaud, B. 2013. Biochemical and nutritional properties of baobab pulp from endemics species of Madagascar and African mainland. *African Journal of Agricultural Research.* 8 (47): 6046-6054.

Inseed Rgph2. 2009. 2e Recensement de la Population et de l'Habitat. Résultats Globaux. République du Tchad.

Kini, F., Saba, A., Ouedraogo, S., Tingueri, B., Sanou, G., Guissou, I.P. 2008. Potentiel nutritionnel et pharmaceutique de quelques espèces fruitières « sauvages » du Burkina Faso. Pharmacopée et Médecine Traditionnelle Africaine. 15 : 32-33.

Kouebou, C., Fadi, G., Bourou, S., Kosga, D., Layla, H., Zenabou, G., Barbi, M., Vunyingah, M., Woin, N. 2013. Biodiversité et valeur alimentaire des fruits au Cameroun: observations préliminaires dans le Département de la Bénoué (Région du Nord). *Journal of Applied Biosciences*. 69 : 5510-5522.

Kouyaté, A.M. 2005. Aspects ethnobotaniques et étude de la variabilité morphologique, biochimique et phénologique de *Detarium microcarpum* Guill et Perr. au Mali. Mémoire de Thèse en Biosciences Ingénieurs. Section Agronomie. Faculté Bio-Ingénieurs. Université de GENT, Allemagne. P1-207.

Kouyaté, A.M., Damme, P.V., Meulenaer, B.D., Diawara, H. 2009. Contribution des produits de cueillette dans l'alimentation humaine. Cas de *Detarium microcarpum*. Africa Focus 22(1): 77-88.

Krishnamurthy, S.R., Sarala, P. 2012. Determination of nutritive value of *Ziziphus rugosa* Lamk.: A famine edible fruit and medicinal plant of Westhern Ghats. *Indian Journal of Natural Products and Resources*, 3(1): 20-27.

Magdi, A.O. 2004. Chemical and nutrient analysis of baobab (*Adansonia digitata*) fruit and seed solubility. Plant Food for Human Nutrition, 59: 29-33.

Makumbelo, E., Lukoki, L., Paulos, J., et Luyindula, N. 2007. Stratégies de valorisation des espèces ressources en produits non ligneux de la savane des environs de Kinshasha. I. Enquête ethnobotanique. Tropicultura 25(1).

Nwosu, F.O., Dosumu, O.O., Okocha, J.O.C. 2008. The potential of *Terminalia catappa* (Almond) and *Hyphaene thebaica* (Dum palm) fruits as raw materials of livestock feed. African Journal of Biotechnology 7(24): 4576-4580.

Oumkalsoum M A. 2004. Mémoire de fin d'études pour le Brevet de Technicien Supérieur. Option Tourisme. Ecole Supérieure d'Interprétation et de Traduction de Techniques Administratives de Management et de Gestion Hôtelière de Dakar (E.T.S.H.O.S). P 1-45.

Oyeleke, G.O., Salam, M.A., and Adetoro, R.O. 2012. Some aspects of the nutrient analysis of seed, pulp and oil of baobab (*Adansonia digitata* L.). IOSR (*Journal of Environnemental Science, Toxicology and Food Technology (IOSR-JESTFT*). 1(4): 32-35.

Pinta, M. 1973. « Méthodes de Référence pour la Détermination des Eléments Minéraux dans les Végétaux. Détermination des Eléments Ca, Mg, Fe, Mn, Zn et Cu par Absorption Atomique », Oléagineux. 28(2) : 87-92.

Sagna, M.B., Diallo, A., Sarr, P.S., Ndiaye, O., Goffner, D., Guisse, A. 2014. Biochemical composition and nutritional value of *Balanites aegyptiaca* (L.) Del. fruit pulps from Northern Ferlo in Senegal. *African Journal of Biotechnology,* 13(2): 336-342.

Tchad Orce. 2009. Document de stratégie pays 2010-2014. Département Régional Centre, Octobre 2009.

Tchago, B., Moupeng, B. 2002. Les produits alimentaires en période de soudure dans la zone sahélo-soudanienne. Cas des régions du lac Fitri et des lacs de Léré (Tchad). MEGA-TCHAD 2002. Université de N'Djamena.

****