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Nutritional Values of *Carica papaya* L. and *Balanites eagyptiaca* Del. Seeds, Two Herbal Infusions in Traditional Medicine

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Abstract *Carica papaya* Linn and *Balanites eagyptiaca* Del. fruits, commonly known as papaya and balanites, are widely used as food, while the seeds are mostly discarded despite their medicinal properties. This study highlights the nutritional value of papaya and balanites seeds, as medicinal herbal teas. The analysis of the physicochemical properties and the proximate composition was performed, based on standard methods. Atomic absorption method was used for minerals determination, High Performance Liquid Chromatography method for the amino acids profile determination and Gas chromatography mass spectrophotometer for fatty acids analysis. The results showed a low moisture content of papaya compared to balanites. The pH ranged from 5.85 to 6.11 for balanites and from 5.02 to 5.86 for papaya seeds, associated with an acidity ranged from 0.47 to 1.52 for papaya and from 0.72 to 0.76 for balanites seeds. The papaya and balanites seeds both presented high contents of lipids (30.36 to 46.23 g/10g), proteins (34.93 to 35.62 g/10g) and essential minerals content (mg/100g), such as potassium (35-68 and 40-95), calcium (366-439 and 238-261), and magnesium (131-312 and 104-260). Except of Thr, all targeted amino acids were detected, with a higher content of essential amino acids in the papaya seeds. Twenty-five (25) fatty acids, including α-linolenic acid, an omega 3, were quantified and, an appreciable diversity and values of fatty acids were observed. The infusion and decoction processes did not impact the nutritional value. These appreciable nutritional values of papaya and balanites seeds constitute an additional value to their primary use as medicinal herb teas. They could contribute to increase a speedy recover during medical cares.

Keywords: *papaya, balanites, seeds, nutritional value, herbal tea*

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1. Introduction

Papaya (*Carica papaya* L.) is a tree-like herbaceous plant belonging to the family of Caricaceae, known for its diverse uses [1]. Papaya is found in all tropical and sub-tropical regions of the world. Balanites aegyptiaca, which belongs to the Zygophyllaceae family and popularly known as desert date, is widely distributed in dry land areas of Africa and South Asia [2]. Several parts of the tree have been used for centuries in many communities. These two trees are commonly known for their uses as food and traditional medicine, worldwide [2,3]. *Carica papaya* is largely used in tropical folk medicines, and several reports exist on its antidiabetic, antihyperlipidemic, hypoglycemic activities nephroprotective, bactericidal, anti-oxidant, anti-inflammatory activities, anthelmintic, antifungal, antimalarial, anti-amoebic, hepatoprotective and immunomodulatory [4-11]. Different parts of the plant are attributed with different medicinal purpose. For example, its fresh leaves are effective for treating gonorrhea, syphilis and amoebic dysentery [12]; the mature (ripe) fruit treats ringworm; the green fruits treat high blood pressure, and are used as an aphrodisiac [13]. Balanites aegyptiaca, *for instance*, is traditionally used in the treatment of various injuries as jaundice, intestinal worm infection, wounds, malaria, syphilis, epilepsy,

dysentery, constipation, diarrhea, hemorrhoid, stomach aches, asthma, and fever. In Burkina Faso, *Balanites aegyptiaca* seeds are directly consumed as food like hazelnut while *Carica papaya* seeds are used as herbal tea. They are usually ground, diluted in hot or cool water, boiled, drink alone or associated with honey, lemon, or sugar. They can then be considered as food next to their medical properties. The phytochemicals and the biochemical content of several varieties of papaya and desert date have been determinate around the world to appreciate their nutritional the nutritional property in addition to their medical role. They can be considered as functional food. They are important sources of minerals, fatty acids, proteins and several phytochemicals [3,14-18]. But, despite their use in traditional medicine in communities in Burkina Faso some decades ago, the nutritional value of both papaya and desert date seeds remain unlighted up to date. This study aimed to evaluate the nutritional values of both papaya and balanites seeds as traditional medicine in endogenous communities.

2. Material and Methods

2.1. Sampling

Both *Balanites aegyptiaca* and *Carica papaya* seeds are purchased in local markets, mainly in Ouagadougou and Ziniaré. Base on the aspect and color, sellers recognized different varieties of papaya that was all sampled. Papaya seeds were sometime washed or not. These aspects have been taken into account during the sampling to appreciate their impact on the biochemical compounds. Papaya seeds have been dried under shade. Two (02) balanites seed samples of 50 kg each and six (06) papaya seed samples of 5 kg each were collected base on criteria mentioned above. Samples are encoded as presented in Table 1.

Table 1. Description of papaya and balanites seed samples

Code	Meaning
BAZI	Balanites from Ziniaré
BAOA	Balanites from Ouagadougou
PAOR	Washed papaya seeds of orange-red color and round fruit of rough skin
PASO	Washed papaya seeds of yellow to orange-red color and elongated fruit (solo)
PATO	Washed papaya seeds of yellow to orange-red color
PAJU	Washed papaya seeds of yellow only color and round fruit of rough skin
PMNL	Unwashed papaya seeds of yellow to orange-red color and mixed form of fruits
PMNT	Unwashed papaya seeds of yellow to orange-red color and mixed form of fruit

2.2. pH and Acidity

The pH was directly measured with a numeric pH-meter (WTW multi line P4) according to the method described by Nout et al., [19]. Ten grams (10 g) of each sample were suspended in 50 mL of sterile water, mixed and the pH was measured. Total acidity was quantified according to NF ISO7305 [20]. Ten grams (10 g) of each sample was added to 50 mL of distilled water and mixed. Then, 10 mL of the dilution was titrated against 0.1 N KOH using phenolphthalein as an indicator. The total acidity was calculated in percentage.

2.3. Proximate Composition Determination

Dry matter was determinate according to NF V 03 707 [21], by drying at 105±2°C overnight, ash content according to ISO 2171 [22] by incineration at 550°C for 12h, crude protein by Kjeldahl method and crude fat content by Soxhlet extraction using n-hexane as solvent [23]. The protein content was calculated using a conversion factor of 6.25. Total carbohydrate content was obtained using differential method and values were expressed in g/100 g of papaya or balanites whole seed dried matter.

2.4. Minerals

The content in minerals (Ca. Mg. Fe. Zn. Na. K. P) was analyzed as described by American Oil Chemists Society [24] based on the atomic absorption spectrophotometry spectrophotometric (AAS). Then, samples firstly digested in a tri-acid of H_2SO_4, HCl and HNO_3 were passed through the AAS system using different lamps and, calibrated for different micronutrients. Potassium and sodium were determined by flame photometer.

2.5. Free Amino Acids Analysis

For amino acid analysis, samples (100 mg) were firstly hydrolyzed with chloridric acid according to ISO 12830 [25]. The PICOTAG method was used for the derivatization of the amino acids. The reagent were composed of 7:1:1:1 solution of ethanol, triethylamine, water and phenylisothiocyanate. Amino acids profile of derivated samples were analyzed by reverse phase high performance liquid chromatography (HPLC) using Waters system 2496 equipped with a PICOTAG 3; 9×150mm column. Water controller 600, In-line Degasser, Waters 2487 UV Detector. The amino acids were identified and quantified by comparing the retention times and peak areas of samples with those of Thermo Scientific Pierce Amino Acid Standards.

2.6. Fatty Acids Analysis

Analysis of fatty acids was carried out according to the method described by Marfo and Afolabi [26], using gas-liquid chromatography after transesterification. The fatty acid methyl esters (FAME) were prepared according to the precedure described by Hartman and Lago [27]. The analyses of FAMEs were performed using a Varian 3900 GC gas-liquid chromatograph (Walnut Creek, USA), model equiped with a flame-ionization detector, a split-splitless injector, and an autosamplar. FAMEs were prepared using CP-Sil 88 fused silica capillary column (50m length, 0.25 mm internal diameter and 0.20µm film thickness). The column oven's temperature was initially held at 50°C for 2 minutes, heated at the rate of 4°C/minute up to 240°C, and maintained at 240°C for 20.5 minutes. The injector and detector temperatures were kept at 230 and 250°C, respectively. Samples of 1.0 µL were injected with a split ratio of 1:50. The carrier gas was hydrogen with a flow rate of 30mL/minute. FAMEs

were identified by comparing their retention times with those of pure FAME standards (Supelco, Bellefonte, USA) under the operating conditions and quantified by area normalization (%).

2.7. Statistical Analysis

Excel (2016) was used for data collection. Analysis, including average, Standard deviation, Analysis of variance and Newman-Keuls test were performed using XLSTAT 2014.5.03.

3. Results

3.1. Physical Properties and Proximate Composition

The physicochemical properties and proximate composition of papaya and balanites are summarized in Table 2. Moisture content ranged from 2.14 to 2.78 for balanitess seeds and from 4.82 to 6.23 for papaya seeds. The pH value of balanites seeds was higher than papaya seeds and the acidity of papaya seeds greater than balanites seeds. The total ash content was two time higher in papaya seeds than in balanites seeds and lipid content was higher in balanites seeds than in papaya. The protein content was similar in both balanites and papaya seeds.

Moisture content was more important in papaya than in balanites seeds (Table 2). The moisture content was homogenous for balanites seeds, with a significant difference among papaya seed samples.

3.2. Minerals Content of Papaya and Balanites Seeds

The mineral content of papaya and balanites seeds is summarized in Table 3. Calcium and magnesium were respectively the more representative minerals in papaya and balanites seeds, while zinc, iron and sodium had lower values. The potassium content varied from 40.04 to 95.40 for balanites and from 34.98 to 67.72 for papaya seeds.

3.3. Amino Acid Content of Papaya and Balanites Seeds

On average, aspartic acid was the most abundant amino acid in seeds, followed by tyrosine, leucine and glutamic acid. Alanine and lysine were the least representative. Methionine and valine were absent from the balanites seeds. However, thymine was not present in any sample and histidine was only present in the seeds of balanites from Ouagadougou. The amino acid profile of each sample was as shown in Table 4.

Table 2. Proximate composition and chemical properties of papaya and balanites seeds (g/100g of dried matter)

Code	Moisture	pH	Acidity	Lipids	Proteins	Carbohydrates	Ashes
PASO	5.45±0.04^{b}	5.28±0.01^{f}	1.35±0.00^{b}	30.36±0.08^{d}	35.36±0.06^{a}	20.48±0.00^{a}	8.37±0.05^{a}
PAJU	4.83±0.01^{c}	5.40±0.02^{e}	0.85±0.02^{c}	33.73±0.55^{c}	35.62±00^{a}	17.85±0.54^{b}	7.97±0.00^{b}
PATO	5.01±0.06^{c}	5.03±0.01^{g}	1.51±0.02^{a}	33.30±0.14^{c}	35.12±0.36^{a}	18.70±0.42^{b}	7.88±0.01^{b}
PAOR	6.16±0.11^{a}	5.56±0.01^{c}	0.47±00^{d}	33.42±0.41^{c}	34.93±00^{a}	17.74±0.45^{c}	7.76±0.06^{c}
PMTL	5.84±0.08^{a}	5.46±0.03^{d}	0.76±0.01^{c}	32.93±1.00^{c}	35.34±0.04^{a}	18.23±1.07^{b}	7.66±0.06^{c}
PMNL	5.36±0.02^{e}	5.04^{g}	1.33±0.01^{b}	34.16±0.33^{c}	35.56±0.03^{a}	17.34±0.21^{c}	7.59±0.11^{c}
APV	**5.10±0.05**	**5.29±0.01**	**1.04±0.01**	**32.98±0.41**	**35.32±0.08**	**18.39±0.45**	**7.87±0.04**
BAZI	2.61±0.24^{d}	5.86±0.01b	0.76±0.01^{c}	49.60±0.11^{a}	35.47±0.10^{a}	9.42±0.51^{e}	2.90±0.06^{d}
BAOA	2.32±0.25^{d}	6.11^{a}	0.73±0.01^{c}	46.23±0.59^{b}	34.90±0.05^{a}	13.59±1.33^{d}	2.97±0.44^{d}
ABV	**2.46±0.25**	**5.98**	**0.75±0.01**	**47.91±0.35**	**35.18±0.07**	**11.50±0.92**	**2.94±0.25**

The values in the same column with different letters are significantly different (p-value <0.05, Newman-Keuls test); APV: average of papaya values; ABV: average of balanites values.

Table 3. Minerals content of papaya and balanites seeds (mg/100g)

Code	Fe	Zn	Na	Ca	Mg	K
PASO	6.16±0.30^{b}	4.24±0.07^{a}	9.41±0.11^{e}	423.15±12.83^{a}	144.40±18.58^{a}	36.69±1.60^{a}
PAJU	5.68±0.28^{b}	4±0.12^{a}	17.87±0.06^{a}	439.03±7.71^{a}	155.93±0.30^{a}	36.14±1.67^{a}
PATO	14.39±0.74^{a}	4.05±0.26^{a}	9.12±1.45^{c}	365.81±20.41^{a}	157.51±1.82^{a}	41.75±8.61^{a}
PAOR	7.55±0.57^{b}	4.09±0.04^{a}	11.89±4.60^{b}	416.50±17.90^{a}	334.70±32.25^{a}	39.40±0.65^{a}
PMNL	10.77±1.07^{b}	3.58±0.18^{a}	12.52±1.12^{b}	383.06±8.33^{a}	153.16±4.45^{a}	37.28±0.62^{a}
PMTL	6.68±0.47^{b}	3.50±0.14^{a}	11.86±4.59^{b}	380.64±11.03^{a}	157.76±1.17^{a}	36.83±0.79^{a}
APV	**8.53±0.57**	**3.91±0.11**	**12.11±1.98**	**401.36±13.03**	**183.91±9.76**	**38.01±2.32**
BAZI	4.47±1.65^{b}	4.22±1.98^{a}	1.06±0.42^{e}	237.78±40.83^{a}	207.21±4.02^{a}	42.21±3.06^{a}
BAOA	5.36±1.66^{b}	2.71±0.23^{a}	3.52±1.36^{d}	260.89±44.55^{a}	236.49±32.70^{a}	42.96±3.46^{a}
ABV	**4.92±1.66**	**3.47±1.10**	**2.29±0.89**	**249.34±42.69**	**221.85±18.36**	**42.59±3.26**

Different letters in a column are significantly different at 5% level according to the test Newman-Keuls; APV: average of papaya values; ABV:average of balanites values.

Table 4. Amino acid content of papaya seeds (mg/100g)

Amino acids	Balanites		Papaya				Mixed papaya	
	BAOA	BAZI	PAOR	PASO	PAJU	PATO	PMNL	PMN
ASP	ND	1.32	17.12	17.19	ND	0.89	1.40	1.40
GLU	0.32	6.56	9.43	ND	6.52	ND	ND	ND
SER	0.15	0.06	1.22	0.45	ND	0.69	0.45	0.45
HIS	2.43	ND	ND	ND	ND	ND	ND	ND
GLY	0.03	0.16	1.38	1.24	ND	1.16	1.19	1.19
THR	ND	ND	ND	ND	ND	ND	ND	ND
ARG	11.01	ND	2.01	ND	ND	ND	ND	ND
ALA	1.06	6.64	0.70	0.44	0.43	ND	0.49	0.49
TYR	ND	0.14	4.48	4.09	ND	4.48	4.43	4.43
CYS	ND	8.58	2.69	2.83	ND	ND	ND	ND
MET	ND	ND	ND	3.43	31.70	10.93	5.40	5.40
PHE	ND	0.44	0.72	0.51	0.50	0.66	ND	ND
VAL	ND	ND	3.80	ND	ND	6.52	2.72	2.72
ILE	0.49	0.16	1.44	1.25	ND	1.18	ND	ND
LEU	0.26	4.63	0.85	1.02	0.58	0.71	2.37	2.37
LYS	3.48	0.73	1.67	2.65	1.73	ND	ND	ND
EAA	4.23	5.96	8.48	8.87	34.51	2.00	10.50	10.50
NEAA	15.00	23.47	39.02	26.23	6.95	7.21	7.95	7.95
TAA	19.22	29.42	47.51	35.10	41.46	27.21	18.45	18.45
%EAA	21.99	20.34	17.86	25.26	83.24	73.49	56.89	56.89
%NEAA	78.01	79.76	82.14	74.74	16.76	26.51	43.11	43.11

EAA: essential amino acids; NEAA not essential amino acid; TAA: total amino acid; ND: not detected.

3.4. Fatty Acids Composition

A total of 25 measurable fatty acids were found in papaya seeds and 18 in balanites seeds. The fatty acid contents were as summarized in Table 5. Palmitic acid, elaidic acid, stearic acid and Linolelaidic acid were the more representative in both papaya and balanites seeds. Undecanoic acid, pentadecanoic acid, oleic acid, y-linolenic acid, a-linolenic acid, cis-8,11,14-eicosatrienoic acid, cis-11,14,17-eicosatrienoic acid, Cis-4,7,10,13,16,19-docosahexaenoic acid and erucic acid that were found in papaya seeds were absent in balanites seeds.

Table 5. Fatty acids composition of papaya and balanites seeds (mg/100g)

	Fatty acids	Balanites	Papaya
1	Undecanoic acid	ND	0.20
2	Myristic acid	0.04	0.09
3	Pentadecanoic acid	ND	0.02
4	Palmitic acid	13.94	13.34
5	Palmitoleic acid	0.09	0.20
6	Heptadecanoic acid	0.14	0.10
7	Cis -10-heptadecanoic acid	ND	0.05
8	Oleic acid	ND	7.80
9	Elaidic acid	14.08	34.41
10	Stearic acid	32.12	6.53
11	Linoleic acid	0.54	29.77
12	Linolelaidic acid	37.90	4.91
13	ϒ-linolenic acid	ND	0.07
14	α-linolenic acid	ND	0.09
15	Arachidic acid	0.57	0.80
16	Cis-11-eicosenoic acid	0.17	0.62
17	Heneicosanoic acid	0.12	0.47
18	Cis-8,11,14-eicosatrienoic acid	ND	0.20
19	Cis-11,14,17-eicosatrienoic acid	ND	0.30
20	Cis-13,16-docosadienoic acid	0.05	0.09
21	Cis-4,7,10,13,16,19-docosahexaenoic acid	ND	0.03
22	Erucic acid	ND	0.07
23	Tricosanoic acid	0.04	0.23
24	Lignoceric acid	0.17	0.06
25	Nervonic acid	0.04	0.3

ND: not detected.

4. Discussion

The results demonstrate a high nutrition value of both *Carica papaya* and *Balanites aegyptiaca* seeds in terms of proteins, lipids, carbohydrates, minerals, amino acids and fatty acids. All investigated minerals were found (Table 3) with significant contents of iron, calcium, magnesium which were of high nutritional interest. An substantial proportion of essential amino acids were found (Table 4) with higher values in papaya seeds. Among the diversity of fatty acids highlighted, α-linolenic acid, an omega 3were found in papaya seeds (Table 5).

This study demonstrates that *Carica papaya* and *Balanites aegyptiaca* seeds were sources of essential nutrients, next to their medicinal properties. The biochemical compounds were more balanced than roots, cereals and others basic food in Burkina Faso but, the ashes content in papaya and balanites were lower than found in cereals [28] and roots [29]. The amino acids profile varied a lot according to the nature and the variety of samples. In balanites seeds, histidine and arginine were found only in Ouagadougou while asparagine, tyrosine, cysteine and phenylalanine were present only in Ziniaré samples. Among papaya samples, yellow-coloured papaya seeds had the lowest amino acid content and the highest methionine content. Solo papaya (PASO) cumulated on average the high level of amino acid content, followed by orange and red papaya (PATO). Balanites seeds from Ziniaré had on average twice higher amino acid contents compared to those of Ouagadougou. Papaya seeds had more important level of essential amino acid compared to balanites. Balanites seeds from Ziniaré had on average twice higher amino acid contents compared to those of Ouagadougou. The more abundant fatty acids in papaya and balanites were palmitic acid, elaidic acid, stearic acid and linoleic acid, which are essentials for human. There were significant differences in the acidity, pH, ashes, lipid contents and the proportion of essential amino acids (EAA) between papaya and balanites seeds.

Some nutrient contents correlated with previous studies while others differed significantly. The high moisture content of balanites than papaya is in accordance with results reported by Adingra et al., Bello and Dandago and Alhassan et al. [15,30,31]. The storage conditions may have affected moisture content of the seeds as the process was not standardized. The proximate composition of papaya seeds found was similar to those of Bello and Dandago and Alhassan et al. [30,31]. The proximate composition of balanites seeds was similar to the previous results reported by Bharathi Parni and Yashodhara Verma and Adingra et al. [3,14,15] and Olakunle Moses and Makanjuola John Olanrewaju [32] have found a low level of lipids (40%) in balanites seeds. The more representative minerals were calcium and magnesium. Adesuyi and Ipinmoroti [16] also found higher content of calcium and magnesium in papaya seeds. The difference in calcium, magnesium, potassium and zinc content was not statistically significant. Umar *et al.*, [33] found similar values in the minerals contents as in this study, while Makanjuola and Makanjuola [32] obtained the highest values of calcium content and lowest values of sodium and zinc contents compared to the present study. *Carica papaya* and *Balanites aegyptiaca* seeds have shown important mineral contents compared to cereals according to Olaofe and Sanni [34]. The amino acid contents found in the present study were low compared to those of Adingra et al. and Sadiq et al. [15,17] and are not enough balanced according to Sadiq et al. [17]. The quantity and diversity of fatty acids found in papaya seeds were more important than the results of Hartman [26]. The nutritional value of papaya and balanites seeds, taking to account the whole chemicals compound content is appreciable for dietetic purpose [35-39].

This study needs to be completed with other compound such as phytochemicals, antioxidant activity and to address each variety or species of papaya or balanites to help surround the nutrition contribution and the industrial better process.

5. Conclusion

As herbal infusion, papaya and balanites seeds uses are increasing for their medical purposes. Therefore, it is important to highlight their nutritional values too. By analyzing the main nutrient contents of papaya and balanites seeds, this study put out their significant nutrition values in terms of proteins, lipids, minerals, amino acids and fatty acid contents. The extraction process did not impact the chemicals composition. The nutritional values of these herbal infusion alongside their medicinal properties can contribute to rapid recovery during medical cares.

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