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Production and Physicochemical Characterization of *Balanites aegyptiaca* Nectar Lyophilisate for a Refreshing Drink Production

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Abstract *Balanites aegyptiaca* is a forest species with high nutritional and medicinal value. Its transformation, which is always artisanal, contributes little to the exploitation of its potential. Thus, the present study aimed to valorize *B. aegyptiaca* by developing a freeze-drying technology for its nectar for better preservation. In his study, a survey was carried out to determine the food and medicinal use of the fruit of *B. aegyptiaca*, a freeze-drying technology was developed for *B. aegyptiaca* nectar production. The pulp and the lyophilisate produced were characterized using standard physicochemical analysis methods and sensory analysis. The survey showed that *B. aegyptiaca* was used for the treatment of constipation (60% of respondents), high blood pressure (45% of respondents), ulcers (31% of respondents), diabetes (7% of respondents) and diarrhea (4% of respondents). The physicochemical analysis revealed average contents of 0.52 ± 0.01% fat, 5.83± 0.05% protein, 73.1 ± 0.01% carbohydrates, and 320.48 ± 0.27 Kcal/100g of energy value for pulps. As for the lyophilisates, the average contents were 0.49% ± 0.01% fat, 4.44 ± 0.013% protein, 76.56 ± 0.54% carbohydrates and 328.40 ± 2.1 Kcal /100g of energy value. Potassium was the mineral with the highest content with respectively average values of 1882.50±0.3 mg/100 g (pulp) and 2051±0.6 mg/100 g (lyophilisate). The contents of phenolic compounds were 20 ± 0.17 mg EAG/100 mg (pulp) and 20.81 ± 0.22 mg EAG/100 mg (lyophilisate). The flavonoid contents were 8.49mgEQ/100 mg (pulp) and 8.07±0.37mg EQ/100 mg (lyophilisate). Nectar reconstituted from lyophilisates were highly appreciated by tasters with sensory characteristics close to those of pulp nectar.

Keywords: *Balanites aegyptiaca, lyophilisate, minerals, phenolic compounds, physico-chemical characteristics, sensory characteristics*

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1. Introduction

Forest ecosystems have great potential for non-timber forest products (NTFPS) and their exploitation in developing countries provides livelihoods for local populations [1,2]. In the Sahelian countries, agricultural production is supplemented by NWFPs while providing food, medicine and fodder to households. National NTFP production in Burkina Faso was estimated at 716,004 tonnes in 2016 [3]. This production makes it possible to contribute, on the one hand, to the nutritional balance of 43% of rural households by providing 23% of income and 566,353 jobs and, on the other hand, to the international trade of Burkina Faso [4]. Traded NWFPs have a total added value of 406.79 million USD, representing 3.85% of the national gross domestic product (GDP) [4]. The unprocessed harvested products dominating the national production of NTFPs consist essentially of Shea nuts, *Adansonia digitata* leaf powder, *Parkia biglobosa* fruit seeds and pulp, desert date palm seeds (*Balanites aegyptiaca* L. Delile *Tamarindus indica* leaves and gum arabic [5]. Most of the harvested products are marketed without added value, thus constituting a great shortfall on the local and national economic level. In view of the economic stakes offered by the transformation, the reinforcement towards products of high added value is a promising option. As a result, the valorization of the fruits of many local plants would offer great potential (nutritional and economic). Among these local plants is *B. aegyptiaca*, named the desert date palm. In Burkina

Faso, *B. aegyptiaca* is one of the dominant species in the Sahelian and Sudano-Sahelian climatic zones [6]. The different parts of the species are used in traditional medicine for their antibacterial, anticancer and antifungal activities [7]. These pharmacological activities are mainly related to the presence of biologically active metabolites, such as saponin, steroids, phenolic acids and flavonoids [8]. Several studies have indicated varying nutritional value of different dairy products of *B. aegyptiaca* [9]. According to NRC [10], the pulp is quite nutritious with a carbohydrate content ranging from 40% (freshly picked fruit) to 70% (completely dried fruit). The pulp would contain proteins and lipids. In Burkina Faso, oil extraction is one of the few transformations made of this fruit. This oil is used to make a variety of products sold in the markets, namely soaps and ointments. However, these various products had not have great economic success. *Balanites aegyptiaca* is still under-exploited despite its strong potential and its virtues that can contribute to food security and poverty reduction. It is therefore necessary to set up a processing technology for this product. Thus, the atomization and the freeze-drying of the nectar of *B. aegyptiaca* could constitute potentialities of creation of added value. This work aimed to valorize the fruit pulp of *B. aegyptiaca* through the use of technologies for the transformation and conservation of its nectar.

2. Material and Methods

2.1. Biological Material

The biological material used for this study is *B. aegyptiaca* (desert date palm) fruits. Sample collection was carried out in Burkina Faso in two cities, namely Kaya and Ouahigouya (Figure 1).

2.2. Production of Lyophilisate

The production of *B. aegyptiaca* nectar was carried out by adapting the process described by Munier [11]. The CHRIST Alpha 1-2 LD plus type freeze dryer coupled to the POM-05 pump was used for the production of lyophilisate. For better monitoring of production, the mass balance from each unit operation was evaluated. The energy balance was also assessed, taking into account thermal energy and electrical energy. The production of the lyophilisate was done in several steps as described in Figure 2.

2.3. Sample Preparation and Processing

The fruits have undergone pretreatment (sorting and washing). The pulp was extracted manually using stainless steel knives. Pulp from samples collected in Kaya was coded (PK) and that of Ouahigouya (PO). Similarly, the lyophilisate from the pulp of Kaya samples was codified (PKL) and that of Ouahigouya (POL).

2.4. Physicochemical Characterization of *Balanites aegyptiaca* Nectar Lyophilisate

The physicochemical parameters studied were the pH, the titratable acidity, the soluble dry extract, the Moisture Content, the ash content, the lipid content, the total sugar content, the protein content, energy density, mineral content, total phenol, and flavonoid content.

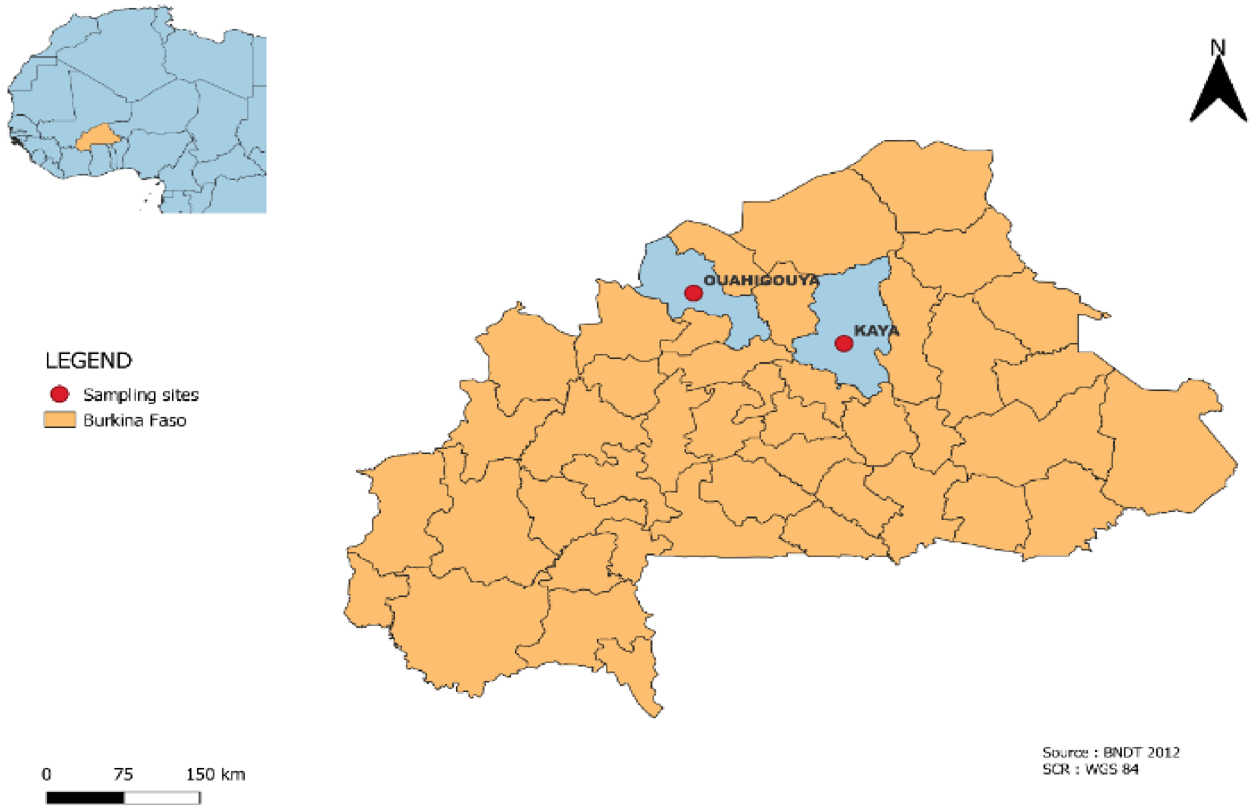

Figure 1. Sampling sites

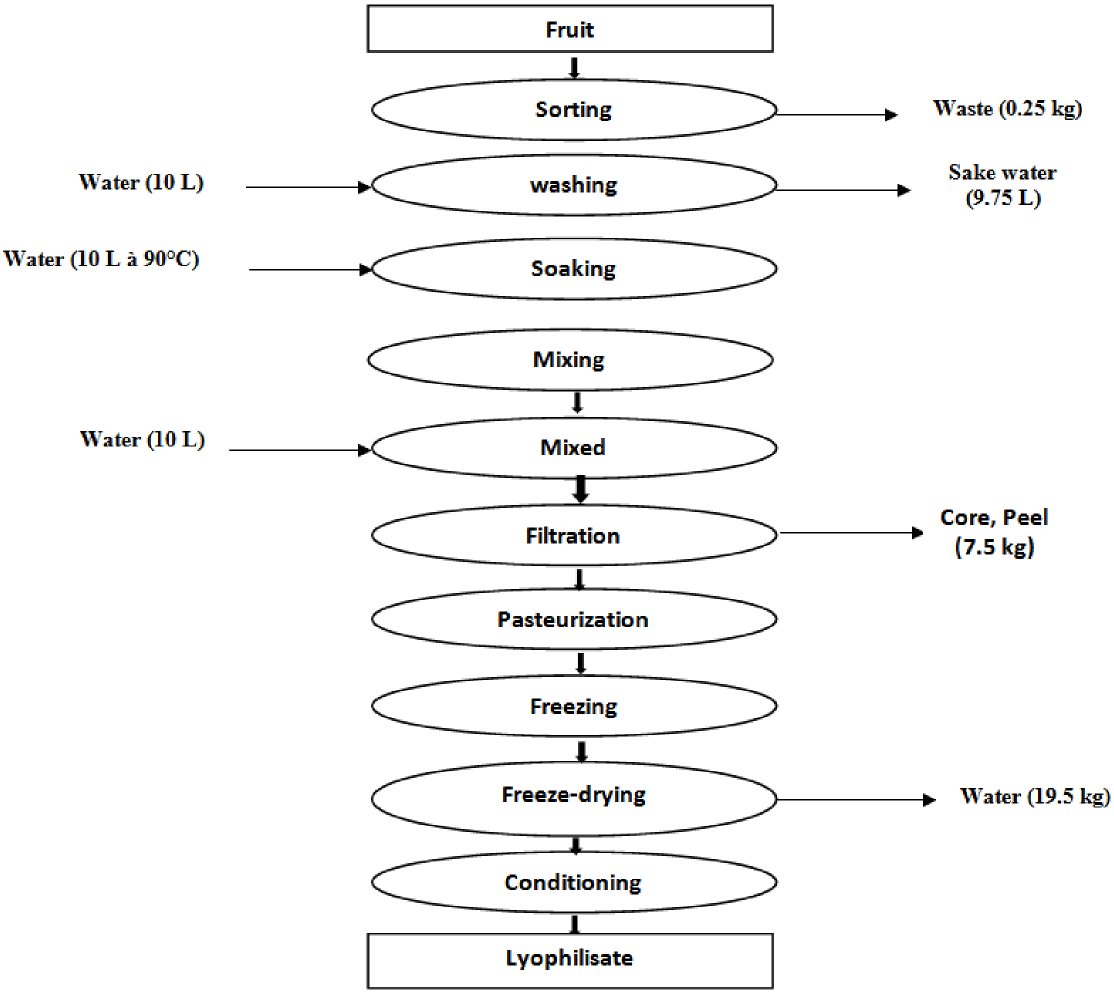

Figure 2. Technological diagram for the production of *Balanites aegyptiaca* lyophilisate

The acidity and the pH of the samples were determined according to the NF V05-105 method [12]. The soluble solids content (SSE) was measured (in°Brix) using a hand-held digital refractometer (ATAGO pocket PAL-α, Japan). The Moisture Content of the samples was determined according to the thermogravimetric method of the French Standard [13]. The total ashes were obtained by incineration of the product at a temperature of 550°C for 12 hours according to the international standard [14]. The total fat content (TMF) of the samples was determined according to the Soxhlet method [15]. Total sugars were determined by the method [16]. The estimaton of the protein content was carried out according to the Bradford assay method [17]. The theoretical energy value was obtained according to the method described by Merrill and Watt [18]. The dosage of minerals was carried out according to the standard AOAC [15]. The assay of total phenolic was carried out according to the method described by Singleton [19]. The total flavonoids were determined by the colorimetric method of Dowd adapted by Arvouet-Grand *et al.* [20]. A hedonic test was carried out. It included the visual, olfactory and taste examination of the nectar produced. It is very important for the evaluation of the organoleptic quality of products. This analysis obeyed conventional rules in order to arrive at a fair judgment of the quality of the product. The analyses were carried out on the 4 nectars, namely the pulp nectars of *B. aegyptiaca* from the two localities and the nectars reconstituted from lyophilisates. Indeed, from the pulp, 2 nectars were produced. Similarly, the lyophilisates were transformed into nectar by dilution (10 g per 100 mL). Excel 2016 software was used for data entry and processing. The analysis of variance (ANOVA) was carried out using the XL-STAT 2016 software for the comparison of the means of the various parameters studied. The Turkey test was used at the probability threshold p=0.05. The Test is significant if p is less than 0.05 and not significant if p is greater than 0.05.

3. Results and Discussion

The results of the survey showed that *B. aegyptiaca* was used for the treatment of ulcers (31% of respondents), hypertension (45% of respondents), diabetes (7% of respondents), constipation (60% of respondents), diarrhoea (4% of respondents).

3.1. Material Balance of *Balanites aegyptiaca* Nectar Lyophilisate Production

Figure 3 presents the Nectar and the lyphilisate of *Balanites aegyptiaca.*

a. Nectar b. Lyophilisate

Figure 3. Nectar and lyphilisate of *Balanites aegyptiaca*

Table 1 presents the different unit operations for the production of *B. aegyptiaca* fruit powder and the amount of material for each operation. Thus, 10 kg of *B. aegyptiaca* fruit produced 20 L of nectar with a concentration of 1.09 kg/L. The freeze-drying of 1 L of this nectar allowed to obtain 150 g of lyophilisate. Thus, 3 kg of lyophilisate were produced from 10 kg of *B. aegyptiaca* fruit, hence a yield of 0.3.

3.2. Energy Balance of Production

For the energy balance of the production of the lyophilisate of *B. aegyptiaca*, we have:

3.2.1. Thermal Energy Consumed during Soaking and Pasteurization

For soaking, heating of 10 L of water with a temperature of 30°C to 90°C resulted in a heat quantity of 2508 KJ (Q1). Regarding pasteurization, raising the temperature of 22 L of nectar from 40 °C to 72 °C resulted in a heat quantity of 3210.24 KJ (Q2). As for the useful thermal energy, it represents the sum of Q1 and Q2 used for carrying out unit operations (Thermal energy: 2508+3210.24= 5718.24 KJ). The losses are estimated at 10%, and the total thermal energy of the production is 6290.06 KJ (useful thermal energy × loss). A volume of 0.127 kg of butane gas (calorific value, 49510 KJ/Kg) was used for heating.

3.2.2. Electrical Energy Consumed during Freezing and Freeze-drying

The 100 W freezer consumed 0.5 kWh for 5 h to freeze the nectar. The freeze-dryer 230V, 3A) consumed 49.68 kWh for 72 h for the freeze-drying of 3 L of nectar, hence 364.32 kWh for 22L. The total electrical energy consumed is 364.82 kWh or, 1313352 KJ.

- Energy

The energy required for the production of 3 kg of *B. aegyptiaca* nectar lyophilisate is 1319642.06 KJ

- Cost of producing *Balanites aegyptiaca* nectar lyophilisate

The production cost of the lyophilisate takes into account all the costs generated by the various processes implemented. Thus, the inputs of the different stages as well as the energy consumption of different devices used during the processes have been taken into account. The data for the calculation of the production price of 3 kg of lyophilisate are given in Table 2. High power consumption has been reported with the use of the freeze dryer. The production cost of 3 kg of lyophilisate amounts to, 61,76 USD, i.e. a cost of 2,06 USD for the production of 100 g of lyophilisate.

Table 1. Mass balance of Balanites aegyptiaca nectar lyophilisate production

Unit operation	Mass before a unit operation M=kg	Mass of input or products used M=kg	Mass of outgoing product M=kg	Mass after a unit operation M=kg
Sorting	10		Waste =0.25	9.75
Washing	9.75	Water =10.00	Water =9.75	10.00
Soaking	10.00	Water (90 °C) =10.00		20.00
Mixing	20.00			20.00
Mixed	20.00	Water=10.00		30.00
Filtration	30.00		Waste =7.50	22.5 (1.09 kg/L)
Pasteurization	22.50	Butane gas = 0.127 kg		22.50
Freezing	22.50			22.50
Freeze-drying	22.5 kg= 20 L		Water = 19.50 kg	3.00 kg

Table 2. Cost of production of 3 kg of *Balanites aegyptiaca* pulp lyophilisate

Data	Amount	Cost (USD)
Water	50 L	0.045
Raw material	10 kg	2.25
GAS	0.127kg	0.0825 (at the rate of 8,22 USD for 12.5 kg)
Electric energy	364.82 kWh (20 L of nectar for 3 kg of Lyophilisate)	59.64 (0.16 USD the price per kWh for slice 3 of SONABEL, Local electricity distribution company)
TOTAL		62.025 (for 100 g)

Despite the excellent quality of the lyophilisates, the cost of the process was high due to the high energy consumption. The freeze-drying of 3 L of the nectar consumed 49.68 kWh. Marin *et al.* [21] pointed out that the energy consumption of freeze-drying is 1500 to 2500 kWh per ton of water to be eliminated. This disadvantage is directly related to the long operation times caused by the resistance of the dry material to heat transfer, by the configuration of the sample, its properties and the operating conditions [22]. In our study, 72 h were required for the complete elimination of water. This very high energy cost led to a high production cost which was 2,06 USD for 100 g of lyophilisate powder. The energy required to produce 3 kg of lyophilisate was 1319642 KJ. To counteract this major constraint, several studies have been carried out to reduce the time of the process by analyzing the various possibilities for controlling the intensity of the heat and the level of the vacuum in order to optimize the process Kuu *et al.* [22]. Barrett *et al.* [23] combined microwave drying and freeze-drying by adding gums to the product and compared this combination with conventional freeze-drying. They concluded that the combination of processes exhibits higher rehydrating power and structural integrity than freeze-drying alone. Litvin *et al.* [24], for their part, tried to combine different drying processes, namely freeze-drying, microwaves and hot-air drying in order to have the same quality as freeze-dried products but in a shorter time to reduce costs. They observed that there is not a great difference between the products obtained by the combination of these methods and those freeze-dried.

3.3. Physicochemical Characteristics of *Balanites aegyptiaca* Nectar Lyophilisate

3.3.1. Titratable Acidity, pH and Soluble Solids

The values of the pH, the titratable acidity and the soluble dry extract of the samples analyzed are recorded in Table 3.

The pH of the analyzed samples varied from 4.89 ± 0.01 and 4.91 ± 0.01. These pH values indicate that the pulp and lyophilisate of are acidic. Which is in agreement with the results of Abdelaziz *et al.* (2020) [25] who observed a pH of 4.9 ± 0.01 for the pulps of *Balanites aegyptiaca*. Lyophilization therefore had no impact on the pH.

The titratable acidity of the samples analyzed varied from 0.08 ± 0.02 to 0.32 ± 0.01 g/100 g of dry matter (DM). Analysis of variance revealed that there is a significant difference for titratable acidity ($p<0.05$).

The titratable acidity of *Balanites aegyptiaca pulps* (0.31 ± 0.32 g/100 g) was higher than that of freeze-dried powders (0.086 ± 0.08 g/100 g). The value of the titratable acidity of the pulps is similar to that found by Abdelaziz *et al.* [25] which was 0.3 ± 0.1 g /100 g. Askar *et al.* [26] also reported a loss of titratable acidity after freeze-drying guava puree.

3.3.2. Carbohydrate Content

The average carbohydrate, fat and protein contents, expressed as a percentage of dry matter, then the energy value in kcal/100 g are recorded in Table 4.

The average carbohydrate contents of the pulps and lyophilisates of *B. aegyptiaca* were respectively 73.10 ± 0.01% and 76.56 ± 0.54%. *B. aegyptiaca* nectar lyophilisate therefore has a great potential to provide the human body with good amount of its main source of energy. These values are similar to that reported by Achaglinkame *et al.* [36] which was 73.63% and higher than that indicated by Abdelaziz *et al.* [25] which was 45.8 ± 7.1 g/100 g dry matter. The difference in the analysis method used, the age of the ripe fruit and the agro-ecological origins of the dates studied could explain these variations. Nutritionally, the role of sugars is not limited to energy intake; they play an essential role both in the taste of food and in the pleasure of eating.

Table 3. pH and titratable acidity of the pulp and lyophilisate of *B. aegyptiaca*

Samples	pH	Acidity (g/100 gMS)	Soluble solids (° B)
KP	4.89± 0.01^{b}	0.32 ± 0.01^{a}	21.66± 0.44^{a}
PO	4.91 ± 0.01^{a}	0.30 ± 0.14^{a}	18.39±0.66^{b}
PKL	4.91 ± 0.01^{a}	0.08 ±0.02^{b}	20.33±0.44^{c}
POL	4.90 ± 0.0^{ab}	0.08±0.02^{b}	18.40± 0.01^{c}
Medium Pulp	4.902± 0.01^{a}	0.314± 0.32^{a}	20.032± 1.09^{a}
Medium powder	4.912± 0.03^{a}	0.086± 0.08^{b}	19.36± 0.22^{b}
P-value	0.139	0.000	0.000

PK: Pulp of *B. aegyptiaca* from Kaya, **PO** : Pulp of *B. aegyptiaca* from Ouahigouya, **PKL:** Lyophilisate of nectar from *B. aegyptiaca* from Kaya, **POL:** Lyophilisate of nectar from *B. aegyptiaca* from Ouahigouya. For the same column, the values having the same letter in common are not significantly different ($p \leq 0.05$).

Table 4. Contents of total carbohydrates, lipids, proteins and energy value of the pulp and lyophilisate of *B. aegyptiaca*

Samples	Total carbohydrate content (%DM)	Lipid content (%DM)	Protein content (%DM)	Energy value (kcal/100 g of DM)
KP	73.08± 0.84	0.54 ± 0.01	5.90 ± 0.15	320.89 ± 2.93
PO	73.12 ± 0.98	0.51 ± 0.14	5.76 ± 0.14	320.07± 3.40
PKL	77, 37±1.59	0.49 ± 0.02	4.64 ± 0.19	332.48±3.24
POL	75.75 ± 1.04	0.49 ±0.02	4.23±0.06	324.33± 6.35
Medium Pulp	73.10± 0.01^{b}	0.52± 0.01^{a}	5.83± 0.05^{a}	320.48± 0.27^{b}
Medium powder	76.56± 0.54^{a}	0.49± 0.01^{b}	4.44± 0.013^{b}	328.40± 2.71^{a}
P-value	0.00	0.02	0.00	0.03

PK: Pulp of *B. aegyptiaca* from Kaya, **PO** : Pulp of *B. aegyptiaca* from Ouahigouya, **PKL:** Lyophilisate of nectar from *B. aegyptiaca* from Kaya, **POL:** Lyophilisate of nectar from *B. aegyptiaca* from Ouahigouya; **DM :** Dry Matter. For the same column, the values having the same letter in common are not significantly different ($p \leq 0.05$).

Table 5. Minerals content expressed in mg/100 g of DM

Samples	Cu	mg	min	Fe	K	Zn	N a	Ca	Na /K
KP	0.75 ±0.001	99.31±0.03	1.35±0.003	12.86±0.004	1797±0.3	2.338±0.00	10.38±0.08	89.09±0.34	0.005
PO	0.89±0.006	102.10±0.1	0.69±0.004	5.65±0.01	1967.08±0.1	3.536±0.04	11.55±0.11	77.264±0.08	0.005
PKL	0.74±0.02	38.17±0.4	0.49±0.004	8.26±0.02	1988.85±0.3	1.41±0.02	10.33±0.12	118.99±0.16	0.005
POL	0.68±0.05	77.41±0.07	0.47±0.003	9.34±0.006	2113.15±0.6	1.27±0.00	7.50±0.09	103.99±0.17	0.003
Medium Pulp	0.82± 0.0^a	100.71± 0.92^a	1.02± 0.22^a	9.26± 2.40^a	1882.50±0, 3 b	2,94± 0.39^a	10.97± 0.39^a	83.18± 3.94^b	0.005
Medium powder	0.71± 0.02^a	57.79± 13^b	0.48± 0.00^b	8.80± 0.35 ^{a}	2051.00±0,6 ^{a}	1.35± 0.04^b	8.92± 0.94 ^{a}	111.37± 4.91 ^{a}	0.004
P-value	0.07	0.02	0.01	0.83	0.05	0.01	0.08	0.00	

PK: Pulp of *B. aegyptiaca* from Kaya, **PO**: Pulp of *B. aegyptiaca* from Ouahigouya, **PKL:** Lyophilisate of nectar from *B. aegyptiaca* from Kaya, **POL:** Lyophilisate of nectar from *B. aegyptiaca* from Ouahigouya; **DM :** Dry Matter. For the same column, the values having the same letter in common are not significantly different ($p \leq 0.05$).

3.3.3. Lipid Content

The fat contents were quite low, at an average of 0.52 ± 0.01% for the pulps and an average of 0.49 ± 0.021% for the lyophilisates. Sagna *et al.* [27] reported a similar content of 0.41%. The lyophilisate of *B. aegyptiaca* nectar could therefore be a popular food for consumers in a world where our energy expenditure decreases as part of a sedentary lifestyle, where cardiovascular diseases claim many victims [37].

3.3.4. Protein Content

The results showed an average protein content of 5.83 ± 0.05% DM for the pulps and 4.44 ± 0.1% DM for the lyophilisates. These values were lower than those found by Achaglinkame *et al.* [36] on the pulp of *B. aegyptiaca* which was 9.19 g/100 g DM. They are higher than that reported by Cissé [32] for baobab pulp (3 g/100 g). High consumption of fruits such as papaya (0.5g/100g DM), Kiwi (1.14g/100g DM) and passion fruit (2.6 g/100g DM) [38] have lower contents than freeze-dried powders. With these inherent protein values, the pulp and lyophilisate can contribute to the body's daily protein needs.

3.3.5. Energetic Value

Caloric intake derived from protein, sugar and fat contents gave an average value of 320.48 ± 0.27 kcal/100 g of DM for the pulps and 328.40 ± 2.71 kcal /100g MS for lyophilisates. These values were lower than that reported by Achaglinkame *et al.* [36] who observed an energy value of 354.48 kcal /100 g and relatively similar to the value of 300 kcal /100 g indicated by Nour *et al.* [39] in fruits from Sudan. The fruit pulp of *B. aegyptiaca* provides a higher caloric intake than several tropical fruits, for example: banana (89 kcal /100 g), durian (126 kcal/100g) and avocado (139 kcal/100g) [40]. It can therefore be an important energy source, especially in poor rural areas, where the diet is mainly based on cereals.

3.3.6. Total Phenol and Flavonoid Content

The medicinal value of plants lies in certain chemical substances called phytochemicals which have a certain physiological action on the human body. Among the most important of these bioactive plant constituents are flavonoids and phenolics [41]. Polyphenols are known for their anti-free radical and anticancer properties due to their antioxidant activity, Ozcan *et al.* [42]. The average contents of total phenols expressed in mg EAG/100 mg and Flavonoids expressed in mg EQ/100 mg of the samples analyzed are represented in Figure 4. For the contents of phenolic compounds, the average value of the lyophilisates of nectars was 20.00 ± 0.03 mg EAG/100 mg and that of the pulps was 20.82 ± 0.02 mg EAG/100 mg. These values are similar to that reported by Abdallah *et al.* [43] on methanolic extracts of *B. aegyptiaca fruits* from Sudan which were 21.2 mg GAE/100 mg DM. These values are higher than those found by Cissé [32] on Baobab pulp, which varied between 0.6 and 1.7 mg/100 mg for polyphenols. Scalbert and Williamson [37] reported that polyphenols participate in the prevention of cardiovascular diseases. The lyophilisate of *B. aegyptiaca*, because of its high polyphenol content, could be recommended to consumers. The analysis of variance (ANOVA) at the significance level α= 5% showed that there is no significant difference for the average flavonoid content of pulps and lyophilisates of nectars which are respectively 8.50 ± 0.09 mg EQ/100 mg and 8.08± 0.75 mg EQ/100 mg. These flavonoid contents found in the present study were higher than those reported by Abdallah *et al.* [43] in methanolic extracts of *B. aegyptiaca fruits* which is 1.15 mg QE/100 mg DM. This concentration is an asset for health since flavonoids, by their function, protect blood vessels from cholesterol-related damage [44]. A study conducted by Mhya *et al.* [45] shows that the leaves, fruit mesocarp and stem bark of *B. aegyptiaca* exhibit hypoglycemic activity. The activity could be attributed to chemical compounds like phenolics and flavonoids that were present in the extracts.

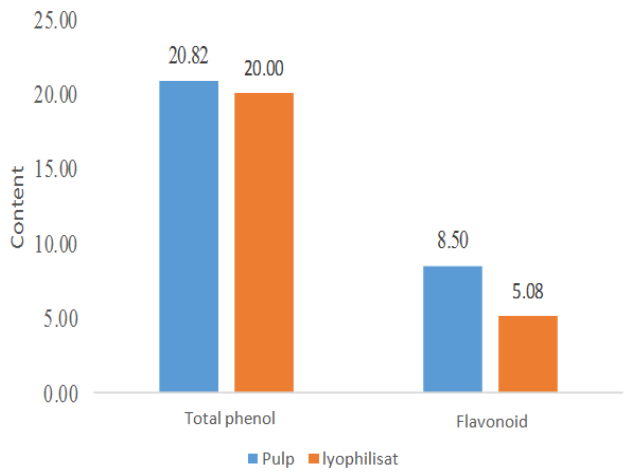

Figure 4. Content of total polyphenols and flavonoids

Hedonic test

Figure 5 summarizes the main results obtained. Remember that this is a test in which the tasters know the nature of the products submitted.

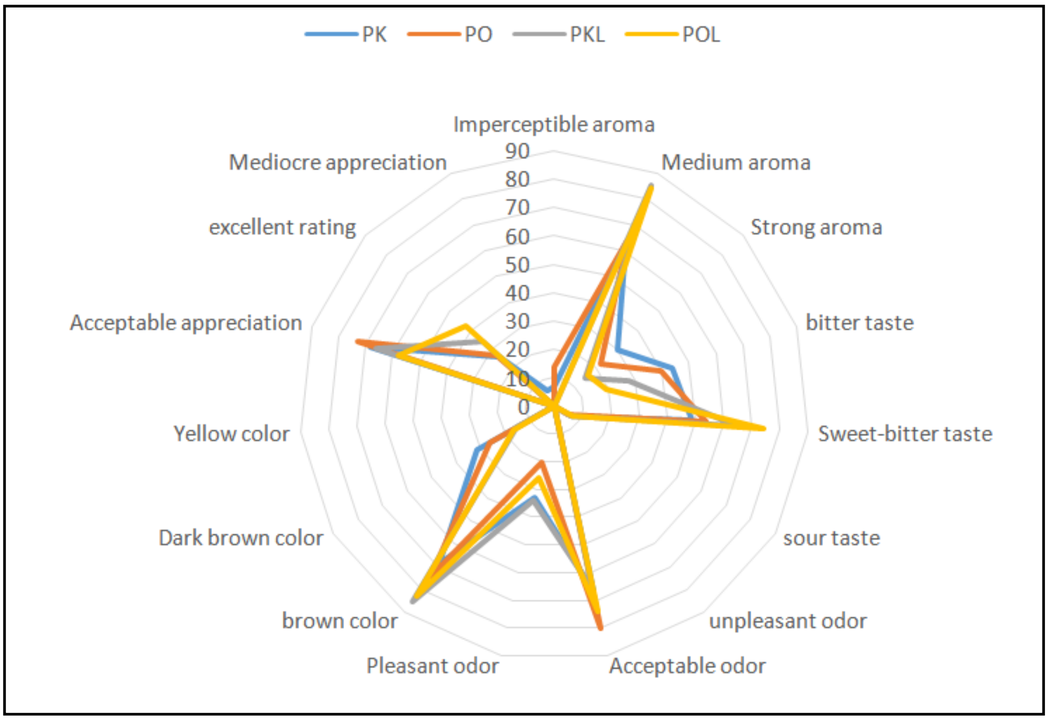

Figure 5. Sensory characteristics of *Balanites aegyptiaca* nectars

The analysis showed that the tasters were able to detect differences between the products produced. In addition, the attributes were described in the same way by the majority of tasters. The nectar had the following characteristics: an average aroma, a sweet taste with a hint of bitterness, and an acceptable odor, a light brown color, an acceptable overall assessment. Bitterness is linked to the presence of sapogenins in the mesocarp [46] and sometimes bother consumers.

Most of the tasters detected an average aroma for the 04 nectars, 85% had detected an average aroma for the nectar reconstituted from Kaya fruit lyophilisate (PKL). The sweet taste with a hint of bitterness was detected by the majority of panelists. Similarly, 74% of the panelists had detected the same taste (sweet taste with a hint of bitterness) in the nectar obtained with the lyophilisate of *B. aegyptiaca* from Ouahigouya (POL). Regarding the smell, 80% of the panelists had observed that the nectar of Ouahigouya (PO) has an acceptable smell. The panelists (85%) assigned the light brown color to the nectar obtained with Kaya lyophilisate (PKL). Overall, 73% of the panelists gave an acceptable appreciation to the nectar of Ouahigouya (PO) and 42% an excellent appreciation to the nectar obtained with the lyophilisate of Ouahigouya (POL) The results of this study reveal that there is no not a strong difference between the organoleptic characteristics of pulp nectars and freeze-dried nectars. Given that taste and smell largely guide the choice of food [47], it can be said that the nectars reconstituted from lyophilisates generally have good organoleptic quality and that freeze-drying does not modify their organoleptic quality.

4. Conclusion

This study allowed to valorize the fruit pulp of *B. aegyptiaca* through the use of technologies for the transformation and preservation of its nectar. It was used to develop a production diagram of a lyophilisate of *B. aegyptiaca* pulp with an energy balance. The content of lipids, proteins and carbohydrates was determined using analysis of the nutritional. The mineral composition of pulp nectars and freeze-dried products by spectrometric method and total phenols and total flavonoids were also quantified. This work on the pulp and powder of *B. aegyptiaca* shows their richness in lipids, proteins, micronutrients and bioactive compounds; which testifies their importance for humans in the food domains and can be considered as an important source of nutritional and antioxidant properties. In the future, it would therefore be interesting to evaluate the vitamin and fatty acid contents, the microbiological quality of the pulp and the lyophilisate, study the stability of the lyophilisate and the effect of preservation on the organoleptic and nutritional characteristics of the lyophilisate.

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