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Nutritional Potential of Two Leafy Vegetables *Leptadenia hastata* Decne and *Senna obtusifolia* Link Consumed in Senegal

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Abstract

This study focused on two woody leafy vegetables *Leptadenia hastata* Decne and *Senna obtusifolia* Link, commonly consumed in Senegal. Leaves were collected from three regions. Then, proximate analyses and micronutrients were carried out to evaluate their nutritional values. Results revealed that protein level of *S. obtusifolia* (SO) is richer (21.75%) than *Leptadenia hastata* (LH) (18.16%). The cellulose and carbohydrate contents of the two vegetable's leaves are in the same order except those of LH from Widou which are less rich in cellulose (8.31%) and richest in carbohydrate (6.35%). These leaves are also good sources of various mineral elements and especially iron. Leaves of LH appear to be richer in iron and magnesium, while SO appears to be richer in calcium. Vitamin C intakes of SO leaves are better than those of LH and respectively range from 142 to 196.5 and 22.5 to 159.5 mg/100 g. According to the use of this leafy vegetable by the populations, a domestication opportunity is thus justified to ensure availability and accessibility of these significant sources of micronutrients.

Keywords

Leptadenia hastata, *Senna obtusifolia*, Woody Leafy Vegetables, Nutritional Values, Domestication

1. Introduction

Human populations of the western Sahel depend upon a number of wild plant

foods to satisfy a substantial part of their nutritional requirements and this dependency increases during drought times [1] [2]. Leafy vegetables occupy a significant place in this diet [1] [3] [4] [5], because of their nutritional intake [6] [7] [8]. These leafy vegetables are mostly herbaceous species but some also come from the Woody [9] [10]. Some are also used for oral therapeutic purposes [3] [11] [12] and thus fulfill a dual food and therapeutic function.

In Senegal, the most commonly exploited parts of species are respectively leaf (40%), roots (20%), and bark (13.3%) ([3]). *Lepatadenia hastata* and *Senna obtusifolia* are two leafy vegetables very well distributed in Senegal but consumed by a weak fringe of the population. Leaves of *L. hastata* are used as fodder in most regions while they are very consumed by indigenous ethnic groups of the Kédougou region (**Figure 1**). In contrast, *S. obtusifolia* is widely known by several Senegalese ethnic groups and accompanies the millet couscous dish [3]. In a context of integrated local development, a policy, involved by WHO is the use of local resources. Some results are available on the leaves composition of *L. hastata* from Burkina [5], Niger [13], Uganda [14] and those of *S. obtusifolia* from Nigeria [15] [16]. Neither nutritional composition of *L. hastata* nor *S. obtusifolia*'s ones from Senegal area are available. Thus, the objectives of this work is to provide nutritional information on these two plant species consumed in Senegal in order to promote them and give them a better place in the diet of the populations.

2. Materials and Methods

2.1. Plant Materials

Three batches of *Leptadenia hastata* and two of *Sesbania obtusifolia leaves* were

Figure 1. Collection of *L. Hastata*'s leaves in the bush during dry season at Kédougou.

consecutively harvested and sampled in three regions of Senegal (Figure 2): Kédougou, Bakel and Widou (Ferlo). Young leaves were sampling during the dry season (March and April) of 2017 and 2012. They were collected and sun-dried in rural areas and conveyed to the laboratory. Drying is continued at 75˚C for 24 hours. The whole intact leaves are ground and finely homogenized on a 500 µm sieve. Each of leaves samples was analyzed in triplicate and the results are reported relative to the dry matter.

2.2. Major Macronutrient Determinations

Analyses for protein, cellulose, total carbohydrate and ashes (total mineral) were carried out according to the procedure described in the AFNOR standards [17]. Total carbohydrate was obtained using Luff-Schrool's method while cellulose is checked by method NF ISO 6865. Nitrogen determination was accomplished by the Kjeldhal method (NF 03-050 standard) and proteins were calculated using 5.7 as coefficient. The total minerals were determined after 3 hours incineration at 550˚C (V76-101 standard).

2.3. Minor and Specific Nutrients

2.3.1. Ascorbic Acid

10 g. of leaves powder was dissolved in metaphosphoric acid solution dilued in 4% distilled water (Metaphosphoric acid ~65% HPO_3 basis from Sigma (St. Louis, MO, USA) to extract the ascorbic acid. The mixture was centrifuged at 1000 g for 15 min. A second extraction was conducted after removing supernatant. All supernatants were added before the determination of total ascorbic. Analysis was completed using Thermo Scientific HPLC 1000 SCM (with Licrospher 100 RP-18 column from Thermo Fisher Scientific Inc., Illkirch, France).

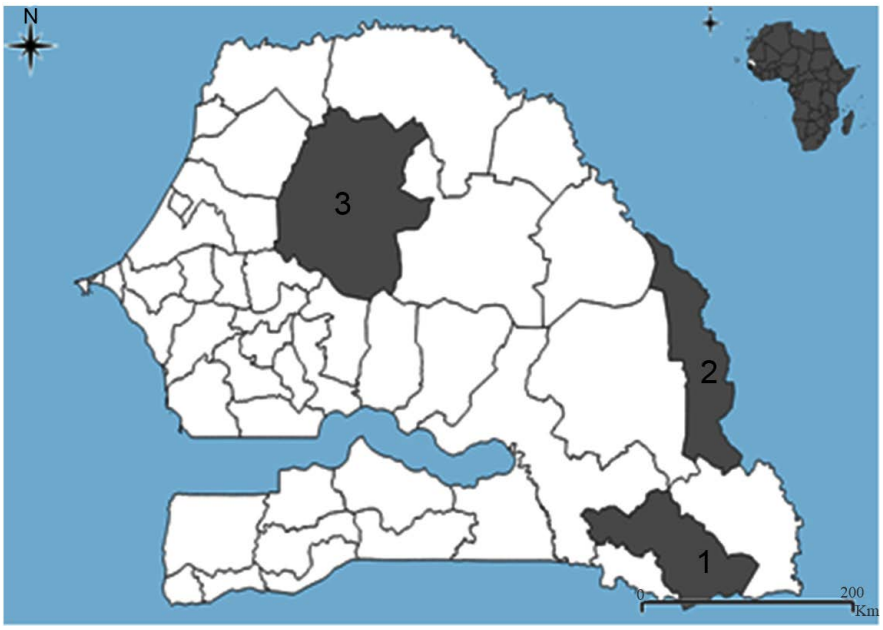

Figure 2. Sample collection regions (1, Kédougou, 2, Bakel and 3, Widou-Ferlo).

Separations were achieved using a mobile phase of 0.01% isocratic sulfuric acid (from Sigma (St. Louis, MO, USA). The volume injection was 10 µL. The comparison was carried out using external calibration between 10 and 200 mg/L L-Ascorbic acid (L-Ascorbic acid A5960 BioXtra, ≥ 99.0% from Sigma, St. Louis, MO, USA) as described by Dhuique-Mayer *et al.*, (2007) [18]. The calibration curve was linear in the range studied with an accepted correlation coefficient of 0.997 minimum. The limit of detection (LOD) was determined to be 2.4 mg/L.

2.3.2. *β*-Caroten

The content of select lipid-soluble vitamins including vitamin A (as carotenoids) was determined using HPLC 1100 Agilent. The solvent extraction was a mixture of ethanol/hexane (4:3 v/v) with $CaCO_3$ and 0.1% of butylhydroxytoluen (added as an antioxidant). 0.5 g of dried leaves *powder* was mixed with 20 mL of extract solution and centrifuged at 15,000 g for 15 min at 4˚C. A second extraction was conducted with 20 mL of extract solution. All supernatants were recovered and evaporated to dryness under nitrogen. After evaporation to dryness, samples were solubilized in a mixture of dichloromethane/Tert-Butyl methyl ether/methanol. Separations were carried out by gradient elution with water (solution A)/methanol (solution B)/Tert-Butyl methyl ether (solution C) as follows: initial conditions 40%A/60% B; 0 - 5 min, 20% A/80% B; 5 - 10 min, 4%A/81% B/15% C; 10 - 60 min, 4% A/11% B/85% C; 60 - 71 min, 100% B 71 - 72 min, and back to the initial conditions for re-equilibration. To record chromatograms with Agilent 1100, a detector at 350, 400, 450 and 470 nm was used. Comparisons were carried out using authentic standards as reported by Dhuique-Mayer *et al.* (2007) [18] with limit of detection (LOD) and limit of quantification (LOQ), respectively 0.035 and 0.119 mg/100 g sample for vitamin A. All reagents used for these analyses were from Sigma (St. Louis, MO, USA); HPLC Agilent 1100, diode array detector (Agilent France, Massy, France); Column YMC C_{30} (250 × 4.6 mm; 5 µm, YMC, Dislaken, Germany).

2.3.3. Mineral Determination

A 500 mg portion of leaves powder was incinerated at 500˚C, weighed and desilicated with 4 mL of 40% hydrofluoric acid from Sigma (St. Louis, MO, USA). The obtained solution was then evaporated at 90˚C to dryness. The residue was mixed with 50 mL distilled water followed by filtration. Detection of sodium, potassium, calcium, magnesium, phosphorus, copper, zinc and iron were realized using inductive coupled plasma atomic emission spectrometry (ICP-AES, Varian Vista) with coupled charge device detector (Agilent France, Massy). Quantification of element concentrations was carried out using specific calibration of 5 points for each element in the range 0 to 1000 µg/L (Mineral standard from Fisons Scientific Equipment, Loughborough, England). The limits of quantification (LOQ) related to samples were 0.05 mg/100 g for Ca, K, Na, Mg P and 0.005 mg/100 g for Fe, Zn, Mn, Cu.

2.3.4. Statistical Analysis

All analyses were carried out in triplicate and the data were analyzed using excel software.

3. Results and Discussion

Maronutrients composition of this two species show a good level of protein (Table 1) but *S. obtusifolia* (SO) is richer (21.75%) than *Leptadenia hastata* (LH) (18.16%). The cellulose contents of the two vegetable's leaves are in the same order (on average 11.38 for LH and 15.45% for SO) except those of LH from Widou which are less rich (8.31%). The levels of sugars appear equivalent between the two species except the leaves of LH from Widou. The comparison of the data overall shows a good uniformity of results within each species regardless of the origin of the samples. However, we note the case of LH leaves from Widou, whose low cellulose content is offset by a better carbohydrate content (6.35%); this sugar is essentially made of sucrose. On the other hand, LH is a better source of minerals.

The ash content that reflects the total mineral content reveals a greater richness of *L. hastata* than *S. obtusifolia*. However in detail, the conclusions are not accurate. The two-way analysis of variance (ANOVA) reveals a strong similarity of the different mineral elements contained in the leaves of both species, despite their provenance (Bakel, Kédougou and Widou) (Table 2). These leaves are good sources of various mineral elements and especially iron. Leaves of LH appear to be richer in iron and magnesium while vitamin C intakes of S.O. leaves are better than those of LH and respectively range from 142 to 196.5 and 22.5 to 159.5. These values of vitamin C seem to correspond to the results obtained on 22 leafy vegetables whose range of variation is between 22 and 135 mg/100 g [19].

Comparatively to others legumes, protein levels of SO (21.75% ± 9.88%) are relatively close to beans [20] and LH are close to *Amaranthus hybridus* from Nigeria which contain 17.92% protein, 13.80% ashes and 8.61% total fibers [21]. It also appears that the leaves of *L. hastata* harvested in Senegal are lower in protein than those of Burkina, thus marking a certain geographical variability. LH leaves collected in Senegal are richer in protein and ash than those in Uganda (Table 3), with 9.96% ash; but the contents of the latter in cellulose are

Table 1. Proximate composition of *L. hastata* and *S. obtusifolia* leaves (% DM).

Species	*Leptadenia hastata*			*Senna obtusifolia*	
Parameters	Bakel	Kédougou	Widou*	Bakel	Widou*
Protein	14.37 ± 0.56[a]	18.16 ± 2.54[a]	15.96 ± 1.13[a]	21.75 ± 9.88[a]	19.55 ± 1.70[a]
Cellulose	11.47 ± 1. 31[a]	11.29 ± 0.79[a]	8.31 ± 0.86[b]	14.63 ± 1.73[a]	16.33 ± 9.44[a]
Ash	15.01 ± 3.33[a]	14.25 ±5.97[a]	12.34 ± 1.92[a]	6.43 ± 0.21[a]	5.24 ± 0.73[a]
Sugar	3.71 ± 0.19[a]	3.47 ± 0.22[a]	6.35 ± 0.39[b]	4.38 ± 0.15[a]	5.51± 0.41[a]
Saccharose	3.35 ± 0.19	3.06 ± 0.22	5.58 ± 0.39	3.8 ± 0.15	4.31 ± 0.25

Table 2. Micronutrients composition of *L. hastata* and *S. obtusifolia* leaves (mg/100 g DM).

Species (mg/100 g DM) (mg/100 g DM)	**Leptadenia hastata (N = 3)**			**Senna obtusifolia (N = 3)**	
Elements	**Bakel**	**Kédougou**	**Widou**	**Bakel**	**Widou**
P	322 ± 2.13[a]	213 ± 0.15[a]	302 ± 1.17[a]	425 ± 0.08[a]	292 ± 0.70[a]
K	2042 ± 11.49[a]	2417 ± 87.7[a]	1956 ± 13.6[a]	1749 ± 91.8[a]	1968 ± 2.4[a]
Ca	3248 ± 14.67[a]	3876 ± 17.49[a]	2385 ± 62.7[a]	4594 ± 15.02[b]	2482 ± 56.5[a]
Mg	800 ± 29.6[a]	578 ± 13.7[a]	688 ± 18[a]	383 ± 68[b]	342 ± 62[b]
Na	21.4 ± 0.2[a]	12.31 ± 0.2[a]	20.33 ± 0.2[a]	17.76 ± 0.01[a]	17.70 ± 0.06[a]
Cu	0.91 ± 0.35[a]	1.05 ±0.41[a]	1.35 ± 0.39[a]	1.11 ± 0.27[a]	0.8 ± 0.06[a]
Fe	119.95 ± 5.16[a]	97.79± 65.62 [b]	68.4 ± 25.04[b]	55.41 ± 6.64[b]	84 ± 15.2[b]
Mn	8.48 ± 4.06[a]	7.51 ± 0.76[a]	6.77± 2.24[a]	6.31 ± 0.32[a]	4.96 ± 0.65[a]
Zn	2.92 ± 0.93[a]	4.87 ± 0.89[a]	3.3± 0.19[a]	3.9 ± 0.65[a]	2.81 ± 0.29[a]
β-carotène	17.95 ± 0.75[a]	22.7 ± 1.1[a]	16.8 ± 0.3[a]	26.85 ± 2.6[a]	13.5 ± 0.25[a]
Vitamine C	56 ± 11.31[a]	22.5 ± 12.02[a]	159.5 ± 84.15[a]	142 ± 56.57[a]	196.5 ± 31.82[a]

Values are means of three (3) individual measurements ± standard deviation. Means in each column followed by different superscript letters are significantly different (Tukey's HSD, $p < 0.05$).

Table 3. Proximate composition of different source of *Leptadenia hastata.*

Elements	Actual average (Senegal)	Freiberger *et al.*, 1998 (Niger)	[1] (Niger)	[14] (Uganda)
	(mg/100 g)		(mg/kg)	
P	213 - 322	2.3		2.2
K	1956 - 2417	19.8	30421	-
Ca	2385 - 3876	21.4	17106	7.1
Mg	578 - 800	5.66	4696	1.0
Na	12.31 - 21.4	1.1	934	Traces
Cu	0.91 - 1.35	9.5	13.2	-
Fe	68.4 - 119.95	211	437	15.4
Mn	6.77 - 8.48	81.9	78.5	-
Zn	4.87 - 2.92	-	52.7	-

higher (24.06%). However, the protein content of leaves from Niger found by several authors is mixed and varies between 14% and 22.8% (**Table 3**), [1] [13]. Concerning the composition of the major elements of *Senna obtusifolia*, the leaves of Senegal display higher levels of protein and cellulose than leaves of Nigerian revealed by Sudi *et al.*, (2011) [15] and Tambari *et al.*, (2015) [16]. These differences in results had been explained in accordance with the age and the season of collection [16].

Comparing mineral content, Senegal's LH samples are significantly richer than those from Niger and Uganda (**Table 3**). These remarks remain valid for *Senna obtusifolia*.

The levels of micronutrients such as manganese, copper and zinc are important to report because they are of the order of mg/100 g whereas they are generally expressed in mg/kg (**Table 3**). According to their physiological importance, these micronutrients will be of nutritional and health interests for populations that consume those leaves.

These results encourage the more frequent use of these two leafy vegetables by populations where dietary habits permit since the consumption of leafy vegetables is linked to the traditions and dietary patterns of each ethnic and socio-economic group [22]. Indeed LH remains popular with the indigenous people of Kédougou who consider it like a main source of vegetables during the lean season in default of vegetable market gardening. In the area of Bakel and Widou, however, these leaves of LH are rather reserved exclusively for livestock. The knowledge of the composition of these leaves seems to be a major nutritional argument to promote their consumption. They are good sources of supplementation in essential mineral elements during periods when food is reduced to subsidence. In addition, some leafy vegetables are consumed for therapeutic purposes [12]. For example, leaves of LH contain two essential fatty acids (linoleic and α-linolenic acids) [14] with the protective properties of the cardiovascular system. Other studies reveal their galactogenic and purgative properties [23] [24], antitumorals [25] and anti inflammatory and analgesic activities [26]. A domestication opportunity is thus justified to ensure availability and accessibility of these significant sources of micronutrients. Improving this availability can be ensured by simple technical preservation such as bleaching and drying [27].

4. Conclusion

The nutritional intake of *Leptadenia hastata* and *Senna obtusifolia* in the diet is significant from the point of view of mineral elements. To overcome the difficulties of availability of these two leaf vegetables during the lean season, domestication would be an appropriate response to contribute for food security of the populations.

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