

Full Length Research Paper

Evaluation of the consumption and nutritional quality of *Basella alba* L. in Brazzaville

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Leafy vegetables are generally neglected by consumers because of their rural lifestyle and low social status. As a result, they are often considered a "food of the poor. The general objective of our study is to carry out a nutritional and nutritional characterization of the vegetable *Basella alba* L. A cross-sectional survey of the consumption of *B. alba* L. leaves was carried out in the 9 districts of Brazzaville and concerned 150 households, as well as physicochemical analyzes carried out in the laboratory. The results show that the average age of respondents is 41.18 ± 15.36 years. The female sex is more represented with 83.3%. Many consumers are single (38.7%). Respondents are sourcing from the market (99.3%) per purchase (98.0%). The leaves of *B. alba* L are eaten cooked 99.3%. Its frequency of consumption is 1 time in the week 46%. 71.3% of those surveyed consume them all seasons. Laboratory results give the following morphological characteristics and nutritive values: leaf length 10.75 ± 2.10 cm, leaf width 9.5 ± 2.54 cm, petiole length 4 ± 0.70 cm, leaf water (89.03 g/100 g of fresh material); protein content (11.15 g / 100 g of dry matter); carbohydrate content 68.98 g/100 g of dry matter. The ashes have a content of 15.05 g/100 g of dry matter. Energy 363.9 kcal (or 1521.102 kJ). The leaves of *B. alba* L. have a good nutritional value, take into account the content of proteins and minerals and can contribute to the improvement of the nutritional state of the populations.

Key words: Leaf vegetable, consumer survey, nutritional value, Brazzaville.

INTRODUCTION

In developing countries, leafy vegetables play an important role in the diversification of people's diets. Of the 45,000 plant species present in sub-Saharan Africa, about 1,000 may be consumed as leafy vegetables (CTA, 2004; Ogoye and Aagaard-Hansen, 2003). These leafy vegetables are rich in micronutrients and some macronutrients (Grubben and Danton, 2004; Berger, 2003; Batawila et al., 2007). As a result, they contribute

to improving the nutritional status of populations in both rural and urban areas. In addition to their nutrient richness, traditional leafy vegetables are available, adapted to the agro-ecological conditions and low production cost (Abukutsa-Onyango, 2004). In Congo Brazzaville, most people depend on non-timber forest products for food and health care. In addition, through various informal channels, these products offer

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Figure 1. *B. alba*'s foot L.

employment opportunities and generate income for the many actors involved in their exploitation and marketing (Gockwiski, 2003).

Despite their importance, leafy vegetables are generally neglected by consumers because of their rural lifestyle and may be it is due to the lack of knowledge. As a result, they are often considered a "food for the poor" (Itoua Okouango et al., 2015). Alongside all these leafy vegetables, there remains a wild vegetable called *Basella alba* L., poorly known and consumed by the population of Brazzaville. Indeed, this plant is present in the Congolese savannas resembling a vegetable much more consumed by the Congolese population, commonly called wild spinach (*Spinacia oleracea*). It should be noted that in Congo-Brazzaville, no study has been carried out on this vegetable, especially as regards its nutritional virtues and its consumption. The objective of this study is to determine the nutritional and nutritional value of the vegetable *B. alba* L. in the dietary habits of the population of Brazzaville.

METHODOLOGY

Field of study

The study was conducted among the inhabitants of Brazzaville in nine districts. Brazzaville is located on the right bank of the majestic Congo River, the second largest river in the world after the Amazon

by the power of its flow (40000 m³ / s). The agglomeration of Brazzaville covers an area of nearly 100 km² with a population estimated at 2,000,000 million inhabitants. It is bounded to the North by the district of Ignié, Department of Pool; South and East by the Congo River and the DRC; to the West by the district of Goma Tsétsé, Department of Pool. Brazzaville is one of the few African capitals that brings together several nationalities. It is a transit city because of its natural and exceptional geographical location which places it at the heart of the main communication routes within Central Africa. It is nicknamed "Brazza-la-verte", because of the omnipresence of the greenery.

Equipment

Target population

This survey was conducted in 150 households consuming leaves of *B. alba* L. Evaluation of the consumption and nutritional quality of *B. alba* L. in Brazzaville. *B. alba* L. leaves purchased at the Total market, located in the Bacongo district and transported to the laboratory for physicochemical analyses (Figure 1).

Teaching materials

The didactic material consisted of a survey sheet, consisting of open questions and closed questions that are asked of the respondent and whose answers are noted or checked on the form by the interviewer. The main points of this sheet were: knowledge of the vegetable, utility of the plant, methods of preparation taking into account its organoleptic characteristics and frequency of consumption.

Household survey

The fieldwork was characterized by a food consumption survey of leaves of *B. alba* L. called in vernacular (Lari) Moudjiri. The survey was conducted in Brazzaville from 17 July to 06 August 2018 among 150 households. The survey was conducted in households in nine districts of Brazzaville. The survey consists of meeting the respondent at home. In each household, only one consumer was interviewed, designated by the person who usually takes care of the meals. The respondent is submitted to the questionnaires following the chronology of the survey sheet and the answers are noted by the interviewer. The dialogue took place in the official language (French) or in the national language (Lingala and Kituba) according to the language mastered by the respondent.

Type of investigation

We used a cross-sectional survey; chosen because it was carried out on part of the population for a period of 21 days.

Inclusion criteria

The persons subject to the survey must meet the following criteria:

1. Being a consumer of *B. alba* L. (Moudjiri)
2. Reside in Brazzaville at the time of the survey
3. Agree to answer the questionnaires posed by the investigator.

Sample frame

The source population of the survey is households which were considered as statistical unit, defined as all related or unmarried persons, usually sharing the same meals, living under the authority of the same individual called the head of household and living in the same house. The choice of the household as a statistical unit made it possible to collect the desired information (information on households).

Place of identification

The plant material after purchase, was sent to the Botanical Laboratory of the Center of Study on Plant Resources (CERVE) of the General Delegation of Scientific and Technical Research in Brazzaville for the confirmation of the name of the species and of its morphological characteristics.

Chemical analyses

The chemical analyses in of sample focused on the content of moisture, dry matter, lipid, protein and ash.

Preparation of the sample for the chemical analysis

The leaves of *B. alba* L. were weighed then dried with the drying oven at the temperature of 70°C until stabilization of the mass. With the resulting one from this drying, the sheets were crushed. The powder obtained was used in this form for the chemical analysis.

Determination of the water content

The water content was determined by a drying of the leaves of *B.*

alba L. to the drying oven of mark thermosi SR3000. A mass M_f of fresh sheets was weighed and placed at the drying oven at the temperature of 70°C. Drying was stopped after obtaining constant mass M_s and the difference in weight gives the water content reported to 100 g of fresh matter.

Determination of the content of lipids

The content of lipids of the sample was determined by extraction according to the method with the soxhlet by using cyclohexane like solvent of extraction according to the protocol hereafter: 50 g of the powder resulting from the crushing of the leaves of *Basella alba* L. was placed in a cartridge, which in its turn is placed in the soxhlet. In an empty balloon of 250 ml weighed beforehand (M_0), one pours 150 ml solvent. The balloon is heated for 4 h, and then cooled. The solvent is evaporated by rotovapor. After evaporation, the balloon containing of lipids is weighed (M_1). The difference in mass between the balloon containing of lipids and the empty balloon gives the mass of lipids reported at 100 g of vegetable matter.

Determination of the content of proteins

The total nitrogen content was determined by the method of kjeldahl (AOAC, 1990) which consists of the mineralization of the organic matter by the concentrated sulphuric acid, in the presence of a catalyst. The contents of proteins were determined by the method of Kjeldahl by using a coefficient of conversion of nitrogen in protein of 6.25.

Determination of the content of carbohydrates

The carbohydrates were extracted by their solubility in ethanol after delipidation of the broyat of the sheets of *B. alba* L. (AOAC, 1990).

Determination of the content total rock salt (ashes)

The contents of total rock salt were determined by incineration with the muffle furnace at a temperature of 550°C for 8 h. Once the 8 h passed, the furnace was extinct and the ashes obtained was allowed to cool until the ambient temperature. Ashes were left in the furnace, and then weighed with a balance of precision (AOAC, 1990).

Determination of the energy value

The corresponding energy value was calculated using the Merrill and Watt (1955) coefficient for proteins, lipids and carbohydrates.

Statistical analysis

The counting was done with the creation of a database in the software Epi-info 6. The student test or comparison was used. It makes it possible to decide whether the difference observed between the two movements is attributable to a systematic cause or if it can be considered as the effect of a fluctuation due to chance.

RESULTS AND DISCUSSION

Sociodemographic characteristics of consumers of *B. alba* L.

The age, sex, and educational level of consumers of *B.*

Table 1. Age, sex and education of *B. alba* L. consumers.

Parameter	Variable	Effective	Percentage	Statistical test
Age of consumers	20-24	25	16.7	$\chi^2=20.939$ ddl=149 $p<0.001$
	25-29	18	12.0	
	30-34	12	8.0	
	35-39	15	10.0	
	40-44	20	13.3	
	45-49	8	5.3	
	50-54	22	14.0	
	55-59	12	8.0	
	60-64	9	6.0	
	≥65	9	6.0	
	Mean = 41.18 ± 15.36 years			
Consumer sex	Male	25	16.7	$\chi^2=60.048$ ddl=149 $p<0.001$
	Female	125	83.3	
Level of education of consumers	Primary	16	10.7	$\chi^2=35.146$ ddl=149 $p<0.001$
	Middle School	52	34.7	
	High school	58	38.7	
	Superior	22	14.6	
	Never schooled	2	1.3	

alba L. leaves are shown in Table 1. This result shows that of the 150 households surveyed, the age ranges from 20 to 65 years and over. It appears that 16.7% have an age between 20-24 years and 14.0% are in the age group of 50-54 years. A prevalence of 13.3% was recorded for people aged 40-44 years and 12.0% for those between 25-29 years old. Other age groups are poorly represented with an average age of 41.18 ± 15.36 years. Regarding the sex of the respondents, there are more women (83.3%) than men (16.7%). Regarding the level of education, it appears that the level of education of the school was more represented with a proportion of 38.7%.

Professional activity, household composition and marital status of consumers of *B. alba* L.

The result of the professional activity, the household composition and marital status of the consumers of *B. alba* L. are shown in Table 2. Almost half of the surveyed consumers (43.3%) are informal and 38.1% are shopkeepers. Civil servants and respondents in the private sector are poorly represented, with 9.3% each.

With regard to household composition, these results show that households with 5 persons are the most represented with an occurrence of 35.3%. The proportions of households with more than 6 persons and three persons are respectively 28.0 and 22.0%. Other households

are poorly represented. Consumers of *B. alba* L. live in households averaging 5.64 ± 3.28 members. As for marital status, 38.7% of consumers are single. The prevalence of 26.0% is observed for common-law unions. It is 18% for married couples. The rates of widowed and divorced are the least compared to the other categories surveyed. They represent respectively 8.0 and 9.3% of the surveyed population.

Knowledge, consumption form and organoleptic characteristics of *B. alba* L. leaves

Table 3 presents the knowledge, consumption form, and organoleptic characteristics of the leaves of *B. alba* L. where 100.0% of those surveyed know and consume *B. alba* L. whose leaves are consumed in cooked form (99.3%). A high prevalence is observed of raw consumption of the leaves of *B. alba* L. This prevalence is 0.7% of the surveyed population. The statistical analysis results reveal a "form of consumption" effect of the highly-sensitive leaves according to the Qui2 test. Regarding the organoleptic characteristics of the leaves of *B. alba* L. these results show that the rate of 48.7% of respondents stated that the leaves of *B. alba* L. are tasteless. The sweet taste of these leaves is noted at an occurrence of 45.3% of the surveyed population. Bitter and acidic tastes are poorly represented with a prevalence of 4.7 and 1.3%, respectively.

Table 2. Professional activity, household composition and marital status of consumers of *B. alba* L.

Parameter	Variable	Effective	Percentage	Statistical test
Professional activity of consumers	Official	14	9.3	$\chi^2=41.369$ ddl=149 p<0.001
	Private sector	14	9.3	
	Informal	65	43.3	
	Merchant	57	38.1	
Household composition	1 person	10	6.7	$\chi^2=32.937$ ddl=149 p<0.001
	2 persons	10	6.7	
	3 people	33	22.0	
	5 people	53	35.3	
	6 persons	2	1.3	
	> 6personnes	42	28.0	
	Mean \pm standard deviation: 5.64 \pm 3.28			
Marital status	Single	58	38.7	$\chi^2=21.173$ ddl=149 p<0.001
	Married	27	18.0	
	Divorced	14	9.3	
	free Union	39	26.0	
	Widower (Ve)	12	8.0	

Table 3. Knowledge, form of consumption and organoleptic qualities of *B. alba* L.

Parameter	Variable	Effective	Percentage	Statistical test
Knowledge of <i>B. alba</i> L.	Yes	150	100.0	
Consumption of <i>B. alba</i> L.	Yes	150	100.0	
The form of consumption	Cooked	149	99.3	$\chi^2=76.000$ ddl=149 p < 0.001
	Flood	1	0.7	
The tastes of these leaves	Sugar	68	45.3	$\chi^2=21.194$ ddl=149 p<0.001
	Bitter	7	4.7	
	Acid	2	1.3	
	Tasteless	73	48.7	

Form of use of leaves of *B. alba* L.

The Table 4 specifies the different forms of use of *B. alba* L. The leaves of *B. alba* L are used as seasoning or as a vegetable. Most respondents (96.0%) use these leaves as a vegetable. Only 4.0% of respondents use them as seasoning. Among the respondents, 72.7% say that the leaves of *B. alba* L. give a gooey appearance in the soup, 31.3% say that the leaves of *B. alba* L. can replace the okra. On the other hand, 68.7% say that leaves of *B. alba* L. do not replace okra and 27.0% say they do not look slimy in soup.

Association and accompaniment foods with leaves of *B. alba* L

Table 5 presents the association and accompanying

foods with the leaves of *B. alba* L. From these results, among the 150 households surveyed, 82.0% of households prepare these vegetables with either smoked fish or fresh meat; 13.3% of respondents only prepare them with smoked fish. The consumption of *B. alba* leaves prepared with fresh meat is poorly represented at 4.7%. The staple foods that accompany the leaves of *B. alba* L., 61.3% of respondents alternate staple foods, 20.7% use only cassava, 17.3% use only fofou (cassava flour). Bread is weakly associated with a prevalence of 0.7%.

Frequency of weekly consumption of leaves of *B. alba* L.

Figure 2 illustrates the frequency of consumption in the week. The leaves of *B. alba* L. are consumed once in the

Table 4. Form of use of leaves of *B. alba* L.

Parameter	Variable	Effective	Percentage	Statistical test
Use of leaves as a seasoning or vegetable	Seasoning	6	4.0	$\chi^2=122.091$ ddl=149 p<0.001
	Vegetable	144	96.0	
Can replace okra	Yes	46	31.3	$\chi^2=42.674$ ddl=149 p<0.001
	No	104	68.7	
Does it give the thickening aspect in the soup?	Yes	109	72.7	$\chi^2=34.876$ ddl=149 p<0.001

Table 5. Association and companion foods with *B. alba* L.

Parameter	Variable	Effective	Percentage	Statistical test
Types of fish or meat associated with leaves	Fresh meat	7	4.7	$\chi^2=38.789$ ddl=149 p<0.001
	Smoked fish	20	13.3	
	Alternate Association	123	82.0	
Basic food accompanying the leaves	Cassava	31	20.7	$\chi^2=25.468$ ddl=149 p<0.001

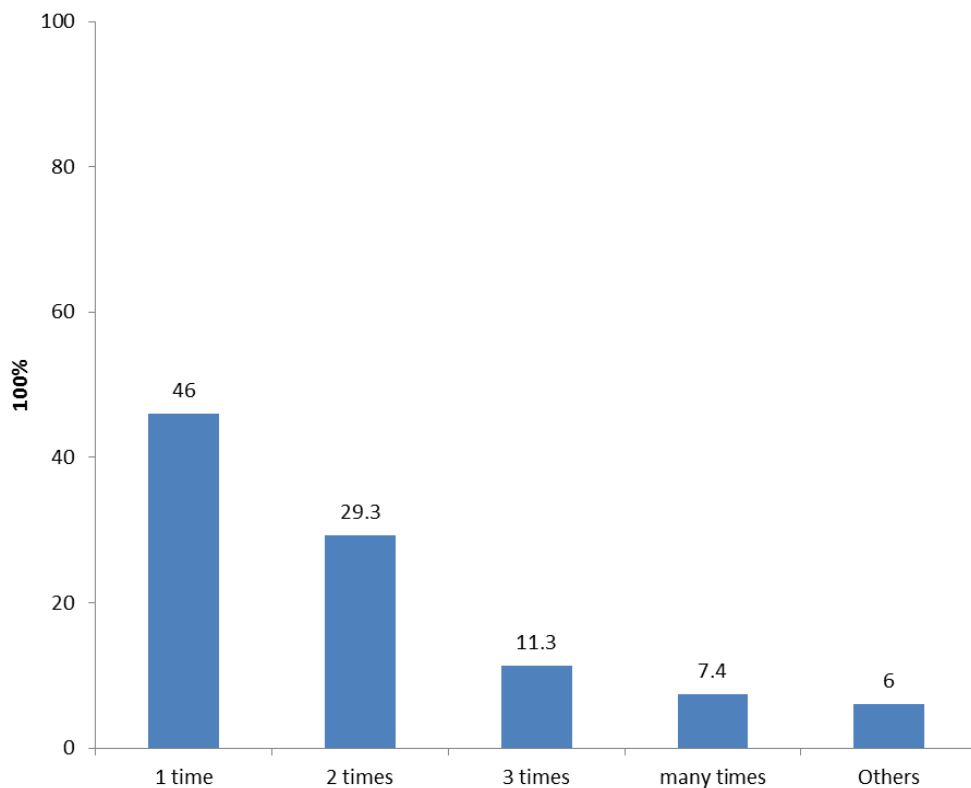


Figure 2. Distribution of respondents according to the frequency of consumption of leaves of *B. alba* L. in the week.

Table 6. Morphological characteristics of leaves of *B. alba* L.

Physical characteristics	<i>B. alba</i> L.
Length (cm)	10.75±2.10
Width (cm)	9.5±2.54
Length of the petiole (cm)	4±0.70
Number of ribs	6.5±1.0

Table 7. Nutritional and energy value of *B. alba* L.

Moisture, macro-nutriments and ashes	Value
Moisture (%)	89.03±0.10
Proteins (g/100 g)	11.15±0.68
Lipids (g/100 g)	4.82±0.84
Carbohydrates (g/100 g)	68.98±2.35
Ashes (g)	15.05±0.74
Energy in Kcal	323.68±57.89

week with a percentage of (46.0%), followed by households that consume them twice during the week (29.3%). 11.3% of households consume them three times a week, 7.4% of households consume them several times a week. However, 6% of households do not know the number of times they have consumed these leaves in the week.

Morphological characteristics of leaves of *B. alba* L.

The results in Table 6 show that *B. alba* L. has leaves that have the following morphological characteristics: leaf length 10.75 cm, leaf width 9.5 cm, number of secondary veins 5.5, number of veins main 1 and finally the petiole length 4 cm.

Overall nutritional value of *B. alba* L.

Table 7 shows the nutritional and nutritional quality of *B. alba* L.. This table shows that the leaves of *B. alba* L. have a water content of 89.03% MF, the dry matter content is 10.97% from MS. However, the proteins, the lipids and the carbohydrates show respective contents of 11.15% of MS; 4.82% MS and 68.98% MS. *B. alba* leaves have an ash content of 15.05% DM. These nutrients (proteins, lipids, carbohydrates) provide 323.68 Kcal (or 1352.98 KJ).

DISCUSSION

The most important consumers of *B. alba* L. are people whose age is between 20-24 years old with a prevalence

of 16.7%. The value found in our study is higher than that reported by Elenga et al. (2016) for the same age group, on a *Salacia pynaertii* study (4.3%). This difference could be explained by the choice of vegetables. Regarding the sex of the respondents, 83.3% of the consumers are female. This is analogous to what Probst (2008) said that women are responsible for choosing vegetables and cooking meals. Food-related activities are almost exclusively for women. As for the level of education of the respondents, the results of our study show that consumers of *B. alba* L. have a high school (38.7%), high school (34.7%) and upper secondary (14.6%) level of education (%). However, 43.3% of them engage in an informal activity. These results are consistent with those of Elenga et al. (2017) on a study of the Nutritional Characterization of Local Flours of Manufacturing Units for Infants and Young Children in Congo-Brazzaville. The author mentions that the majority of respondents exercise a informal activity (54.5%). The consumption of the leaf vegetable studied is not related to the social level of the household or the educational level of the subject. Thus, Jansen et al. (2004) stated that "people in Africa often use plant species to meet their food needs and ensure food security". On the knowledge of this leaf vegetable, the present work shows that *B. alba* L. is a vegetable known by all respondents (100%). These results are in agreement with those obtained by Tchiegang et al. (2004), in a study of nutritional data and physicochemical characteristics of leafy vegetables consumed in the savanna of Adamaoua, 100% of those surveyed know leafy vegetables.

With regard to consumption, 100% of respondents consume *B. alba* L. The results corroborate with those of Elenga et al. (2016). These authors reported, in a study on the consumption of *S. pynaertii* leaves, that 100% of

the respondents consume this plant. *B. alba* L is a commonly consumed vegetable in Brazzaville. The leaves of *B. alba* L. are consumed in cooked form (99.3%). This same result was found by Itoua et al. (2015) on *Phytolacca dodecandra* Herit (100%). However, Richard (2007) mentioned that "the consumption of many leafy vegetables requires cooking to avoid irritating or toxic effects".

Regarding the organoleptic characteristics of the leaves of *B. alba* L., 48.7% of households find these vegetables tasteless against 45.3% who find them sweet. The results differ from those obtained by Itoua Okouango et al. (2019) in a study on the characterization of the food value of the leafy vegetable *Lagenaria siceraria*, of which 88.6% of the respondents found these sweet vegetables compared to 11.4% who find them tasteless.

The results show that 96% of the people surveyed use the leaves of *B. alba* L as a vegetable and 4% use them as seasoning. *B. alba* L replaces *okra* for 31.3% of those surveyed and 72.7% say that it gives a thickening appearance in the soup. According to Romanchik et al. (2002), *okra* contains a mucilaginous substance, that is, it swells on contact with water and produces thick, viscous substances. This substance can be used as a thickener in various culinary preparations (soups, stews). In addition, it could be used as a substitute for fat in certain food preparations. Regarding the preparation of the leaves of *B. alba* L., 82% of the respondents make an alternating association with fresh meat and smoked fish, against 13.3% of the respondents prepare them only with smoked fish and 4.7% with fresh meat. This association with meat or fish could benefit consumers of animal protein that has good biological value than plant-based proteins.

With regard to the staple foods that accompany the leaves of *B. alba* L, the present study shows that 61.3% of the respondents alternate fufou (cassava flour) with cassava, while 20.7% only accompany dishes with cassava and 17.3% with the fufou (cassava flour). The work corroborates with those of Itoua Okouango et al. (2015), who report that fufou and cassava are part of the Congolese food habits.

Weekly consumption of *B. alba* L, 46% of respondents consume once a week, 29.3% twice. The work is superior to that obtained by Itoua Okouango et al. (2015). These authors mentioned that *P. dodecandra* L' Herit is consumed once a week (20%). This difference could be explained by the seasonality of leafy vegetables which reduces their frequency of consumption. On the other hand, the present work is similar to those who consume it twice a week (28%).

With regard to the morphology of the leaf, *B. alba* L has an average length of 10.75 ± 2.10 cm, and a width of 9.5 ± 2.54 cm. The petiole length is 4 ± 0.70 cm, the number of veins is 6.5 ± 1.0 . Our work differs from those obtained by Mbemba et al. (2013) for *Gnetum africanum* (length: 12.92 ± 0.94 cm, width: 06.87 ± 0.49 cm with number of ribs: 10.50 ± 0.86).

With regard to the chemical composition of the leaves of *B. alba* L, the result of this study shows that the moisture content of these leaves is 89.03% fresh material. These results are close to those found by Tchiegang and Kitikil (2004), who found a moisture content of 90.85% fresh material for *Hibiscus sabdariffa*. *B. alba* L and *H. sabdariffa* are two different species or the leaves are engorged with water.

The ash content gives a value of 15.05%. These results are significantly lower than those obtained by Oulai et al. (2014) observe an ash content of 25.67% dry matter, for leaves of *Ceiba pendandra*. This difference could be explained by the maturity of the plants. The protein content gives a value of 11.15% dry matter. Our work is similar to the results obtained by Mbemba et al. (2013) obtain a protein content of 09.59 g/ 100 g dry matter on a study of *Cuervea isangiensis* leaves. The total carbohydrate analysis gives a value of 68.98% dry matter. These results are similar to those obtained by Elenga et al. (2016) on *S. pynaertii* leaves (total carbohydrate 67.54g / 100g dry matter). The energy value of the leaves of *B.alba* L. is 323.68 Kcal. The results are far superior to those obtained by Itoua Okouango et al. (2015) find a value of 161.84 Kcal for *P. dodecandra*. *B. alba* L, leaf vegetable studied could be an energy food.

Conclusion

B. alba L. is a vegetable commonly consumed by people with different socio-demographic levels, so this leaf vegetable fits into the eating habits of the people of Brazzaville. This study revealed that the leaves of *B. alba* L. have a good nutritional value, therefore they have an important food resource took into account to the content of in proteins and minerals and can contribute to the improvement of the nutritional state of the populations.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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