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Ethnobotany and demography of *Berlinia grandiflora* (Vahl) Hutch. and Dalziel (Fabaceae)

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Abstract

B.grandiflora has a great importance in Cameroon. The purpose initiated encircle the main uses and demography structure of the species in the perspective to know its socio-economic potentialities. Unfortunately, it is under numerous anthropic pressures. Ethnobotanic investigations were carried out in 200 households and botanical inventories were undertaken in riverside forest, predilection habitat. The Fabaceae is a multipurpose tree species: feeding, handicraft, construction, traditional medicine, cultural, ways and customs, etc. Seed commercialization is an important source of income for the households. The seeds dealing brings a revenue of 213859.45-274962.15$/an. A total of 1034 stems was quoted for a mean density of 82.72inds/ha. The average diameter of the trunks is of 76.94±31.19cm, while the average height of the trees is of 14.94 ±4.78m. The analysis of the structure of population of this species reveals that natural regeneration is strongly compromised by various anthropic activities and abiotic pressures. The most frightening anthropic pressure is the collection of seeds for great marketing. These findings will help the development of the participatory domestication programme with the actors in order to facilitate its sustainable management by the communities.

Key words: *B. grandiflora*, Uses, Demography, Commercialization, Sustainable management, Adamawa.

Introduction

In Central Africa, 50% of the effective population is poor and underneath feed whereas 30% of persons living in extreme poverty[1]. For their living daily requirements, local populations exploit forest in searching subsistence means and revenues.

Management, transformation and commercialization of some non-timber forest products (NTFP) permits to supply food deficits and furnish important revenues[2]. Some of these NTFP are more appreciated by consumers and have win economic interesting channels according to the quantity of products which enter markets. The number of actors involved in this channel, revenues gotten by them and the function they play in the feeding of different consumers are important[3].

In the Guinean savannah Highlands of Cameroon, management and commercialization of *B. grandiflora* seeds contribute to the improvement of the living conditions of rural populations[4]. This Fabaceae is among the various species managed by the local populations in the wild[5]. Since 2013, it was classified as «Least Concern» threatened species[6]. However, it became a strategical resource in the area because of the population subordination. Commercialization of its seeds is flourishing in the Guinean savannah highlands. The massive gathering of these seeds since a decade could compromise the survival of the species in the area at long date.

There is necessity of sustainable management and development of a conservation programme of the species[7]. To develop these conservation strategies, knowledges on the main uses and population status in natural habitat are vital. Scientific works on tree demography are scarce in Guinean savannah highlands conditions, except those reported on *Parkia biglobosa*[8], *Vitellaria paradoxa*[9] and *Boswellia dalzielii*[10].

Yet without knowledge's on population structure, abundance and management level of the species, any serious decision can be envisaged on the sustainable management of the species[11]. Uses, demographic distribution and abundance of a resource is a prerequisite for the evaluation of its state.

Therefore, the purpose of the present work is to document different uses and actual demographic status of *B.grandiflora* facing crescent anthropic pressure, in order to develop sustainable management strategies for the resource. Specifically, it consists to take a senses of domestic and commercial uses of the species. Draw up the exploitation status of the species by the populations. Assess the demographic population of the species. and propose a sustainable management programme of the species consistent with biological potentialities. These information's will serve as baseline to develop appropriate management techniques. They could help farmers to introduce and grow this species in homegardens to get maximum benefits.

Materials and Methods

Study site: The work has been undertaken in 5 villages (Table-1) of the Guinean Savannah Highlands in Adamawa (GSHA) Region of Cameroon (LN: 7°2′36 N, LE: 13°34′72 E). The climate is guinean type with one active dry season (October–March) and a rainy season covering the remaining of the year. The yearly average total precipitation and evaporation are respectively 1315.6 mm, 1902.95 mm. The distribution of the rainfall is monomodal. Two main winds blow in the region notably the monsoon during the rainy season from the South and the Harmattan from the North responsible for the drought[7,12]. The soil of the area is rich in ferruginous compounds derived from granites, granodiorites, and of gneiss after rejuvenation and is composed of red ferralitic soil developed on old basalts[13]. The vegetation is mainly composed of shrubby and/or woody savannahs with consistent predominance of Daniellia oliveri and Lophira lanceolata[14]. Nowadays, the density of these species has significantly decreased under the influence of human activities[15].

Table-1: Characteristics of the study villages.

Villages	Latitude	Longitude	Altitude (m)
Libong Marche	07°28’20.7’’N	13°00’ 13.6’’E	952
Lewa Boum	07°23’01.3’’ N	13°04’56.8’’E	934
Sodepa	07°17’03.2’’N	12°53’23.6’’E	998
Mandourou	7° 29’33.6’’N	13° 16’12.2’’E	1010
Masangar	07°28’14.3’’N	13°02’7.8’’E	988

Methodology: The work was undertaken both in households and in the field. Households Survey: Ethnobotanical data were collected through visiting the respondents in households for the species uses. Semi–structured interviews as well as field visits were conducted. Households survey involved 200 farmers of which 20 per village, using a semi - structured questionnaire as the survey instrument. Each farmer was asked to give the main uses of B.grandiflora and its perceptions on the plant. Rubriques deal with the main uses of the species, the fruiting period, the quantity of seeds collected, selling unit and price, the commercialization channel, constraints, etc.

Floristic inventories: A transect of 1km long and 20m width was delimited following methodologies developed by numerous authors[8-10]. A total of 100 transects were realized for the 5 villages being 20 per village. Diameter at the breast height, height of the first large alive branch as well as diameter of the tree canopy were determined using dbh-meter and clinometer. Each village was georeferenced by the global positioning tool.

Results and Discussion

Berlinia grandiflora is a multipurpose tree colonizing mainly riverside forest, its predilection habitat. Locally, the species is known in Cameroon as «djing» by the Fulani while in Nigeria, «ububa» or «apado» respectively by the Igbos and Yorubas. The seeds are the most important used part of the species. According to respondents, the seeds are eating as beans in Cameroon mainly in Tikar’ plain and in Nigeria.

Socio-economic characteristics of the households: The total sample of the farmers is constituted by 42.7±9.01 of farmers between 30 and 45 years old followed by those from 15-30 years (40.7±8.08). Farmers of more than 45 years old are scarce. This absence can be justified by the fact that it is difficult for old people to spend a day in the forest in collecting seeds. When the fruits become mature, they crack up and seeds are disseminated and mixed up with litter. To find them, farmers have to bend their skin all the daylong to pick them one by one. These populations are dominated by women (52%). The most important ethnolinguistic groups involved in the activity of harvesting seeds of Berlinia grandiflora are Gbaya (34.7±18.58%), Mboum (28±22.53%), Peulh (17.33±5.03 %) and Dii (11.33±5.77 %). The Fulani group has good knowledge on the species and is the main concerned in each village except in Libong Marché where the Gbaya are dominant (56%). Most of their claims agreed together revealing the common use of this Fabaceae.

Ethnobotanical uses: Many uses are associated to *Berlinia grandiflora* according to respondents: feeding, handicraft, construction, traditional medicine, custom, etc. Different parts of the tree are valorized: cockle of the fruit, seeds, flowers, leaves and barks, branches and wood. According to them, the use of the non-wood forest products (NWFP) from this species date since a few decade. Before the arrival of nigerians in the region, the socio-economic value of the species was unknown in the Guinean Savannah Highlands. In the year 2000, nigerians arrived in villages of the region, brandishing the seed samples of the species to local farmers and asked them if they know the species, where it is grown. Farmers took recognizance of the species and it was then the departure of its exploitation in the region. From that time till nowadays, the species become operative an important socio-economic one in the Adamawa region of Cameroon.

The seeds are eaten only in Tikar plain of Cameroon where they are cooked and eaten as beans. Respondents claim also that they are imported by Nigerian operators for use as seasoning. *Berlinia grandiflora* seeds contain saturated and monounsaturated fatty acids[16]. Similarly, it is equally reported that pathogenic phytochals against bacteria were absent[17]. The presence of toxic phytochemicals that can lead to instant death were not evident from the findings of those authors. The wood has many applications: it is appreciated in construction and handicraft. It is used for furniture’s, light carpentry, turnery, flooring, drums and veneer. The branches are used in house construction. The wood is resistant to termites. Its bark is harvested and used as rope in many ways (creeper for house and bundle of fuel woods, etc.). In Burkina Faso, the wood of the species is also sought for construction, handicraft, dyeing and domestic tools[18]. The interest of the species in Nigeria is based

on its capacity to produce excellent wood for construction[19].
The medicinal value of *B. grandiflora* is well known to herbalists and traditional medicine practitioners in Cameroon and neighboring countries. The plant is used for the treatment of several disease conditions in ethnomedicine. Bark decoctions are administered to taret hemorrhoids and liver problems. The leaf and stem bark extracts have been shown to have appreciable antimicrobial and antihelminthic properties. In Burkina Faso, it treats fever and general tiredness[18]. In Nigeria, the bark decoction is used to treat stomach upset while the leaves and bark are used for malarial bathing[20]. The bark extract is also used to ease labor pain during childbirth and for treating gastrointestinal disorder[21]. The leaf decoction is drunk as a tonic and used to improve blood circulation[22]. The aqueous extract of the stem bark powder using hydrodistillation contains three chemical families' compounds such as saponines, tanins and steroid terpenoid[23]. In Ivory Coast, the species is a medicinal plant belonging to the category of multipurpose tree species[24].

For custom and tradition, the abundance of blossom in *B. grandiflora* marks the beginning of the ceremony of marriage in Senoufo tribe of Burkina Faso as well as announces that crop production in the year will be good[18].

In agroforestry use, *Berlinia grandiflora* is a forest tree that is sometimes planted as shade tree in villages and coffee plantations. It is occasionally browsed by livestock especially sheep and goats[23,25]. Its seeds are harvested and internationally commercialized. These activities make it a great important socio-economic species in the region which provide income to farmers.

Harvesting and commercialization of *Berlinia grandiflora* seeds: The gathering campaign of the seeds of *B. grandiflora* coincides with the fruiting phenology period. Fruits reach maturity between February and April. During this period every year, there is mobilization of local farmers as well as that of nigerian collectors in villages involved in the harvesting of these seeds. Farmers organized themselves in teams according families, quarters and affinities among them. They cover long distances to look for population of the species. Sometimes, they travel with children and kitchen tools and settle temporally where the population of the species is found. Seeds are collected with calabashes, plates, etc. and put in bags and carry on head to home where they are packed or sell if they are well dried. Some local producers kept their production in stores waiting a favorable period to sell it to Nigerian collectors. The quantity harvested varies from villages to another (Table-2). The retail selling unit all over the region is locally known as ''koro'' and a bag for a wholesale. The content of koro is equal to 1kg while that of the bag correspond to 100kg. The total quantity of seeds harvested in the year 1999 is 356.95 bags being 35.695kg or 35.695t. This amount is less than what has been reported in other ecosystems of Cameroon[4].

For the wholesale sale, the price of the bag varies according the seasons. The bag cost 599.13$ during the fruiting season and 770.31$ off-season. The total income from the sale of the seeds of *B. grandiflora* fluctuates between 213859.45 to 274962.15$ (Table-2). Farmers of the area have forsaken the cultivation of the cotton versus collection of seeds of the species. They claim that seeds of *B. grandiflora* are interesting source of income than cotton cultivated in the area.

Table-2: Quantities of seeds bags collected and saled.

Parameters	Libong Market	Lewa Mboum	Mandourou	Total
Quantity /day (kg)	2.26	2.26	2.25	6.78
Quantity/week (kg)	12.89	14.041	12.73	39.67
Quantity/Campaign (kg)	11599	12636	11459	35695
Minimum cost ($)	69493.255	75706.0668	68654.307	213859.45
Maximum cost($)	89348.26	97336.37	88269.82	274962.15

Stems diameter of Berlinia grandiflora: Regarding B. grandiflora population, 1034 stems of height more than 1.5m were recorded in an area of 12.5ha, giving an average of 82.72 stems/ha. It varies from 78 stems/ha in Libong Market to 88.5 stems/ha in Masangar (Figure-1). This finding is less than what was reported in Benin in Dialium guineense[26] and in Pentadesma butyracea[27]. The stem diameter varies from 14.8 cm in Libong Market to 203.8 cm in Lewa Mboum. The average stem diameter of B. grandiflora is 76.94±31.19cm.

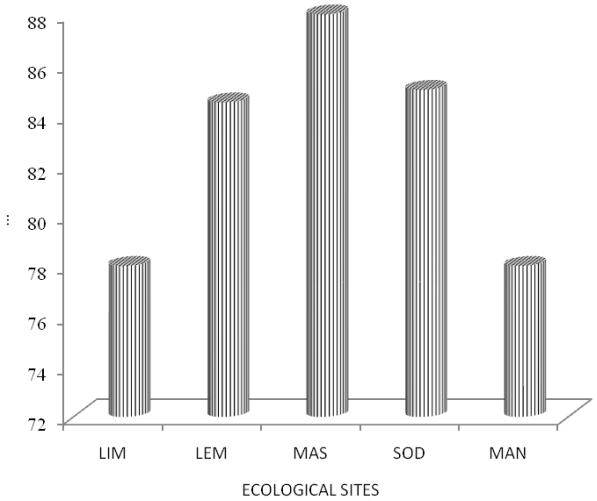

Figure-1: Density of *Berlinia grandiflora*. LIM=Libong-Market, LB=Lewa-Mboum, MA= Masangar, SO= Sodepa, MD= Mandourou.

The trend of histogram corresponding to diametric distribution of *B. grandiflora* individuals in the five sites follows a normal distribution (Figure-2). The scarcity of stems in the diameter classes both less than 10cm and more than 70cm is remarkable (Figure-2). The lower population of the youthful stems can be explained by the fact that, mature trees are rare, and the farmers usually collect the majority of seeds. Natural regeneration and survival of seedlings are consequently weak.

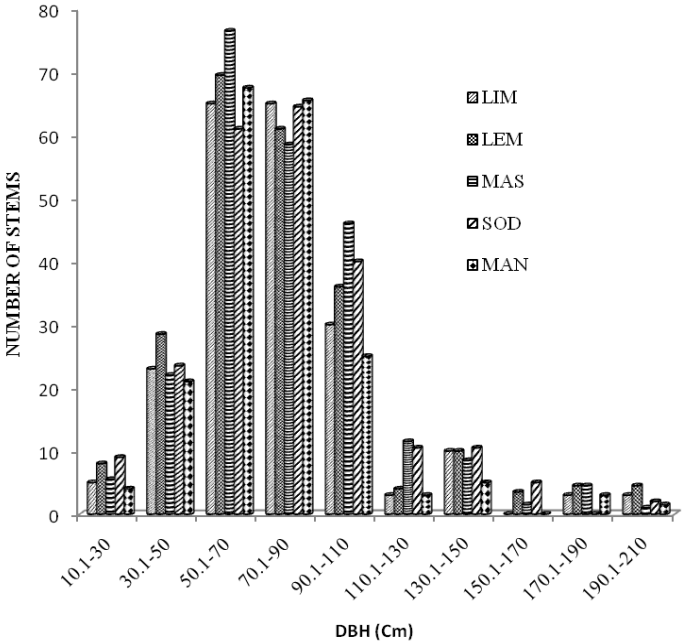

Figure-2: Diametric distribution of Berlinia grandiflora. DBH = Diameter at breast height. LIM=Libong-Marché, LEM=Lewa-Mboum, MAS= Masangar, SOD = Sodepa, MAN=Mandourou.

Class diameter less than 10cm, individuals are absent in all the sites. This situation justifies the scarceness of seedlings which will prepare to take over the old trees. In addition, there is also rarity of old trees in all sites. These results suggest that natural regeneration of the plant and maintenance of old trees are difficult. Analogous behaviors in *Boswellia dalzielli*, *Parkia biglobosa* in Mbe and Ngaoundéré savannahs were reported[8,10]. In *Vitellaria paradoxa*, distribution shows good regeneration of the species and difficult survival of old trees[9]. This trend indicates that the distribution behavior varies according to species.

In the site of Libong-Market, the maximum of individuals of *B. grandiflora* are concentrated in the class diameter 50.1-90cm whereas in Lewa Mboum, Sodepa, Masangar, et Mandourou, the optimum is located in the class diameter 50.1-70cm. The findings reported in *Balanites aegyptiaca* exhibiting maximum individuals in 21-50 class diameter disagrees this one[28]. The average tree diameter fluctuates between 10 and 210 cm (Figure-2). This finding disagrees the one obtained in *Chrysophyllum albidum*[23]. This permits to see the importance of the species in sylviculture, if a participatory domestication project on the species is developed in the area. In general, the diameter at breast height of the species (81.76 m) is less than the one registered in Benin[29].

Height of the tree and the living large branch: The height of individuals varies significantly from 5.1-10m to 20.1-25m (0.0001<0.001). The average height is 14.94±4.78m. This is higher than the one reported in *Vitellaria paradoxa* in the Guinean Savannah Highlands[9].

On the whole, maximum individuals (891 stems) of *B. grandiflora* has high concentration in the 10.1-20m height class (Table-3). The concentration in this class by the individuals from Masangar and Sodepa are remarkable. Individuals of a height class less than 10m are very few confirming more the conclusions rose in previous chapters concerning the scarcity of young plants. The important height of the tree does not permit its easy management because the access to fruits is difficult obliging farmers to wait until they fall before harvesting. The height of this tree (7.2±4.25m) was reported in the gloves of Burkina Faso[30].

For the height of the living large branch of *B.grandiflora*, majority (1023 stems) of individuals are concentrated in the class height < 5m and 5-10m in all villages except in Masangar and Sodepa (Table-3). There is a significant difference between sites (0.0000<0.001). The average height of the living large branch is 8.2± 2.54m. This indicates that *B. grandiflora* produces ramifications at a high level. The height explains that collection of seeds is limited to picking.

Table-3. Distribution of stem height and living large branch of *B. grandiflora*.

Sites	Height (m)				Height of living large branch (m)		
	5.1-10	10.115	15.120	20.1-25	< 5	5.1-10	10.1-15
Libong - Market	10	85	78	23	118	80	10
Lewa - Mboum	19	114	63	14	120	90	10
Masangar	5	127	76	13	95	110	30
Sodepa	11	127	62	12	105	115	5
Mandourou	15	81	78	22	120	70	10
Total	59	534	357	84	558	465	65

Farmers experience difficulty to harvest pods because of the size which is high. It is necessary to identify individuals presenting interesting characteristics (low branches, fruiting precocity, long pods, large seeds, etc.) to domesticate and introduce in the farmer existing production systems. Designing orchards with interesting genotypes will be a good option to alleviate farmer's difficulties. Farmers could remain stand and collect seeds in such prototype of tree. Knowledge on this parameter is important in the guinea savannah highlands of Adamawa[31].

***Crown diameter of* Berlinia grandiflora:** The top diameter varies from 4.3m in Libong Market to 21.2m to Lewa Mboum and Mandourou. The mean summit diameter is 10.24±4.60m. Significant difference exits between sites (0.051<0.01). The maximum of trees (744 stems) is concentrated in the diameter class 5.1-15m (Table-4). A few trees (29 stems) are present in the diameter class 20.1-25cm. This confirms the fact that some old trees succeed to survive. B. grandiflora develops a large

crown. This parameter can permit to make predictions on plant production. Trees with large crown may product many fruits. The variability of results can be explained by edaphic and climatic factors in the sites as well as the anthropic actions.

Table-4: Distribution of crown diameter of *B.grandiflora*.

Sites	Diameter (m)				
	0.1-5	5.1-10	10.1-15	15.1-20	20.1-25
Libon-Market	14	83	64	28	07
Lewa-Mboum	24	91	49	35	11
Masangar	31	85	73	30	02
Sodepa	33	89	69	19	02
Mandourou	18	78	63	29	07
Total	120	426	318	141	29

Management sketch of the species: Field observations did not show that harvesting technics put resources in danger because no dead trunk has recorded. However, systematic gathering of seeds do not allow regeneration of the tree and has a non negligeable effect on population dynamic. It could be at the origin of a desesquilibrum between seedlings and old individus of the population[9]. A participatory approach allows the direct implication of the local populations in its regeneration process in order to define a sustainable management system of the plant which guarantees satisfaction of needs however leaving regeneration luck to the species. This participatory action consists to: -regenerate the species; -regulate the plant management because, in the peasant perception, savannah is a public domain which is free for everybody; -domesticate trees presenting preferable characters such as low ramification, large canopies, long pods and big seeds through low cost vegetative propagation (grafting, air layering, root segment cuttings, stem cuttings, etc.) in order to plant them in the farm where management is regulated.

Conclusion

B. grandiflora figure among the species of great importance in Cameroon. Its seeds constitute the main use of the species. The seeds commercialized permit to diversify the revenu of the farmers of the GSHA. Regeneration of the species as well as maintenance of adult trees are difficult. The diametric distribution of the population is irregular. The responsible factor is human activities. To conserve the species for the next generation, its sustainable management appears necessary.

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