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Quantitative ethnobotany of *Lophira lanceolata* Tiegh. ex Keay (Ochnaceae) in Benin (West Africa)

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ABSTRACT

Understanding the utilization of plant is fundamental for efficient conservation of species. The present study aimed at assessing the quatitative ethnobotany of *Lophira lanceolata* Tiegh. ex Keay (Ochnaceae) utilization in Benin. A number of 1261 persons were randomly selected and interviewed using semi-structured questionnaires. Principal Components Analysis was performed to relate utilizations and organs to ethnic groups. The diversity (ID) and equitability (IE) values were globally low (< 0.50) and indicated that local knowledge on *L. lanceolata* utilization is not fairly distributed among groups. *L. lanceolata* was not well-known by all the respondents and its utilization varied significantly among ethnic groups, between sex and fairly between age classes. The ethnic group consensus values for *L. lanceolata* parts showed that leaves are the most used organ. Local knowledge on the species was well-diversified and was influenced by the ethnic group. Our study has provided basic information that may help for sustainable management and conservation of the species in Benin.

Keywords: False shea, endogenous knowledge, ethnic differences, use value, use pattern.

INTRODUCTION

Natural forests provide a wide range of good and service to local population, enabling them to meet their needs. Millions of people in developing countries still rely on Non Timber Forest Products (NTFP) in natural vegetations to satisfy their livelihood (Gaoué and Ticktin, 2007). NTFP include any part of plants (tree or herbaceous) and animals (Avocevou-Ayisso et al., 2009) used by local population to meet their various needs, especially insurance of health and food security (Takasaki et al., 2004). However, there is growing evidence that NTFP are overharvested with non-convenient traditional methods which have negative effect on

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species reproduction (Betti, 2001; Gaoué and Ticktin, 2007).

But NTFP are not harvested at the same frequency and pressure for all species. This depends on the species utilization potential which is influenced by socioeconomic, cultural or ecological factors (Camou-Guerrero et al., 2008). Factors such as gender, age, ethnic group and relationship between groups can have a synergetic influence on the utilization value of a species (Gouwakinnou et al., 2011). This underlines the importance of ethnobotanical study recognized as complementary tool for managing and conserving plant resources in tropical regions (Albuquerque et al., 2009). Some ethnobotanical studies have highlighted the need to integrate the perspective of traditional knowledge into ecological research (Albuquerque et al., 2009). Additionally, there is growing efforts on the understanding of traditional ecological knowledge (López-Hoffman et al., 2006; Gaoue and Ticktin, 2009). Indeed, the success of natural resources management schedule requires the integration of local population perception and knowledge.

The red ironwood *(Lophira lanceolata* Tiegh. ex Keay, Ochnaceae) is a multipurpose use and oleaginous species used by west African local communities (Mapongmetsem, 2007). This species is associated to well-diversified utilizations and is therefore a natural resource of great socioeconomic importance. Like many other species in west African arid and semi-arid zones (Traoré et al., 2011; Dassou et al., 2014), *Lophira lanceolata* has become vulnerable due to the overexploitation of its organs, including barks, roots, flowers and fruits (Kouaro and Tasso, 2010).

Up to now, no management program or conservation method (modern or traditional) of *L. lanceolata* has been established for its sustainable exploitation.

Some studies have concerned *L. lanceolata* in Benin and Nigeria, a neighboring country. For example, a study in Benin by Kouaro and Tasso (2010) revealed that the species becomes rare in its natural distribution range and suggested to established sustainable management strategies of its populations. Nonviho et al. (2014) realized that oil extracted from the seeds of *L. lanceolata* can be used for various purposes because it contains much polyunsaturated and essential fatty acid. In Nigeria, Fariku and Kidah (2008) demonstrated that biomass of *L. lanceolata* fruit has high local energy potential. Lohlum et al. (2010) study on the biochemical composition of *L. lanceolata* seeds revealed seeds are sources of protein, mineral elements and energy in livestock feeds. However, ethnobotanical importance of *L. lanceolata* is poorly understood. This study used a quantitative approach to show how ethnobotanical knowledge of *L. lanceolata* is affected by local population characteristics such the ethnic group, age and gender. This study will provide baseline information for the sustainable management and conservation of *L. lanceolata* in Benin.

MATERIALS AND METHODS

Study species

L. lanceolata, also known as the red oak is a tree species that may reach 16(-24) m tall (Mapongmetsem, 2007). Its leaves are simple, entire, and alternate but clustered at the end of branches. Its inflorescence is a terminal, pyramidal, lax panicle with 15 to 20 cm long. Flowers are bisexual, regular and white in color. Fruits are assimilated to conical shape. Seed are ovoid in shape, chestnut-colored and glabrous (Mapongmetsem, 2007).

L. lanceolata is widely distributed across the Sudano-Guinean savannas (Persinos and Guimby, 1968) from Senegal through the Central African Republic and northern of Congo to Uganda (Mapongmetsem, 2007). It is majorly met in fields and fallows and is established on sandy or gravelly soils. The species can tolerate fire at adult stage, but seedlings are affected by regular bushfires (Mapongmetsem, 2007).

Study area

The study was carried out in three bioclimatic zones of Benin including Guineo-Congolean 6°25' N – 7°30' N), Sudano-Guinean transition (7°30' N – 9°45' N) and Sudanian (9°45' N-12° N) zones. Nine (09) departments out of the twelve (12) prospected where adult specimens of *L. lanceolata* have been recorded were considered as the study area (Figure 1). In each department, we randomly selected one (1) to five (5) district (s) where the species presence was recorded. A number of 24 districts out of the 77 districts of the country were sampled. In each district, 3 or 4 villages not very far from the species natural habitats (set 10 km far from plant communities with *L. lanceolata*) were selected for intensive ethnobotanical data collection.

Data collection

A preliminary investigation was conducted up on fifty (50) persons randomly selected from various ethnic groups in each department. Based on this, we calculated the percentage of respondents that have once or more used *L. lanceolata*. This percentage was used to estimate the sample size for the definitive ethnobotanical investigation using the formula of Dagnelie (1998) as follow:

$N = U^2_{(1-\alpha/2)} X P(1-P) \Big/ d$;, where N is the sample size, $U^2_{1-\alpha/2}$ is the normal distribution variable at the threshold of α=0.05; $U_{1-\alpha/2}$ = 1.96; *p* denotes the frequency of persons having once or more used the species from the preliminary investigation, *d* is the expected error margin of any parameter to be computerized, which we fixed here at 8% (Assogbadjo et al., 2010; Koura et al., 2011). Table 1 summarizes the number of persons investigated per department, ethnic group, sex and age group.

We investigated people using semi-structured interviews technique up on twenty-nine (29) ethnic groups in the study area. Table 2 summarizes local names of *L. lanceolata* for each sampled ethnic group.

Data analysis

For quatitative ethnobotanical analysis, the following diversity metrics were used (Byg and Basley, 2001; Monteiro et al., 2006):

- *Interviewee diversity value (ID)*

ID = Ux/Ut, where Ux is the number of utilization citations by a given interviewee; Ut is the total number of utilization

- *Interviewee equitability value (IE)*

IE = ID/IDmax, where ID is the interviewee diversity value; IDmax is ID maximum value

- *utilization diversity value (UD)*

UD = Ucx/Uct, where Ucx is the number of indications recorded by category; Uct is the total number of indications for all categories

- *Utilization equitability value (UE)*

UE = UD/UDmax, where UD is the utilization diversity value; UD max is the UD maximum value

- *Consensus value for plant parts (CPP)*

CPP = Px/Pt, where Px is the number of times a given plant part was cited; Pt is the total number of citations of all parts

These parameters indicate how the species is used and how knowledge about their utilization is shared among the respondents (Koura et al., 2011). To compute the utilization diversity value (UD), recorded utilizations of *L. Lanceolata* were classified into five categories. We used non-parametric Kruskal-Wallis test in Minitab16 to verify whether the ID and IE metrics differ significantly between sex, age, localities and ethnic groups. This test was prefered since the normality and varaiance homogeneity assuptions were not satisfied (Koura et al., 2011). The ID, CPP and UD values of utilizations and organs were submitted to Principal Components Analysis (PCA) in Minitab software in order to describe relationships between utilizations and ethnic groups and between organs and ethnic groups.

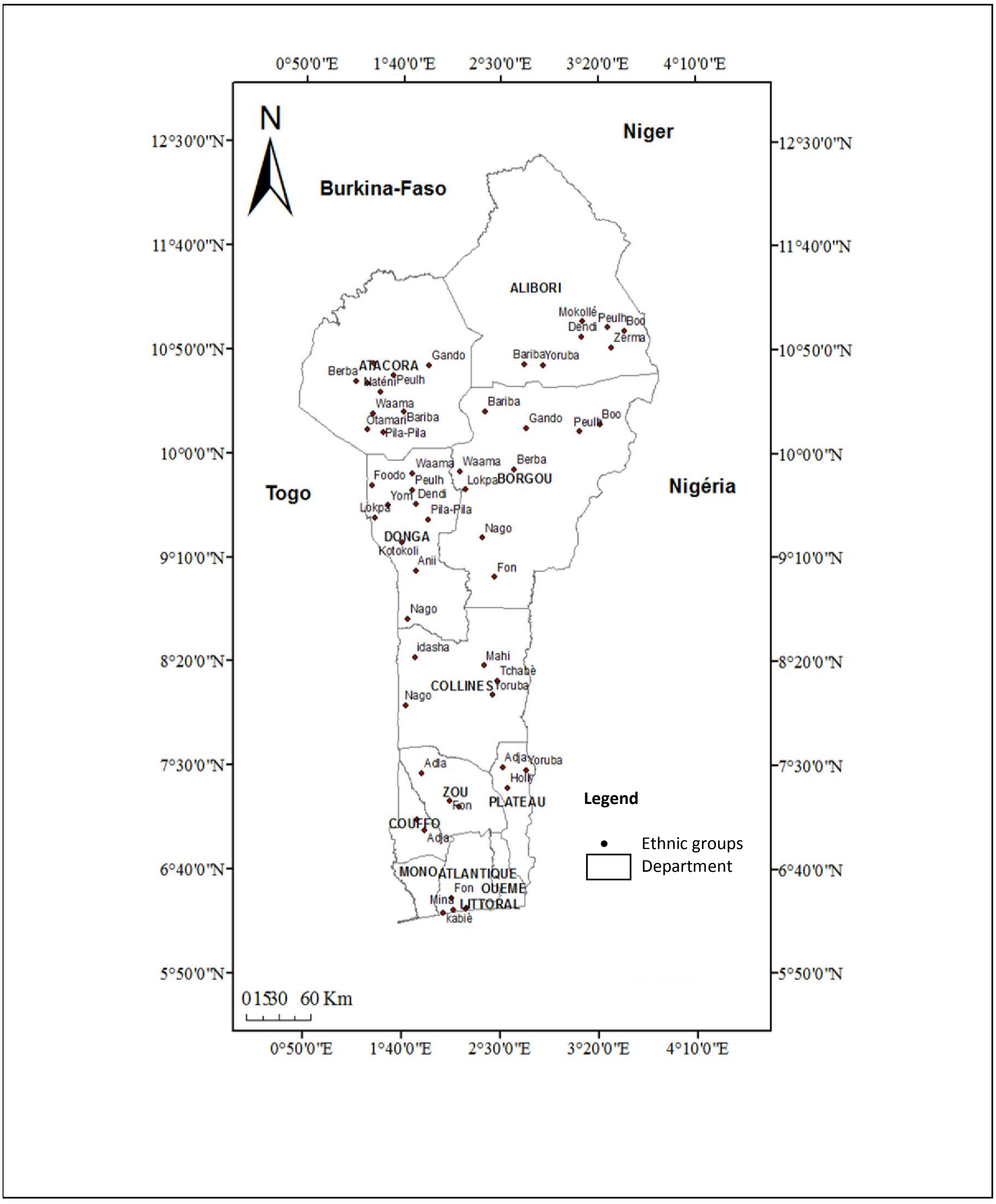

Figure 1: Map showing the departments of survey and their related ethnic groups.

Table 1: Sample size per Department, ethnic group, gender and age.

Department	**Size**	**Ethnic groups**	**Sex**		**Age**			**Total**	**Department**	**Size**	**Ethnic group**	**Sex**		**Age**			**Total**
			M	**F**	**≤30**	**30-60**	**>60**					**M**	**F**	**≤30**	**30-60**	**>60**	
Alibori	164	Batombu	14	5	1	8	10	19	Borgou	285	Batombu	60	11	12	35	24	71
		Boo	9	3	5	6	1	12			Biali	4	2	0	6	0	6
		Dendi	15	5	1	18	1	20			Boo	10	7	4	10	3	17
		Mokollé	21	9	3	25	2	30			Fon	20	6	7	15	4	26
		Fulfuldé	20	10	4	18	8	30			Gando	21	9	20	9	1	30
		Yoruba	11	12	3	13	7	23			Lokpa	17	3	10	3	7	20
		Zerma	16	14	3	25	2	30			Tchabè	20	7	2	21	4	27
											Fulfuldé	403	8	16	28	4	48
Atacora	199	Batombu	15	12	7	5	15	27			Waama	0	10	10	25	5	40

		Biali	13	11	5	12	7	24
		Ottamari	22	8	9	16	5	30
		Gando	3	4	2	4	1	7
		Yendé	21	9	5	21	4	30
		Naténi	20	10	4	18	8	30
		Fulfuldé	3	3	2	2	2	6
		Yom	20	9	7	14	8	29
		Waama	10	6	5	7	4	16
Atlantique	134	Cotafon	20	10	8	12	10	30
		Fon	4	2	2	2	2	6
		Goun	24	6	10	16	4	30
		Mina	20	10	15	5	10	30
		Fulfuldé	6	0	1	3	2	6
		Sahouè	21	11	9	13	10	32
Colline	122	Idasha	18	11	14	10	5	29
		Ifè	40	11	6	36	9	51
		Mahi	18	12	17	8	5	30
		Tchabè	3	3	0	6	0	6
		Yoruba	4	2	1	3	2	6

Donga	170	Ani	24	6	11	15	4	30
		Dendi	5	5	3	4	3	10
		Foodo	18	12	12	11	7	30
		Fulfuldé	6	0	0	4	2	6
		Kotokoli	23	7	5	23	2	30
		Lokpa	7	3	2	8	0	10
		Ifè	32	6	4	17	17	38
		Waama Yom	6	0	0	4	2	6
			6	4	3	3	4	10
Couffo	48	Adja	16	11	13	12	2	27
		Fon	9	12	2	17	2	21
		Adja	6	0	5	1	0	6
Plateau	100	Holly Yoruba	194	1119	5	17	8	30
			5		16	34	14	64
Zou	39	Adja	5	0	2	3	0	5
		Fon	17	7	4	19	1	24
		Yoruba	5	5	2	8	0	10

Note: F=woman, M=Man.

Table 2: Local names of *L. lanceolata* per ethnic group in Benin.

Departments	Ethnic groups	Local names	Departments	Ethnies groups	Local names
ALIBORI	Fulfuldé	Kareré, Hareré	DONGA	Foodo	Kagbandanâ
	Batombu	Sountouhan		Lokpa	Kpajamoré
	Boo	kolè		Yom	Mama kooyo
	Dendi	Sin-touri		Dendi	Zini-touri
	Mokollé	Sém		Waama	Ninguinfa
	Yoruba	Kpanhan		Fulfuldé	Haradèho
	Zerma	Harira-boulanga		Ani	M'Bolanga
BORGOU	Fon	KotobléAssou		Kotokoli	Bôbôtou-tôhôo
	Fulfuldé	Hareré, Kareré		Ifè	Okpaah
	Boo	Kolé, kolè, kouè	ZOU	Fon,	Wugoasou
	Batombu	Sountouhan		Yoruba	Panhan
	Biali	Tamkdaga		Adja	Kotoblèsu
	Waama	Nangafa	COLLINE	Mahi	Kotobléassouhô

	Gando	Haréréhi		Ifè	Okpaah
	Lokpa	Kpajamoré		Tchabè	Emiakô
	Tchabè	Okpaah		Idasha	Iponhon
ATACORA	Batombu	Kinnousso		Yoruba	Kpanhan
	Gando	Tchègnigadia,	PLATEAU	Adja	Yokouasou
	Naténi	Tokontoboui		Holly	Panhan
	Fulfuldé	Karéléhi		Yoruba	Kpanhan
	Yom	Mamacognoun	ATLANTIQUE	Cotafon	Wougo
	Waama	Ninkifa, Nangafa,		Fon	Wougo
	Ottamari	Moutoua/Moutoto		Fulfuldé	Sinagouradarou
	Biali	Tamkdaga		Goun	Limouman
	Yendé	Moutchayabou		Mina	Wougo
COUFFO	Fon	Wugoasou, Yokoumitchi		Sahouè	Hougo
	Adja	assoutô			

RESULTS

Diversity and distribution of knowledge among respondents

Results showed that all the respondents have at least one used *L. lanceolata*. The ID (0.048±0.0007) and IE (0.407±0.0061) values were generally low (< 0.50) suggesting that knowledge of *L. lanceolata* was not fairly distributed within interviewees (Table 3). The ID and IE values were significantly different between departments (W=405.35, $p<0.001$).

The Principal Components Analysis (PCA) showed that the first two axes account for 76% of the total variance. These axes were therefore considered to describe the relationship between *L. lanceolata* utilization and ethnic groups. Table 4 shows the correlation coefficients between different age classes and the two axes. The ID and IE were generally low. However, we found high values of ID and IE in two departments by taking into account ethnic groups, sex and the age (Figure 2). Indeed, the ID and IE were higher for Bariba and Waama old men and women in the departments of Borgou and Atacora comparing to the other departments.

Utilization diversity value

Utilizations of *L. lanceolata* belong to five different categories including medicinal, magico-mystic, wood, food and pesticide. The species is most used for medicinal purpose whatever the department.

The Principal Component Analysis (PCA) relating categories of utilization to ethnic groups showed that the first two axes accounted for 63.70% of the total variation. Therefore, these axes were chosen to describe the relationship between utilizations and ethnic groups. Utilizations such medicinal, magico-mystic and wood are positively correlated with axis 1 whereas pesticide and food are positively correlated with the axis 2 (Table 5). Ethnic groups projection on the factorial map (Figure 3) showed that Batombu, Fulfuldé, Ottamari and yom most use the species for medicinal purposes, the Batombu and Mokollé for magico-mystic purposes, the Nateni, Fulfuldé and Ifè like pesticide, the Bariba, Naténi and Ottamari for food purposes. Considering each ethnic group, diversity value of wood utilization was higher for Biali, Yendé, Naténi, Yom, Batombu, Mokollé, Boo, Zerma, Dendi, Fulfulde and Idasha compared with the other ethnic groups.

Uses of *L. Lanceolata* parts

Leaves are the most used parts (93.35% of the informants), followed by barks (80.65%), trunk (68.99%), branches (66.45%) and roots (48.72%). The sap (11.42%), fruits (11.65%), oilseed cakes (5.94%) and flower (1.65%) were marginal in use.

The Principal Component Analysis (PCA) ralating the *L. Lanceolata* parts to ethnic groups showed that the first two axes accounted for 70.40% of the total variance, these axes were therefore considered to describe the relationship between *L. lanceolata* parts and ethnic groups. The correlation coefficients between different parts of *L. lanceolata* and the two axes are summarized in Table 6. The first axis is positively linked to the roots, bark, leaves, and trunk and branches whereas Axis 2 is positively linked to the flowers and sap. Moreover, ethnic groups projection on the factorial map (Figure 4) shows that the leaves, barks, roots, trunk and branches are most used by the Batombu than the other ethnic groups. Fruits are most used by Waama, Naténi, Batombu, Yom and Ottamari while oil extracted from seeds is most used by Waama and Nateni. Utilization values were higher for flowers and sap for Mokolle and Fulfulde compared with the one of other ethnic groups.

Table 3: Interviewee Diversity value (ID) and Equitability value (IE).

Department	Sample size	Indices	Mean ± SE	Department	Sample size	Indices	Mean ± SE
Alibori	164	ID	0.039 ± 0.0011	Donga	170	ID	0.040 ± 0.0016
		IE	0.331 ± 0.0093			IE	0.339 ± 0.0133
Atacora	199	ID	0.066 ± 0.0017	Couffo	48	ID	0.021 ± 0.0019
		IE	0.561± 0.0143			IE	0.178 ± 0.0165
Atlantique	134	ID	0.031 ± 0.0012	Plateau	100	ID	0.053 ± 0.0031
		IE	0.259 ± 0.0105			IE	0.450 ± 0.0265
Borgou	285	ID	0.061 ± 0.0016	Zou	39	ID	0.021 ± 0.0022
		IE	0.519 ± 0.0132			IE	0.182 ± 0.0189
Colline	122	ID	0.046 ± 0.0012	OVERALL	1261	ID	0.048 ± 0.0007
		IE	0.390 ± 0.0102			IE	0.407 ± 0.0061

SE=Standard Error

Table 4: Correlation coefficients between different age classes and the two axes.

Variables	PC1	PC2
Young women	0.425	0.316
Adult women	0.467	0.084
Old women	0.406	-0.194
Young men	0.366	0.581
Adult men	0.335	-0.7
Old men	0.436	-0.167

PC = Principal Component

Table 5: Use categories.

Variables	PC1	PC2
Medicinal	0.573	0.043
Food	0.404	0.406
Magico-mystic	0.495	-0.301
Wood	0.490	-0.333
Pesticide	0.156	0.795

PC = Principal Component

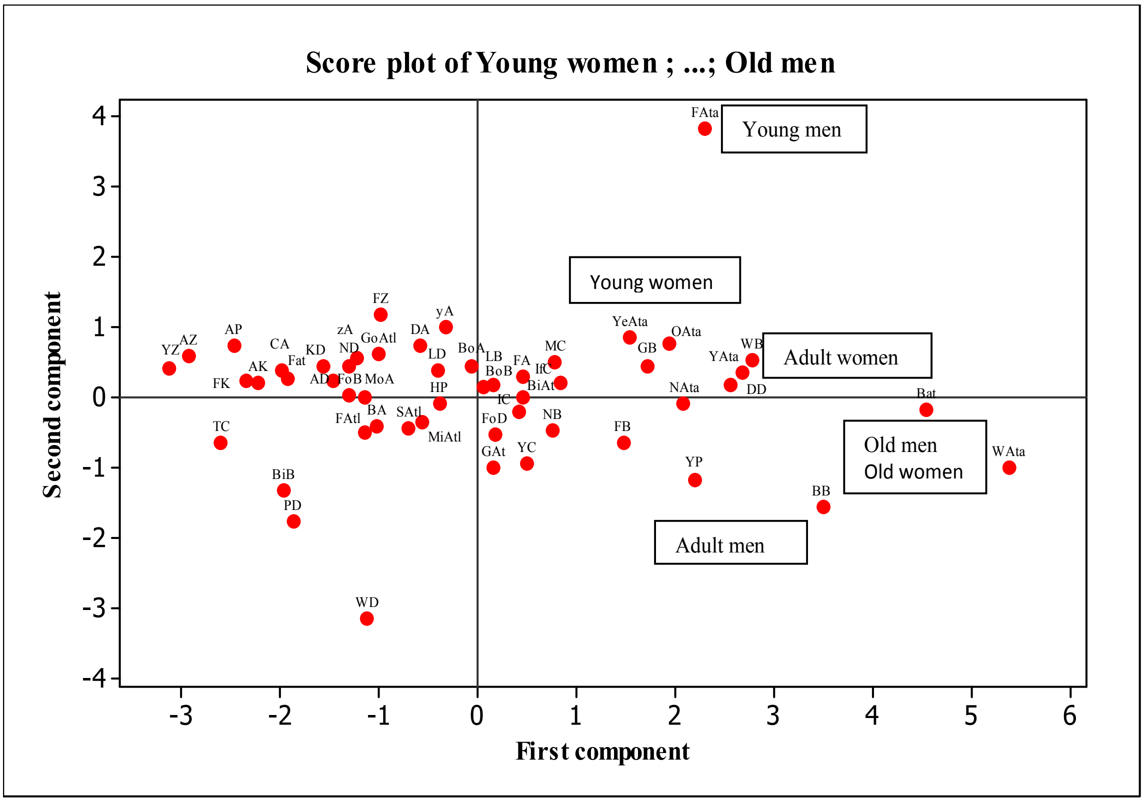

Figure 2: Projection of targeted ethnic groups on PCA axis defined by sub-groups.
BA(Batombu-Alibori), BoA(Boo-Alibori), DA(Dendi-Alibori), MoA(Mokollé-Alibori), FA (Fulfuldé-Alibori), YA (Yoruba-Alibori), ZA (Zerma-Alibori), Bat (Batombu-Atacora), BiAt (Biali-Atacora), OAta (Ottamari-Atacora), Gat (Gando-Atacora), YeAta (Yendé-Atacora), Nata (Naténi-Atacora), Fata (Fulfuldé-Atacora), YAta (Yom-Atacora), WAta (Waama-Atacora), CA (Cotafon-Atlantique), Fat (Fon-Atlantique), GoAtl (Goun-Atlantique), MiAtl (Mina-Atlantique), FAtl (Fulfuldé-Atlantique), SAtl (Sahouè-Atlantique), BB (Batombu-Borgou), BiB (Biali-Borgou), BoB (Boo-Borgou), FoB (Fon-Borgou), GB (Gando-Borgou), LB (Lokpa-Borgou), NB (Tchabè-Borgou), FB (Fulfuldé-Borgou), WB (Waama-Borgou), IC (Idasha-Colline), IfC (Ifè-Colline), MC (Mahi-Colline), TC (Tchabè-Colline), YC (Yoruba-Colline), AD (Ani-Donga), DD (Dendi-Donga), FoD (Foodo-Donga), KD (Kotokoli-Donga), LD (Lokpa-Donga), ND (Ifè-Donga), PD (Fulfuldé-Donga), WD (Waama-Donga), YD (Yom-Donga), AK (Adja-Couffo), FK (Fon-Couffo), AP (Adja-Plateau), HP(Holly-Plateau), YP (Yoruba-Plateau), AZ (Adja-Zou), FZ (Fon-Zou), YZ (Yoruba-Zou).

Table 6: Plant parts.

Variables	PC1	PC2
Roots	0.429	0.020
Barks	0.444	0.027
Trunk	0.453	-0.091
Branches	0.434	-0.163
Leaves	0.441	-0.077
Flowers	0.056	0.644
Sap	0.056	0.653
Fruits	0.135	0.276
Oilseed cake	0.074	0.202

PC = Principal Component

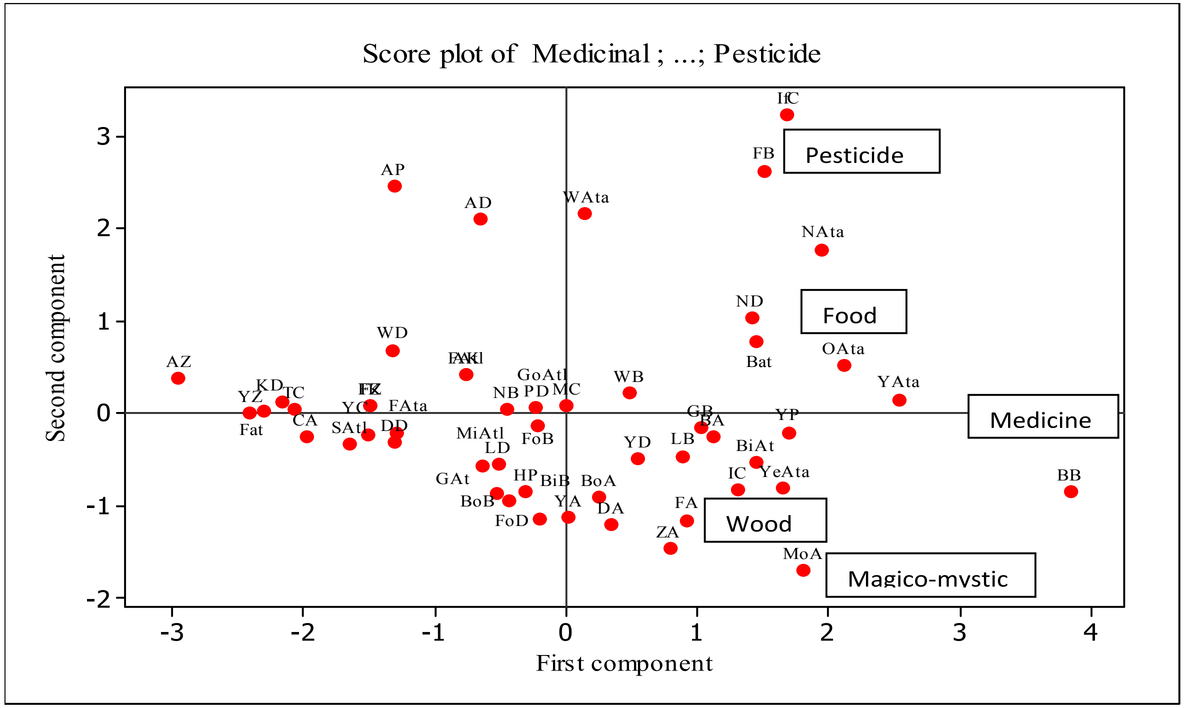

Figure 3: Projection of targeted ethnic groups on PCA axis defined by categories of uses. *BA(Batombu-Alibori), BoA(Boo-Alibori), DA(Dendi-Alibori), MoA(Mokollé-Alibori), FA (Fulfuldé-Alibori), YA (Yoruba-Alibori), ZA (Zerma-Alibori), Bat (Batombu-Atacora), BiAt (Biali-Atacora), OAta (Ottamari-Atacora), Gat (Gando-Atacora), YeAta (Yendé-Atacora), Nata (Naténi-Atacora), Fata (Fulfuldé-Atacora), YAta (Yom-Atacora), WAta (Waama-Atacora), CA (Cotafon-Atlantique), Fat (Fon-Atlantique), GoAtl (Goun-Atlantique), MiAtl (Mina-Atlantique), FAtl (Fulfuldé-Atlantique), SAtl (Sahouè-Atlantique), BB (Batombu-Borgou), BiB (Biali-Borgou), BoB (Boo-Borgou), FoB (Fon-Borgou), GB (Gando-Borgou), LB (Lokpa-Borgou), NB (Tchabè-Borgou), FB (Fulfuldé-Borgou), WB (Waama-Borgou), IC (Idasha-Colline), IfC (Ifè-Colline), MC (Mahi-Colline), TC (Tchabè-Colline), YC (Yoruba-Colline), AD (Ani-Donga), DD (Dendi-Donga), FoD (Foodo-Donga), KD (Kotokoli-Donga), LD (Lokpa-Donga), ND (Ifè-Donga), PD (Fulfuldé-Donga), WD (Waama-Donga), YD (Yom-Donga), AK (Adja-Couffo), FK (Fon-Couffo), AP (Adja-Plateau), HP(Holly-Plateau), YP (Yoruba-Plateau), AZ (Adja-Zou), FZ (Fon-Zou), YZ (Yoruba-Zou).*

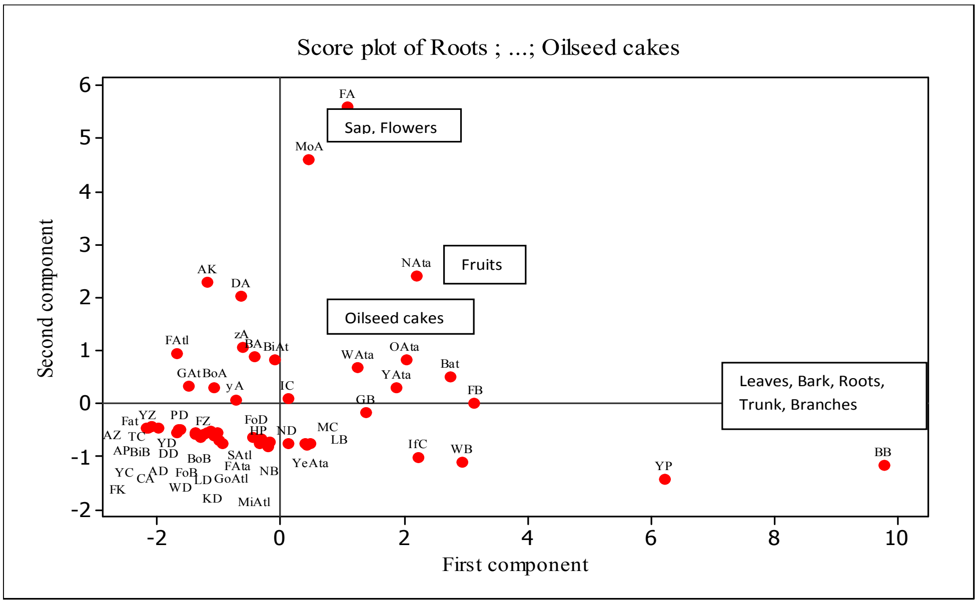

Figure 4: Projection of targeted ethnic groups on PCA axis defined by plant parts. *BA(Batombu-Alibori), BoA(Boo-Alibori), DA(Dendi-Alibori), MoA(Mokollé-Alibori), FA (Fulfuldé-Alibori), YA (Yoruba-Alibori), ZA (Zerma-Alibori), Bat (Batombu-Atacora), BiAt (Biali-Atacora), OAta (Ottamari-Atacora), Gat (Gando-Atacora), YeAta (Yendé-Atacora), Nata (Naténi-Atacora), Fata (Fulfuldé-Atacora), YAta (Yom-Atacora), WAta (Waama-Atacora), CA (Cotafon-Atlantique), Fat (Fon-Atlantique), GoAtl (Goun-Atlantique), MiAtl (Mina-Atlantique), FAtl (Fulfuldé-Atlantique), SAtl (Sahouè-Atlantique), BB (Batombu-Borgou), BiB (Biali-Borgou), BoB (Boo-Borgou), FoB (Fon-Borgou), GB (Gando-Borgou), LB (Lokpa-Borgou), NB (Tchabè-Borgou), FB (Fulfuldé-Borgou), WB (Waama-Borgou), IC (Idasha-Colline), IfC (Ifè-Colline), MC (Mahi-Colline), TC (Tchabè-Colline), YC (Yoruba-Colline), AD (Ani-Donga), DD (Dendi-Donga), FoD (Foodo-Donga), KD (Kotokoli-Donga), LD (Lokpa-Donga), ND (Ifê-Donga), PD (Fulfuldé-Donga), WD (Waama-Donga), YD (Yom-Donga), AK (Adja-Couffo), FK (Fon-Couffo), AP (Adja-Plateau), HP(Holly-Plateau), YP (Yoruba-Plateau), AZ (Adja-Zou), FZ (Fon-Zou), YZ (Yoruba-Zou).*

DISCUSSION

In this study, five (05) categories of utilizations were found for *L. lanceolata*, thus showing the importance of the species for the local populations. This oleaginous species is mostly used as medicinal ingredient in Benin. Still, the values of total diversity and total equitability in relation to the use of different organs were low (respectively 0.048 and 0.407). This indicates that knowledge on the species utilization is not fairly distributed. These results are consistent to those of Akouehou et al. (2014) on *Artocarpus altilis* in the South of Benin. Our results indicated that *L. lanceolata* is used for multiple purposes. These valorizations of the species were also indicated by Kouaro and Tasso (2010) in the north-western region of Benin.

The number of ethnobotanical studies using quantitative methods has increased over the last decades and some introduced quantitative metrics to analyze the relative cultural importance of plant species. Preferences for useful plant species and general interest for forest resources can differ among men and women due to labor division which is gender-associated in traditional societies (Vodouhê et al., 2009). Moreover, elderly people proved to have more traditional knowledge than younger (Müller-Schwarze, 2006). In this study, ethnobotanical metrics showed that utilization of *L lanceolata* is shared but not fairly among interviewees. This is not surprised since culture is globally considered as shared knowledge (Reyes-Garcia et al., 2004). Investigating local population on the local knowledge of species is important as it could help determining the potential of the species, leading to more rational decisions about its sustainable utilization (Koura et al., 2011). Knowledge of the local utilization of vegetable resources is essential for the elaboration of conservation strategies (Achigan-Dako et al., 2011).

To our knowledge, our study is the first attempt to have quantifed the ethnobotanical knowledge of *L. lanceolata* in our study area. Overall, we found significant ethnic variation in knowledge and utilization of *L. lanceolata*, as it has been found for several multipurpose use tree species in Benin: *Parkia biglobosa* (Koura et al., 2011), *Tamarindus indica* (Fandohan et al., 2010), *Adansonia digitata* (Assogbadjo et al., 2008) and *Caesalpinia bonduc* (Assogbadjo et al., 2010). Our results confirmed difference of knowledge between age classes and gender in medicinal plants utilization previously observed (Müller-Schwarze, 2006; Camou-Guerrero et al., 2008). However, even our study showed that men have more knowledge on the species than women, this was not evident between age classes (< 30, 30-60 and > 60) suggesting fair knowledge between age classes in each ethnic group. Our result is contrary to the conclusions of Amorozo (2004) suggesting that knowledge and utilization value of species increases with age implying the transmission of knowledge over generations in order to ensure knowledge conservation.

This study identified diseases treated by *L. lanceolata.* All organs/parts of the species were recognized as being used either for food, medicinal, magico-mystic, wood or like pesticide. This is a well-known phenomenon for most West Africa tree species where all their organs are used as main recipe or in combination with other plants in the treatment of several diseases (Assogbadjo et al., 2010). The medicinal utilizations of the species were the most diversified in our study.

Several medicinal utilizations of *L. lanceolata*'s leaves matches with the findings of Kouaro and Tasso (2010) suggesting that leaves infusion treated malaria and jaundice. They also found that the infusion of the leaves added to potash helps fight against some sexually transmitted infections such as syphilis. Similarly, according to Mapongmetsem (2007), the young red leaves decoctions are also used to treat headaches, hypertension and syphilis. The leaves are also used to treat stomach aches and Malaria (Salifou et al., 2013). Decoctions of fresh/dried young leaves can treat pain caused by intestinal worms, dysentery and diarrhea for children. Similarly to our study, Gueye et al. (2012) have revealed in a locality of Senegal that leaves and roots of other species (*Combretum glutinosum*, *Tamarindus indica* , *Adansonia digitata*, *Ozoroa insignis* and *Hibiscus sabdariffa*) are effective in the treatment of constipation.

Women take the decoction of roots against menstrual pain, intestinal disorders and malaria (Kouaro and Tasso, 2010). But other utilizations were observed in our study. Results showed that roots are used for treating abscesses, diarrhea, muscle aches, sprains, epilepsy, sexual weakness, yellow and typhoid fever, insanity, hernia, jaundice, leprosy, headaches, snake bites, colds, infertility, cough, ulcer, chickenpox and vomiting. This study revealed that the flowers of *L. lanceolata* are used against cold, hemorrhoid and to accelerate wound healing. The sap of *L. Lanceolata* is used by Diis, Fulbe and Gbayas in Cameroon to treat tiredness (Mapongmetsem, 2007). Other sap utilizations include treatment of hiccups, sore throat, stomachaches, wound and absent minder.

Several therapeutic utilizations of *L. lanceolata* bark cited by respondents in this study are consistent with previous studies. According to Kadiri (2008), the bark of *L. lanceolata* is used in southern Nigeria to treat yellow fever and gastrointestinal disorders. Kouaro and Tasso (2010) confirmed that the bark is an aphrodisiac and its decoction can treat infections (STIs included). The infusion of the combination of the bark and leaves is an anti-trypanosome (Diallo et al., 2012). The bark infusion also treats malaria and jaundice

(Kouaro and Tasso, 2010). Similarly, the species bark combined with *Pennisetum glaucum* is effective against diarrhea and stomachaches (Haxaire, 2012). But leaves are also effective in the treatment of diarrhea (Agbankpé et al., 2014). New medicinal utilizations of barks recorded in our study include treatment of hemorrhoids, hepatitis, amenorrhea, hernia, hypertension, toothache, snake bites and spider, chronic wounds, painful menstruation, measles, cough, ulcers, chicken pox, vomiting, itching and body aches. Some utilizations were not recognized by our respondents. These include root and bark utilization in the treatment of lung pain (Kadiri, 2008) and bark utilization for treating diabetes (Haxaire, 2012). Mapongmetsem (2007) asserts that the young stems and sometimes roots are used in Guinea, Mali and Nigeria as chewing sticks, and bark infusion is used as a mouthwash against toothache. According to this author, an infusion of young twigs is used to treat yellow fever, respiratory infections and dysentery. *L. lanceolata* oil is known as an effective treatment against toothache and muscle pain in Nigeria (Fariku and Kidah, 2008). According to Kouaro and Tasso (2010), the potion of *L. lanceolata* oil is effective for burns healing and coughing. The seeds and oil can also treat dermatitis (Fariku and Kidah, 2008). Respondents also recognized oil effectiveness in the treatment of epilepsy. However, certain utilizations of oil mentioned by previous studies were not recorded in our study. For example, Kouaro and Tasso (2010), Mapongmetsem (2007) reported the use of *L. lanceolata* oil in the manufacturing of soap.

Chemical analysis of *L. lanceolata* oil revealed that it contains sodium, potassium, calcium, magnesium, zinc, iron and phosphorus, polyinsatured fatty acids and essential amino acids (Lohlum et al., 2010; Nonviho et al., 2014) and is probably the main reason of the species utilization by local people. Consequently, *L. lanceolata* has a medicinal potential on which research could relate for the development of phyto-medicine and reduce pressures on this species in its natural habitats. It is also important to valorize *L. lanceolata* oil since it is of important nutritional values. The various and important functions of *L. lanceolata* especially in food security and traditional medicine show that the species deserves *in situ* conservation. Although specific studies have not concerned debarking of *L. lanceolata*, we believe that bark harvesting will have more negative impacts on its population than leaves and fruits harvesting as previously reported by Gaoue and Ticktin (2009) on *Khaya senegalensis* in Benin. However, excessive fruits collection may have a negative impact on the regeneration development (Avocèvou-Ayisso et al., 2009) depending on the persistence of regeneration process such as pollination, seeds maturity, dispersal and germination, seedlings growth and survival. The study suggests that strategies for sustainable management and conservation are needed for the sustainable utilization of *L. lanceolata*.

Conclusion

This study has provided sounding information on the quantitative ethnobotany of *L. lanceolata*. This study showed that the species is used for different purposes by local people. However *L. lanceolata* is not widely well-known compared with many other native tree species. The quantitative metrics showed that although all parts of *L. lanceolata* are used for numerous purposes, its utilization knowledge is not fairly distributed within ethnic groups. Among all the studied ethnic groups, Batombu was the one that had the highest knowledge on *L. lanceolata* parts and utilization compared with other ethnic groups. Local knowledge varied also according to the age and sex. Knowledge of *L. lanceolata* were more diversified and more distributed within young and adult Batombu men compared with the other groups. This work confirms that the use of quantitative metrics can give more insight about the qualitative knowledge on the utilization of multipurpose use plant species and is therefore helpful to establish sustainable management and conservation strategies of species.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

AD designed and performed the field work, analyzed and drafted the manuscript. HSSB and GG gave conceptual advice, read and improved the drafted manuscript. AKN supervised the work, read and improved the manuscript. All authors have read and approved the final manuscript.

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