Ethnic and generational differences in traditional knowledge and cultural importance of *Lannea microcarpa* Engl. & K. Krause in Benin's Sudanian savannah

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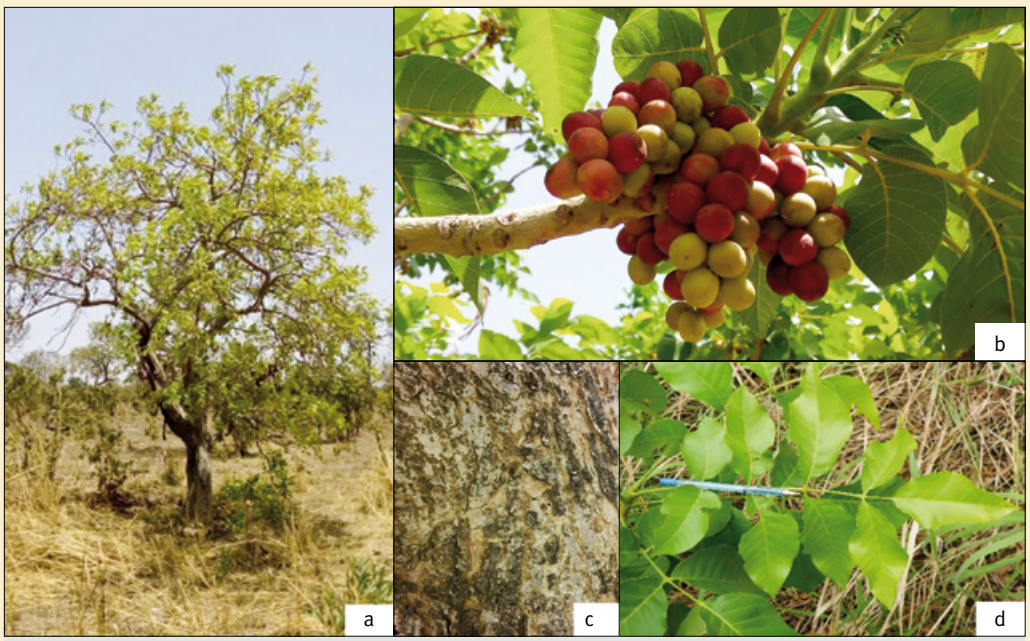

Photo 1.
Whole tree (a), grape-fruits (b), bark (c) and leaves (d) photo of *Lannea microcarpa*.
Photo E. O. A. Goudégnon, 2016.

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RÉSUMÉ

DIFFÉRENCE ENTRE LES GÉNÉRATIONS ET GROUPES ETHNIQUES DES CONNAISSANCES TRADITIONNELLES ET DE L'IMPORTANCE CULTURELLE DE *LANNEA MICROCARPA* ENGL. & K. KRAUSE EN SAVANE SOUDANIENNE AU BÉNIN

Connaître l'importance socioculturelle des arbres fruitiers autochtones et des facteurs qui la déterminent est un préalable indispensable à leur valorisation et aux décisions sur leur mode de gestion. La présente étude s'est attachée à documenter les connaissances traditionnelles (CT) et l'importance culturelle (IC) de *Lannea microcarpa*, arbre fruitier autochtone peu connu et sous-utilisé de la zone soudanienne au Bénin. L'étude s'est également penchée sur les éventuelles variations en termes de CT et de IC selon les groupes ethniques et les générations. Nous avons recueilli des informations sur les utilisations et l'importance de l'essence auprès de 262 personnes sélectionnées de manière aléatoire dans la zone de distribution de l'arbre, à l'aide de listes libres et d'un système de notation. Vingt-huit utilisations réparties en huit catégories d'usages ont été recensées, dont 21 médicinales, deux commerciales et une chacune pour l'alimentation humaine, le fourrage, le bois de feu, la construction, l'emballage et les cure-dents. Contrairement au cas des autres catégories d'utilisation, les connaissances traditionnelles liées aux usages pour l'alimentation n'ont pas varié selon les générations ou les groupes ethniques. De plus, les utilisations alimentaires sont culturellement les plus importantes, suivies par les utilisations médicinales. Globalement, le fruit est la partie préférée de l'arbre, et la plus souvent commercialisée. Les problèmes de santé traités à l'aide de *L. microcarpa* comprennent l'anémie, la diarrhée, la toux, les ulcères, les maux d'estomac et les hémorragies suite aux accouchements. Nos résultats indiquent que la domestication de *L. microcarpa* devra privilégier le fruit, la partie de l'arbre la plus appréciée. D'autres études pourront ainsi se pencher sur les possibilités de domestication de *L. microcarpa* en privilégiant ses caractéristiques fruitières et l'amélioration de la production de fruits.

Mots-clés : *Lannea microcarpa*, connaissances traditionnelles, valorisation des essences fruitières, zone soudanienne, Bénin.

ABSTRACT

ETHNIC AND GENERATIONAL DIFFERENCES IN TRADITIONAL KNOWLEDGE AND CULTURAL IMPORTANCE OF *LANNEA MICROCARPA* ENGL. & K. KRAUSE IN BENIN'S SUDANIAN SAVANNAH

Understanding the socio-cultural importance of indigenous fruit trees (IFT) and its determining factors is a prerequisite for developing their value and making management decisions. This study documented traditional knowledge (TK) and the cultural importance (CI) of *Lannea microcarpa*, a neglected and underused indigenous fruit tree found in Benin's Sudanian region. The study further tested whether TK and CI varied according to ethnic groups and generations. We collected data on the uses and importance of the species from 262 informants who were randomly selected within its zone of occurrence, using free lists and scoring, respectively. Twenty-eight specific usages divided in eigth categories of uses were reported, of which 21 were medicinal, 2 were commercial, and 1 each was for human food, fodder, firewood, construction, packaging and toothpicks. Contrary to the other use categories, traditional knowledge on food uses did not vary either between generations or among ethnic groups. In addition, food use was culturally the most important, followed by medicinal uses. Overall, the fruit was the most preferred and most frequently commercialised part of the plant. Medical conditions treated with *L. microcarpa* include anaemia, diarrhoea, coughs, ulcers, stomach aches and blood evacuation after childbirth. Our findings suggest that domestication of *L. microcarpa* should prioritise the fruit, which is the most valued part of the plant. Further studies should therefore focus on the domestication potential of *L. microcarpa* for its fruit traits and on how to improve fruit production.

Keywords: *Lannea microcarpa*, folk knowledge, development of fruit species, Sudanian zone, Benin.

RESUMEN

VARIACIONES GENERACIONALES Y ÉTNICAS EN EL CONOCIMIENTO TRADICIONAL Y EN LA IMPORTANCIA CULTURAL DE *LANNEA MICROCARPA* ENGL. & K. KRAUSE EN LA SABANA SUDANESA DE BENÍN

Conocer la importancia sociocultural de los árboles frutales autóctonos y los factores que la determinan es una condición previa imprescindible para tomar decisiones sobre la valorización y el manejo. Este estudio documentó el conocimiento tradicional (CT) y la importancia cultural (IC) de *Lannea microcarpa*, un frutal autóctono poco conocido e infrautilizado de la zona sudanesa de Benín. El estudio también analizó las posibles variaciones del CT y la IC entre grupos étnicos y generacionales. Mediante el método de listados libres y un sistema de puntuación, se recogió información sobre los usos e importancia de la especie entre 262 personas seleccionadas al azar en la zona de distribución del árbol. Se registraron veintiocho utilizaciónes divididos en 8 categorías de uso, 21 de los cuales eran medicinales, 2 comerciales y uno para cada una de las categorías siguientes: alimentación humana, forraje, leña, construcción, embalaje y palillos de dientes. Al contrario de las demás categorías de usos, los conocimientos tradicionales relacionados con los usos alimentarios no varían según las generaciones o grupos étnicos. Además, los usos alimentarios son los más importantes culturalmente, seguidos por los usos medicinales. En general, el fruto es la parte preferida del árbol y la que más se comercializa. Los problemas de salud tratados con *L. microcarpa* comprenden la anemia, diarrea, tos, úlceras, dolores estomacales y hemorragias postparto. Estos resultados sugieren que se debe priorizar el fruto, la parte más apreciada del árbol, en la domesticación de *L. microcarpa*. Los posteriores estudios podrán analizar las posibilidades de domesticación de *L. microcarpa* centrándose en las características frutales y en el mejoramiento de la producción de fruta.

Palabras clave: *Lannea microcarpa*, conocimiento tradicional, valorización de especies frutales, zona sudanesa, Benín.

Introduction

In developing countries, people living in rural areas rely mainly on a variety of natural resources for their daily needs (Lykke *et al.,* 2004; Dembélé *et al.,* 2015). Indigenous fruit trees (IFT) from natural habitats are sources of a number of non-timber forest products (NTFPs) that supply population needs in terms of food (edible fruits, leaves, roots and stems), energy (provision in fire woods and charcoal), cash income (from sales of plant organs and fruits), medicine (multiple recipes for disease treatment), etc. (Vodouhê *et al.,* 2009; Poopola and Obembé, 2013).

IFT are inherent to tropical landscapes. They form the basis of the most important local survival strategies by supporting people's livelihoods in areas of food insecurity, particularly during food shortages (Ashagre *et al.*, 2016). Because of their importance, there is increasing interest in the management of IFT natural populations to sustain their provisioning ecosystem services. For this goal and because traditional knowledge (TK) on local resources is important for their sustainable use and conservation (Luoga *et al.*, 2000), many ethnobotanical and ethno-ecological studies have addressed the importance of IFT for livelihoods (Cheikhyoussef and Embashu, 2013; Seyoum *et al*., 2015). Other studies have focused on the management and conservation of IFT (Gouwakinnou *et al*., 2011; Seyoum *et al*., 2015) and how both are related to socio-economic, socio-demographic and geographical contexts in tropical regions.

Most studies agree on the close relationship between the uses, importance, management of IFT and the socio-cultural and socio-demographic factors such as ethnic groups (Vodouhê *et al.*, 2009; Fandohan *et al.,* 2010) and generations (see Arévalo-Marín *et al.*, 2015; Geng *et al*., 2016). However, no evident and static relationship was established among uses, importance and ethnic groups (Dadjo *et al.,* 2011), suggesting species-specific patterns and, therefore, a need to be species-specific in accounting for these factors in managing important IFT.

Despite the high number of studies on IFT, there are still some species that are neglected and underutilised with little or no information on their importance for local people. The African grape, *Lannea microcarpa* Engl. & K. Krause (Anacardiaceae) is one such neglected and underutilised IFT species (Awodoyin *et al.*, 2015) in Benin. *L. microcarpa* is a dioecious species (Arbonnier, 2002) restricted to the Sudanian zone landscape in Sub-Saharan Africa, where it is associated with crops in agrosystems (Sinsin and Kampmann, 2010). Local people who consumed them fresh or dried or use them to produce fresh juice/brewed drinks (Marquet and Jansen, 2005) appreciates its fruits. *L. microcarpa* is ranked as the third IFT consumed by Ségou people in Mali (Diop, 2005) and the sixth most valued species around the Pendjari Reserve in Benin (Vodouhê *et al.*, 2009). Assessment of the physicochemical properties of biodiesel from *L. microcarpa* seeds in Nigeria (Yunus *et al*., 2013) showed that most of the important properties were within the recommended standards for a biofuel grade biodiesel and suggested the potential of the seeds as a source of biodiesel. Edible oil can also be extracted from the seeds (Bazongo *et al*., 2014). A made-up powder made from the leaves has great potential in cosmetics, foods and nutraceutical products (Sansone *et al.*, 2014). In Benin, little research has focused on this species. They have assessed the influence of climate change on the geographic distribution of *L. microcarpa* populations (Dossou *et al.,* 2016) and its fruit and pulp production under the dry and humid Sudanian zone environment (Goudégnon *et al.*, 2016).

In spite of its potential as shown elsewhere, little has been done to comprehensively assess how the species is used in Benin and whether the pattern of uses differs among ethnic groups and generations. This is essential to build a local as well as global valorisation and management scheme for the species. The main goal of this study is to assess the knowledge of local people on the uses of *L. microcarpa*, its cultural importance and whether there are ethnic and generational differences influencing the use of the species by local people.

Study system

Study species

L. microcarpa Engl. & K. Krause is a dioecious species of the Sudanian zone, which belongs to the family of Anacardiaceae (Arbonnier, 2002; photo 1). It can reach up to 15 m in height and 70 cm in diameter. It has a rounded parasol like crown with some descending branches with thick, leafy foliage (Marquet and Jansen, 2005). The species occurs in the western part of the Sahel (often in rocky areas in pockets of sand) but is not found in the east (towards the Sudanian zone). In Benin, the species occurs in the Sudanian zone, where it is found on rocky and clayey soil and in farmland (Sinsin and Kampmann, 2010).

Study area

The study was carried out in the Sudanian zone (10°17'-12°25' N and 0°45'-3°51' E) of the republic of Benin (6°25'-12°30' N and 0°45'-4°00' E; Judex *et al.*, 2009). The climate is characterised by a unimodal rainfall regime with an average seven month rainy season (Adomou, 2005). The Sudanian zone includes three phytogeographical districts (also called phytodistricts) that are distinguished on the basis of soil and floristic composition: North Borgou, Atacora chain and Mékrou-Pendjari (Neuenschwander *et al*., 2011). From a climate perspective, the Atacora chain phytodistrict is characterised by a dry season that lasts about seven months with a mean annual rainfall of 1,000 mm, whereas in the Mékrou-Pendjari phytodistrict, the driest part is characterised by eight months of drought and has an average annual rainfall of 750 mm (Neuenschwander *et al*., 2011). North Borgou has 1,000 to 1,150 mm of rain with the driest conditions at Kandi. These three zones are recognised as the most important occurrence zones of *L. microcarpa* (Goudégnon *et al.*, 2016; figure 1). The population in the study area is mostly composed of dominant ethnic groups such as Bariba, Gourmantché, Fulani, Dendi, Mokolé, Berba, Ditamari, Waama and Nagot (Judex *et al.*, 2009).

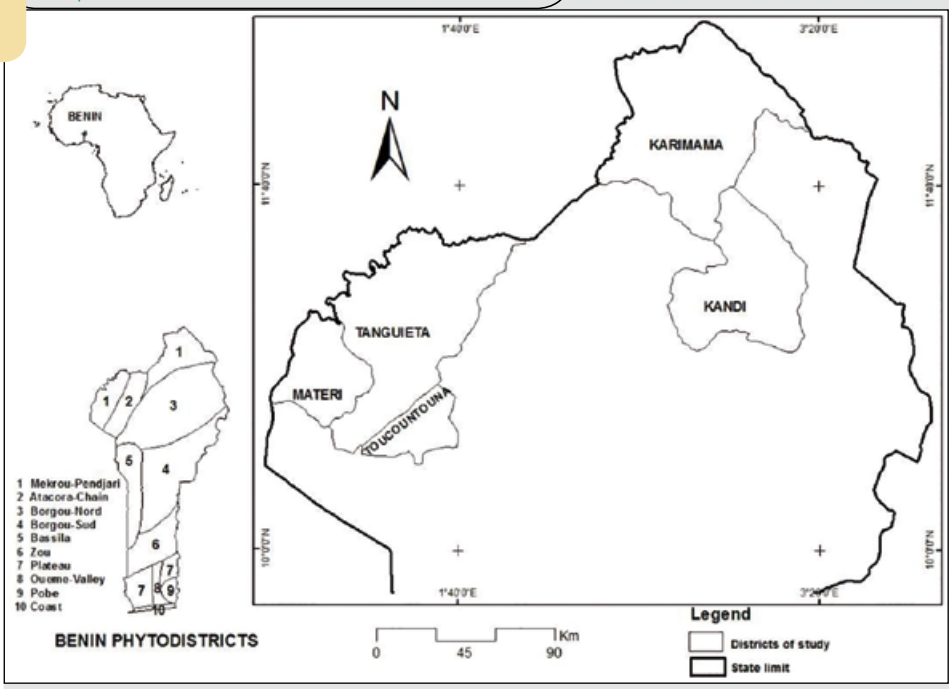

Figure 1.
Map showing the selected localities for the study.

Methodology

Sampling and data collection

An ethnobotanical survey was conducted in the dry season (February–May) in 2015. An exploratory survey was conducted with 30 respondents randomly selected per zone with the aim to determine the number of respondents to be interviewed. The sample size was determined following the normal approximation of the binomial distribution of Dagnélie (1998):

$$N = \frac{U^2_{1-\frac{\alpha}{2}}\, p\,(1-p)}{d^2}$$

Where: N is the total number of people surveyed; $U^2_{1-\frac{\alpha}{2}}$ is the value of the normal random variable for a probability value of $\alpha = 0.05$, $U^2_{1-\frac{\alpha}{2}} = (1.96)2$, p is the proportion of respondents who used or at least knew of the species, and d is the margin error taken as 5%.

Respondents were selected using a random sampling scheme. A semi-structured interview method was used to collect data. The questionnaire was in French and addressed into the interviewee's language with a translator locally engaged. During the survey, in addition to photographs of the whole species, fruits, bark and leaves (see photo 1) were kept and shown to the respondents (Gouwakinnou *et al.*, 2011; Atakpama *et al.*, 2015). Information was gathered through individual interviews. The interview focused on i) the informant's socio-demographic information, which included the informant's ethnic group, age, sex and profession and ii) the informant's knowledge on the uses and cultural importance of the species. Similar uses mentioned were grouped into the same use category (food, medicine, fodder, handcrafts, firewood, packaging, sale, construction, toothpicks and dyeing) based on the results of previous studies (Marquet and Jansen, 2005; Arbonnier, 2002; Mabika *et al.*, 2013).

Statistical analysis

A total of 262 informants (221 males and 41 females), with ages ranging between 16 and 95 years, were interviewed. Prior to the analyses, informants were grouped into two generations (young: ‹ 40 and old: ≥ 40 years) following Koura *et al.* (2011). The two groups were composed by 166 informants aged less than 40 years, and 96 informants aged over 40 years. Eleven ethnic groups were surveyed: Bariba, Biali, Dendi, Gourmantché, Haoussa, Mokolé, Natimba, Otamari, Fulani, Waama and Sèmèrè (table I). Ethnic groups with fewer than 15 informants were grouped in "other ethnic groups" for statistical analyses. The other ethnic groups included Bariba, Gourmantché, Haoussa, Fulani and Sèmèrè. TK on *L. microcarpa* was assessed by the mean of the use-value (Phillips and Gentry, 1993), which is the mean of the number of total reported uses (Tardío and Pardo-de-Santayana, 2008). The use-value was first calculated globally and afterwards per category of uses. To this end, the number of uses was calculated per category of uses and aggregated to obtain the total number of reported uses per interviewee. Eight categories of uses were considered and included medicine, food, fodder, firewood, sale, construction, packaging and toothpicks. Differences among ethnic groups and generations were assessed using generalised linear models with a Poisson error distribution. The full model (main effect with interaction) was built first, and then the effect of each factor (generation, ethnic group and their interaction) was assessed using the Chi-square test with the function *anova* in the R statistical software version 3.3.2. (R Core Team, 2016). The cultural importance of the category of uses and plant parts was assessed as the mean of the importance score attributed to each category of uses and plant part. A Kruskal-Wallis test and Mann-Whitney test were used, respectively, to compare the ethnic groups and generations. A table summarising all the specific uses mentioned for *L. microcarpa* was built. For each specific use, the fidelity level (FL, in %) was computed as the relative frequency of informants who cited that specific use over the sample size. The FL measured the consensus of informants for a specific use.

Table I.
Number of informants according to ethnic groups and generation.

Ethnic groups	Young: < 40 old	Old: ≥ 40 years	Total
Bariba	3	5	8
Biali	29	7	36
Dendi	23	27	50
Gourmantché	1	2	3
Haoussa	5	9	14
Mokolé	15	12	27
Natimba	16	11	27
Otamari	35	7	42
Peulh	2	1	3
Sêmèrè	1	2	3
Waama	36	13	49
Total	166	96	262

Table II.
Effect of ethnic groups and generations on the overall use-value and use-value of category of use: p-value of the likelihood ratio tests.

Use category	Ethnic groups	Generations	Ethnic groups: generations
Total uses	0.211^{ns}	0.001***	0.356^{ns}
Food uses	0.703^{ns}	0.976^{ns}	0.996^{ns}
Medicinal uses	0.002**	< 0.001***	0.428^{ns}
Packaging uses	< 0.001***	0.061^{ns}	0.474^{ns}
Fodder uses	< 0.001**	0.305^{ns}	0.907^{ns}
Firewood uses	< 0.001***	0.224^{ns}	0.770^{ns}
Sale uses	< 0.001***	0.796^{ns}	0.901^{ns}
Others	0.043*	0.485^{ns}	0.230^{ns}

*** = p < 0.001; ** = p < 0.01; * = p < 0.05; ns = p > 0.05.

Results

Differences in the traditional knowledge on the uses of *L. microcarpa* among ethnic groups and generations

Differences in the overall knowledge and per category of uses among ethnic groups and generations

The overall use-value of *L. microcarpa* varied only between the two age groups (p-value < 0.05; table II). The analysis at the level of categories of uses showed that the use-value of *L. microcarpa* for food was similar among ethnic groups and generations (p-value > 0.05; table II). The use-value for medicinal purposes differed between generations and also among ethnic groups (p-value < 0.05; table II). As for packaging use, fodder use, firewood use, sale use, and other uses, their use-value varied only among ethnic groups (p-value < 0.05; table II).

With regards to the use-value per category of uses of *L. microcarpa* among ethnic groups (figure 2a) and generations (figure 2b), all ethnic groups had a similar food use-value. Otamari, Biali and Dendi used the species mostly for medicinal purposes. The "other ethnic groups" valued the species mostly for packaging and were followed by Dendi and Mokolé. Use for sale was common among most of the ethnic groups, except for Dendi, Mokolé and the "other ethnic groups". Biali used the species mostly for firewood purposes, whereas the fodder use was observed mostly with the Mokolé ethnic group.

The overall use-value was lower for young informants (estimate = -2.57; also see figure 2b). Similarly, the medicinal use-value of *L. microcarpa* was lower for young informants (estimate = -3.82; figure 2b).

Differences in the use-value of plant parts of *L. microcarpa* among ethnic groups and generations

The use-value of roots did not differ either among ethnic groups or between generations (p-value > 0.05; table III). In contrast, the use-value of leaves and bark differed between generations and among ethnic groups (p-value < 0.05; table III). The use-value of fruits and stems differed only among ethnic groups (p-value < 0.05; table III).

Regarding the use-value of plant parts among ethnic groups and generations, the fruit was the most used plant part and was followed by the leaves and bark (figure 3a). The root was the least used plant part. Biali, Natimba and Waama were the ethnic groups that valued the fruits the most. Leaves were more valued by Mokolé followed by Dendi, whereas Natimba did not use them. Bark was the most used part by the "other ethnic groups" and Dendi (figure 3a). Young and old informants had a similar use-value for fruits, but young informants had a lower use-value for leaves (estimate = -3.190), bark (estimate = -2.191) and roots (estimate = -2.016) than the old informants (figure 3b).

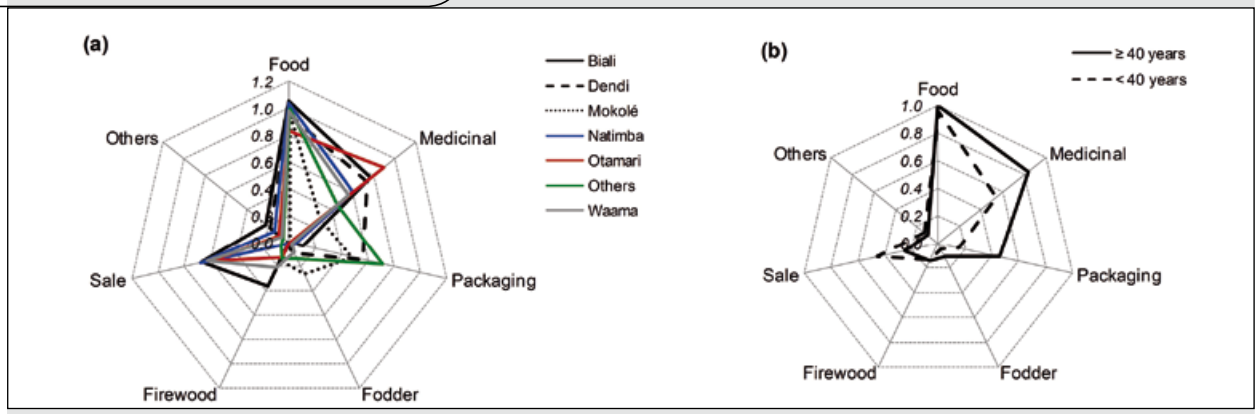

Figure 2.
Differences in the uses of *Lannea microcarpa* among (a) ethnic groups and (b) generations.

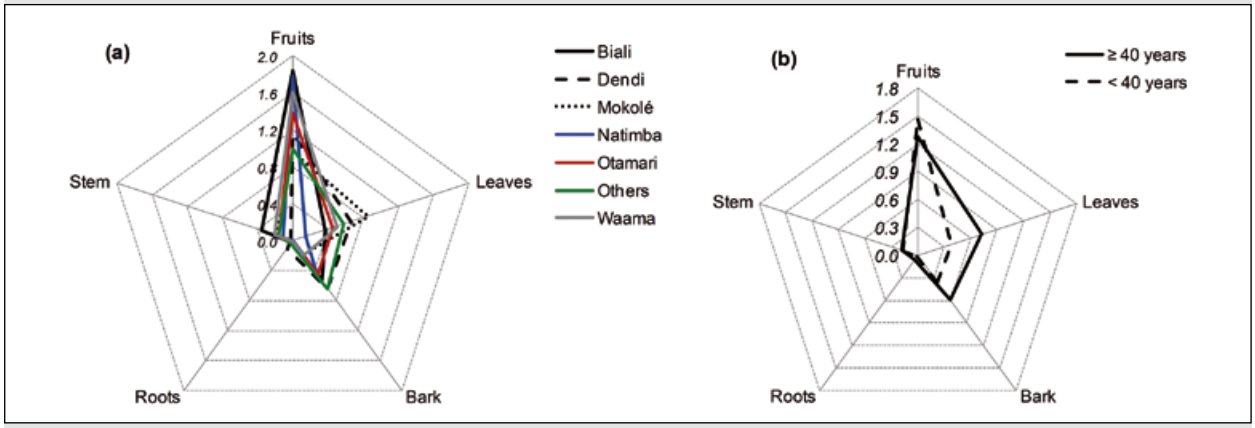

Figure 3.
Differences in the uses of *Lannea microcarpa* plant parts among (a) ethnic groups and (b) generations.

Diversity of the uses of *L. microcarpa*

The survey showed that five plant parts of *L. microcarpa* were used by the local population (table IV). Several recipes were recorded for 28 purposes of uses, and the bark, roots, leaves and stem were used in traditional medicine. The most used parts were, respectively, the fruit, bark and leaves (figure 3). The bark and leaves were the most involved in traditional medicine. Examples of diseases treated include anaemia, diarrhoea, cough, ulcers, stomach aches, blood evacuation after childbirth, and fortification of mothers and new-borns. Often, the plant part used was boiled as an infusion or soaked in boiled water as an infusion, and drinking the infusion as a liquid was the most common form of use.

Table III.
Effect of socio-cultural group and generations on plant part use-value of *Lannea macrocarpa*: p-value of the likelihood ratio tests.

Plant part	Ethnic groups	Generations	Ethnic groups: generations
Fruits	0.008**	0.882 ns	0.982 ns
Leaves	0.011*	0.001***	0.803 ns
Bark	0.005**	0.029*	0.597 ns
Roots	0.144ns	0.131 ns	0.908 ns
Stem	0.004**	0.214 ns	0.862 ns

*** = p ‹ 0.001; ** = p ‹ 0.01; * = p ‹ 0.05; ns = p › 0.05.

Differences in the cultural importance of the uses of *L. microcarpa* among ethnic groups and generations

Differences in the cultural importance per category of uses

Significant differences (p-value ‹ 0.05) were found only among ethnic groups for food and medicinal uses (table V). The food uses category was more important for Otamari, followed by Dendi and Natimba and other ethnic groups. Concerning medicinal uses, *L. microcarpa* ranked first by Biali followed by Waama Mokolé, Dendi and Natimba.

Differences in the cultural importance of plant parts of *L. microcarpa*

Significant differences (p-value ‹ 0.05) were found among ethnic groups and generations for the score of leaves. Scores of fruit, bark and roots differed only among ethnic groups (table VI).

Table IV.
Plant parts, use category, purpose of use, processing methods, forms of use and fidelity level (FL %) of uses.

Plant parts	Use category	Purpose of use	Processing method	Form of use	FL (%)
Bark	Medicine	Anaemia	Boiled as infusion	Drink the liquid	2.29
			Soak in boiled water		
			Soak in boiled water and add milk		
		Blood evacuation after childbirth	Boiled as infusion	Drink the liquid	3.44
		Cough	Soak in boiled water as infusion	Drink the liquid	4.58
			Boiled in water		
		Deworming	Boiled as infusion	Drink the liquid	0.38
		Diarrhoea	Soak in boiled water	Drink the liquid	0.76
			Boiled as infusion		
		Dysentery	Pound and add milk	Drink the liquid	1.15
			Soak in boiled Water		
			Add Baobab fruits and boil as infusion		
		Fever	Soak in boiled water as infusion	Drink the liquid	8.40
			Boiled as infusion		
		Fortify mother after childbirth	Soak in boiled water as infusion	Drink the liquid	2.67
			Boiled in water		
		Fortify new-born health	Soak in boiled water as infusion	Drink the liquid	3.44
			Boiled in water		
		Haemorrhoids	Boiled as infusion	Drink the liquid	0.76
		Head aches	Soak in boiled water	Drink the liquid	0.38
		Malaria	Soak in boiled water	Drink the liquid	6.49
			Boiled as infusion		
		Stomach aches	Soak in boiled water	Drink the liquid	4.58
			Boiled as infusion		
		Ulcer	Soak in boiled water as infusion	Drink the liquid	3.82
		Varicella	Boiled in water	Drink the liquid	0.76
		Wound healing	Soak in boiled water	Dress the wound	4.20
			Boiled as infusion		
	Sale	Local trading	Sell as medicinal plant in local market	-	0.38
Fruits	Sale	Local trading	Sell in local market	-	39.31
	Medicine	Diarrhoea	Suck	Suck the pulp	0.38
	Food	Human nutrition	Suck	Suck the pulp	56.11
Leaves	Fodder	Animal nutrition	Eat	Eat	2.29
	Medicine	Dysentery	Boiled as infusion	Drink the liquid	0.76
		Blood evacuation after childbirth	Boiled as infusion	Massage of underbelly	2.29
		Fever	Soak in boiled water as infusion	Drink the liquid	1.91
		Stomach aches	Add bark and dry then reduce in powder	Lap up	2.29
		Eye pains	Soak in boiled water as infusion	Drink the liquid	0.38
		Malaria	Soak in boiled water	Drink the liquid	7.63
			Boiled as infusion		
		Fortify mother after childbirth	Boiled in water	Take a bath	0.38
		Fortify new-born health	Soak in boiled water as infusion	Take a bath	2.67
			Boiled in water		
		Flu	Boiled in water	Drink the liquid	0.38
		Cough	Boiled in water	Drink the liquid	2.29
		Ulcer	Soak in boiled water as infusion	Drink the liquid	1.15
		Varicella	Soak in boiled water as infusion	Drink the liquid	0.38
	Packaging	Package sold locust beans mustard	Packaging sold locust beans mustard	-	3.81
Roots	Medicine	Digestion facilitation	Soak in boiled water	Drink the liquid	0.38
		Fever	Soak in boiled water as infusion	Drink the liquid	0.76
		Aphrodisiac	Soak in boiled water	Drink the liquid	0.38
		Stomach aches	Soak in boiled water	Drink the liquid	1.91
		Malaria	Soak in boiled water	Drink the liquid	0.76
		Cough	Soak in boiled water as infusion	Drink the liquid	0.38
		Ulcer	Soak in boiled water as infusion	Drink the liquid	0.38
		Snake bite	Boiled as infusion with other plants	Drink the liquid	0.38
Stem	Medicine	Diarrhoea	Boiled as infusion	Drink the liquid	0.38
		Digestion facilitation	Suck	Chew and swallow the saliva	0.38
	Toothpick	Clean tooth	Chew and brush the tooth	-	0.38
	Construction	Hut building	-	-	0.38
	Firewood	Cooking	Collect dried wood	Fire wood	14.12

Table V.
Differences (mean (standard error)) in the importance score of category of use among socio-cultural groups and generations.

	Food	Medicinal	Fodder	Firewood	Sale	Others uses
Ethnic groups						
Biali	1.03 (0.30)	2.41 (0.13)	-	3.00 (0.00)	2.38 (0.13)	2.75 (0.25)
Dendi	1.17 (0.06)	1.89 (0.11)	2.79 (0.10)	3.00 (0.24)	2.43 (0.20)	-
Mokolé	1.04 (0.04)	2.06 (0.10)	2.83 (0.17)	2.40 (0.25)	-	-
Natimba	1.14 (0.07)	1.79 (0.15)	-	-	2.45 (0.16)	3.00 (0.00)
Otamari	1.46 (0.09)	1.30 (0.13)	-	2.75 (0.25)	3.00 (0.00)	3.00 (0.00)
Others	1.16 (0.07)	1.68 (0.10)	3.00 (0.00)	3.00 (0.00)	-	1.50 (0.5)
Waama	1.06 (0.04)	2.23 (0.13)	2.50 (0.29)	2.60 (0.22)	2.11 (0.14)	-
Overall	1.15 (0.02)	1.91 (0.05)	2.79 (0.08)	2.78 (0.08)	2.32 (0.08)	2.64 (0.20)
Kruskal-Wallis test	31.32***	40.36***	3.29^{ns}	9.53^{ns}	4.88^{ns}	7.06^{ns}
Generations						
‹ 40 years	1.13 (0.03)	1.95 (0.08)	2.71 (0.13)	2.74 (0.11)	2.27 (0.09)	2.86 (0.14)
≥ 40 years	1.18 (0.04)	1.88 (0.07)	2.83 (0.10)	2.85 (0.10)	2.50 (0.15)	2.25 (0.48)
Mann-Whitney test	$19,112.5^{ns}$	$5,958.5^{ns}$	248.0^{ns}	415.0^{ns}	$1,056.0^{ns}$	47.5^{ns}

*** = p ‹ 0.001; ns = p › 0.05.

Table VI.
Differences (mean (standard error)) in the importance score of plant part of *Lannea microcarpa* among ethnic groups and generations.

	Leaves	Fruits	Bark	Roots	Stem
Ethnic groups					
Biali	1.90 (0.14)	1.77 (0.17)	1.22 (0.15)	1.30 (0.15)	2.40 (0.024)
Dendi	2.78 (0.09)	1.21 (0.07)	1.76 (0.09)	2.11 (0.35)	3.00 (0.00)
Mokolé	2.33 (0.17)	1.28 (0.14)	1.86 (0.18)	1.50 (0.50)	2.40 (0.24)
Natimba	1.89 (0.26)	1.50 (0.29)	-	1.08 (0.08)	-
Otamari	2.39 (0.12)	1.17 (0.09)	-	2.05 (0.12)	-
Waama	3.00 (0.00)	1.55 (0.14)	1.63 (0.18)	1.27 (0.14)	3.00 (0.00)
Others	2.00 (0.13)	1.00 (0.11)	3.00 (0.00)	-	-
Overall	2.34 (0.06)	1.36 (0.05)	1.70 (0.08)	1.58 (0.08)	2.54 (0.14)
Kruskal-Wallis test	29.96^{***}	18^{*}	11.11^{*}	24.78^{***}	3.09^{ns}
Generations					
‹ 40 years	2.22 (0.08)	1.42 (0.07)	1.65 (0.12)	1.46 (0.10)	2.43 (0.20)
≥ 40 years	2.54 (0.10)	1.29 (0.06)	1.74 (0.09)	1.71 (0.13)	2.67 (0.21)
Mann-Whitney test	$2,988.5^{*}$	$5,867.0^{ns}$	765.5^{ns}	$1,343.0^{ns}$	44.0^{ns}

*** = p ‹ 0.001; * = p ‹ 0.05; ns = p › 0.05

Discussion

Ethnic and generational differences in traditional knowledge of *L. microcarpa* uses

The overall knowledge of *L. microcarpa* uses varied between generations, old people having more knowledge than young people. This is congruent with previous findings relative to species knowledge in rural communities within the semi-arid region of Brazil (Arévalo-Marín *et al*., 2015) and wild edibles used by the Naxi in Baidi Village of northwest Yunnan province (Geng *et al.*, 2016). However, this result contrasted with the findings of other authors, including De Caluwé *et al*. (2009) who did not find any differences in use-value and use patterns of *Adansonia digitata* in northern Benin. Our findings can be justified as knowledge transmission through generations, which is facing a progressive vanishing with the slow demise of old people, as reported by Geng *et al.* (2016). A difference occurring between generations could be linked on one hand to the mode of the species uses transmission through generations and on the other to old people having more experience of the uses and, therefore, more accumulated knowledge than young people accumulate. Old people gained knowledge from their parents as young people (vertical transmission) and from extra-familial knowledge and exchanges, even if these practices agreed or not with what they learned from their one tradition (Eyssartier *et al*., 2008). Therefore, the mode of knowledge transmission could be a source of progressive erosion of some current traditional knowledge and probably contributes to the appearance of new knowledge.

The knowledge on *L. microcarpa* dietary uses was similar among ethnic groups and generations because the food uses are practiced daily and are, therefore, common. In addition, edible fruit trees were spared from destruction by people for their survival in difficult environments and during periods of shortage because these trees represent a relatively substantial source of food (Seyoum *et al.*, 2015) as a complementary or alternative food source (Okia *et al.*, 2008). The similarity in food uses among cultural groups and generations also suggests a general consensus for *L. microcarpa* food uses. Such a remark has been reported for black plum, *Vitex doniana* (Dadjo *et al.*, 2011), and *Sclerocarya birrea* (Gouwakinnou *et al*., 2011) in Benin.

The knowledge on medicinal uses differed between generations and among ethnic groups. This was because medicinal uses are often specific, rare and mostly devoted to adults and old people. This may explain why old people are more knowledgeable than young people, which is consistent with the findings of Avocèvou-Ayisso *et al.* (2011) on *Pentadesma butyracea*. In fact, adults seemed to report more uses of *P. butyracea* than young people even though a difference in use-value according to age was not significant. However, the high use of the species by Otamari, Biali and Dendi for medicinal purposes suggests that detailed knowledge on medicinal uses could be obtained from them. This result supports those of previous studies and could be hypothetically associated with a higher importance of the household's subsistence activities (Vodouhê *et al.*, 2009). In poor rural areas, it is crucial for most people to stay healthy typically through the use of medicinal plants. As for packaging use, fodder use, firewood use, sale use, and other uses, their use-values varied only among ethnic groups. Differences in the other uses (other than food use) suggest that these uses are ethnic-group specific and are probably due to the historical contact and preferences of each ethnic group. Differences could be also the result of transmission of knowledge through generations. Further investigations are needed to gain additional knowledge about the transmission of uses through generations and among coexisting ethnic groups, especially in an African context where ancestral knowledge on species are orally transmitted through generations (Fandohan *et al*., 2010; Atakpama *et al.*, 2015).

Knowledge held by local people differed among plant parts. Leaves were the most used plant parts in medicinal uses. These findings have been reported for several other species (Koura *et al.*, 2011; Geng *et al.,* 2016). Each part of a plant species is valued depending on the knowledge, benefit and experience that people have historically had with that species. Overall, respondents were more knowledgeable on fruits for both food and medicinal uses. This constitutes an asset to valorise the fruits and other parts of the species. Several benefits can then be expected from the single fruits because the species is kept in agroforestry systems for its fruits (Sinsin and Kampmann, 2010; Segnon and Achigan-Dako, 2014; Goudégnon *et al*., 2016).

Ethnic and generational differences in the cultural importance of *L. microcarpa* uses

The study revealed differences between generations and among ethnic groups. Based on these findings, species use as a local food source was the most culturally important followed by medicinal uses. Both use categories are basic needs for people and often what people search for from useful plants. Local people's interest for these use categories was reinforced by the higher importance of the household's subsistence activities in the study area. Indeed, Benin is one of the Sub-Saharan countries where a significant portion of the population is still affected by poverty, which leads several households to explore food and health options relying on IFT. The importance of these two use categories has been reported for several IFT (Gouwakinnou *et al.*, 2011; Okullo *et al.*, 2004). Moreover, fruits ranking first among the preferred plant parts confirm *L. microcarpa* as an IFT and the choice of its fruits as an important source of vitamins for the diet of local people (Sereme *et al.*, 2008; Haarmeyer *et al.*, 2013). The fruits are also sold in local markets contributing to household income, and previous research has reported the high interest of the local people for the fruit's consumption in Benin and Burkina Faso (Vodouhê *et al.*, 2009; Sinsin and Kampmann, 2010; Goudégnon *et al*., 2016).

Implications for valorisation and research avenues for conservation and domestication

This study is a contribution to the knowledge and valorisation of *L. microcarpa*, an underutilised species in Benin. Its utilisation depends on the plant part's availability. In fact, fruits and leaves are seasonal, whereas the bark, stem and root are available year round. The findings suggest that species valorisation should prioritise the fruit, which is the most preferred and commercialised plant part. This interest in fruits as a food supply is an asset for the sustainable management and conservation of *L. microcarpa* because the importance of fruit trees as a food supply is a motivation for their preservation (Dadjo *et al.*, 2011). The diversified medicinal uses shown in this study suggest that further investigations should be carried out on the potential importance of *L. microcarpa* for drug manufacturers. Other studies revealed the species' potential to cure some health disorders. In fact, analyses of *L. microcarpa* fruit and leaf extracts have revealed their potential for the development of new antibacterials and antioxidants (Bationo *et al.*, 2012; Sansone *et al.*, 2014; Garba *et al.*, 2015).

Conclusion

This study emphasised the local knowledge of *Lannea microcarpa*, an under utilised indigenous fruit tree dwelling in the Sudanian savannah in Benin. Although *L. microcarpa* is used by several ethnic groups of the area, it remains undervalued. Our findings established the importance of the species for local people. Therefore, *L. microcarpa* deserves to be promoted in protected areas surrounding agrosystems and conserved through the livelihood improvement of local people. Further studies should focus on the morphological characterisation of the fruits as well as effective propagation methods. A morphological characterisation will reveal the potential for selection, which is necessary to engage the domestication process. A study of propagation methods will ensure a definition of the best way to grow the species. An additional important issue, that research should address, is the improvement of the yield of fruits, and to make it a real cash-income source for rural people and, thereby, improve their livelihoods. Knowledge discrimination across ethnic groups and generations could be used as an asset for sustainable conservation, domestication and better valorisation of *L. microcarpa*. The diversity of medicinal uses suggests that it will be beneficial for further studies to focus on the drug potentials of the species and development perspectives.

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