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Economic and ethnobotanical importance of the genera *Albizia*, *Parkia* and *Tetrapleura* (Leguminosae-Mimosoideae) in Cameroon

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ABSTRACT

People use goods and services related to Leguminosae-Mimosoideae resources to satisfy multiple needs in Cameroon. Despite some work already done, information on these goods and services remains insufficient. To date, the contribution of these plants to the needs of the population is also unknown. The objective of this study was to provide an overview of the uses of Leguminosae-Mimosoideae by rural and urban populations in Cameroon. Focus was on the genera *Albizia*, *Parkia* and *Tetrapleura*. Socio-economic and ethnobotanical data were collected throughout the study area based on semi-structured individual interviews of 173 respondents. Analysis of the data consisted of statistical and descriptive analyses, to study the position and dispersion characteristics of the data and inferential/decisional analyses consisting of parametric and non-parametric tests. Species vulnerability risk index was also calculated. Six parameters were used to assess economic value of the most requested species. The results show that seven species out of nineteen divided into three genera, are used in Cameroon and have ethnobotanical values. For *Albizia*, we noted that the species *A. adianthifolia, A. laurentii, A. lebbeck, A. zygia* have been identified, while for *Parkia we have the species P. bicolor and P. biglobosa* and finally, the species *Tetrapleura tetraptera*, for the genus *Tetrapleura*. Results showed that the *Leguminosae-Mimosoideae* have an ethnobotanical potential to be valorized, even outside Cameroon. The promotion of these species would increase their exploitation potential basis and increase income of rural and urban populations.
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Keywords: Uses, economic potential, genus *Albizia*, *Parkia* and *Tetrapleura* (*Leguminosae-Mimosoideae*), Cameroon.

INTRODUCTION

Human being have age-old relationships with plants for their various needs (Ezebilo & Mattsson, 2010). These relationships may involve edible, medicinal, cultural, artisanal or domestic plants

(Mutamba, 2007; Aké-Assi et al., 2010; Perumal, 2010). In Africa, various ethnobotanical studies revealed that several socio-linguistic groups possess great on plant use (Pathak et al., 2011; Atakpama et al., 2012; Singh and Singh, 2012; Kébenzikato et al., 2015). Due to their multiple uses, plant resources occupy an important role in daily life of rural and urban populations in Cameroon. Although they are of paramount importance, plants are endangered by a combination of several anthropogenic factors including excessive organ collection, inappropriate agricultural and forestry practices, urbanization, pollution, land use changes and climate change that contribute to the loss of indigenous resources (Dadjo, 2011).

Loss of these resources could lead to a decrease in the local potential and capacity of communities that depend on them for income, food and medicine. This situation, which mortgages the future of natural resources in general and forest resources in particular, is an urgent matter of concern. In the long run it will constitute a threat to the existence of species and consequently to the sustainable development of biodiversity (Dah-Dovonon, 2002; Lougbegnon et al., 2015). One of solutions to this problem remains the valorization of available natural resources already integrated in the rural population's habits. Among these resources are Leguminosae-Mimosoideae.

Several ethnobotanical studies have been conducted in Cameroon on non-timber forest products. Most of them focused either on a specific species, or on a specific use or on the socio-cultural, economic or value chain value of these plants (Abdou et al., 2009; Betti et al., 2016; Ladoh-Yemeda et al., 2016; Mpondo et al., 2017; Sutjaritjai et al., 2019). Despite numerous studies, information on the uses of Leguminosae-Mimosoideae in Cameroon remains fragmentary, so that the contribution of these plant species to the needs of the population remains less known. Their uses, which were once reserved to rural populations, have for several years now become part of the eating habits of the urban population.

Assessment carried out in Cameroon, focuses on species of three (3) genera of the sub-family, Leguminosae : Leguminosae-Mimosoideae namely *Albizia, Parkia* and *Tetrapleura* intended to evaluate the degree of use knowledge of the target species by the local population. This study, whose general objective is to provide an overview of the uses of Leguminosae-Mimosoideae by rural and urban populations in Cameroon, aims specifically to : (1) Assess the knowledge of the uses of species of the genera Albizia, Parkia and Tetrapleura, Leguminosae-Mimosoideae in Cameroon ; (2) Evaluate the vulnerability of known and used species of the populations ; (3) Assess the economic value of the species most used by the populations.

The achievement of these objectives was supported by the collection of data on the species of these genera, in order to have information to be documented for an harmonized and sustainable exploitation and for efficient use of Mimosoideae in Cameroon.

MATERIALS AND METHODS
Study area

The study was carried out in the Centre and Littoral regions of Cameroon, in Yaoundé as political and Douala as economical cities. Yaoundé is located between 3° 52′ North latitude and 11° 31′ East longitude. Its surface area is 304 km^2, with a population of 4,100,000 inhabitants. Its density is 13,487 inhabitants/km^2. Douala is located between 4° 03′ North latitude and 9° 42′ East longitude. It has an area of about 410 km^2, a population of 3,793,000 inhabitants, with a density of 9,251 inhabitants/km^2 (Figure 1). The choice of these two sites is justified, as they are not only crossroads cities, but also cosmopolitan cities. Majority of the country's food and non-timber forest products converge to these towns. The cities are made up of almost all different ethnic groups found in Cameroon (Letouzey, 1968). Markets of the two towns receive products from the surrounding forest ecosystems and also from other regions given the diversity of the populations.

Subfamily Leguminosae-Mimosoideae was chosen because of its economic and

ecological importance. Genera chosen are also justified. Indeed, the genus *Albizia* was chosen because of its importance for the understanding of forest dynamics. It is the second stage in forest development after the parasol trees, during forest reconstitution after logging. The genus *Parkia* has a distribution in both forest and savannah. It is important to study it because of information produced on these two types of vegetation. Finally, species the genus *Tetrapleura* have a wide range of uses.

Data collection

Data were collected over five (5) months from June to October 2021 through semi-structured surveys and individual interviews in the selected localities on the basis of stratified sampling. Two levels of stratification adapted from Atato et al. (2012); Péréki et al. (2012); Kébenzikato et al. (2015) were designated. Two capital cities of Cameroon represent the first level and ethnic groups the second level. Information gathered were: the plant parts used, the specific uses, the type of uses (foods, cultural magic-religious, medicinal uses, wood for various uses, cosmetics), the socio-economic importance and value chains resulting from exploitation of the target species. The mode of preparation/transformation or valorization and the availability of the species in the studied environment were also census. Added to this data, socio-demographic characteristics including age, gender, education, occupation and ethnic groups of each respondent were noted. The study was complemented by direct observations of plants in fields, households and markets.

Data processing and analysis

Data collected in the field were entered and encoded using Microsoft Excel® 2013, based on a tabulation grid. They were analysed using SPSS.v.20.0 software. A descriptive analysis that was carried out on the profile of respondents, categories of use within the three (3) genera, categories of use according to region, and use knowledge according to gender. XLSTAT v.20.0 software was used for the Chi-square statistical tests (χ^2), in order to determine relationships between categorical variables related to region and sex and dichotomous variables related to categories and knowledge on uses. A significance level for all statistical tests was set at $p \leq 0.05$. Profile of the respondents; the categories of use within the three genders; the categories of use by region; the knowledge of use by gender and the categories of use by sex were determined from the calculation of frequencies.

Vulnerability index assessment

To highlight the main species of genera that are potentially vulnerable due to high demand for ecosystem goods and services in Cameroon through collect, harvesting or cutting of organs, species vulnerability index (*SVI*) was calculated. The method used was adapted from Betti (2001) and Traoré et al. (2011). Thus, vulnerability risk, to be evaluated was essentially based on stresses of species and their organs and not directly on the scarcity or abundance of species, was calculated on the basis of five parameters:
Frequency of the citation of the species P1,
Number of use categories in which the P2 species is found, Organs used P3, Sampling method P4, and Abundance P5.

These parameters represent major indicators of pressures and threats on species of the three genera Cameroon. A scale of 1 to 3 has been assigned (Table 1). A value of 1 indicates a low risk of vulnerability of the species for the indicated parameters, a value of 2 represents a medium risk of vulnerability and a value of 3 characterizes a species at high risk of vulnerability.

When several parts of a plant are used, only the part within the highest value from the vulnerability scale is taken into consideration in the calculation of index (Traoré et al., 2011; Birregah, 2016; Badjaré et al., 2018).

Based on information contained in Table 1, species vulnerability index is calculated using the formula:

$SVI = \frac{P1+P2+P3+P4+P5}{5}$ (adapted from Betti, 2001; Traoré et al., 2011).

Thus, high vulnerability is assigned for total index strictly above 6, medium vulnerability is assigned for total indices between 3 and 6 and relatively low vulnerability corresponds to indices between 1 and 3.

Evidence of value chains and economic value of the most requested species

Parameters considered to establish a value chain for the most used resource are: identification of the collectors; resource indicating the part collected; place of harvesting of the resource; destination which represents the place of commercialization and/or transformation of resources into other products sold in the village or town; units of measurement of the resource sold; sale price and the amount of money earned per week after selling. All this information was used to determine the main resource collected; quantities collected; selling prices and actors involved in the value chain.
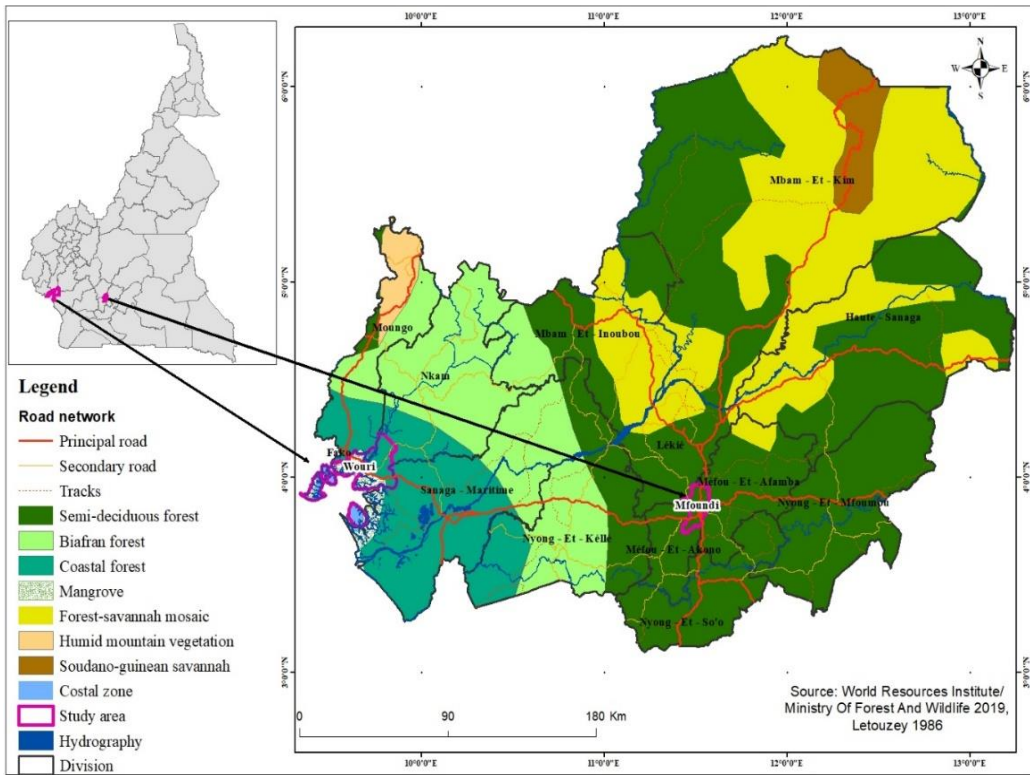
Figure 1 : Study area map.

Table 1: Major parameters for calculation of vulnerability index.

Selected parameter	Low (scale = 1)	Average (scale = 2)	Strong (scale = 3)
Frequency of citation: P1	P1 < 5%	5 % ≤ P1 < 15%	P1 ≥ 15 %
Number of uses: P2	P2 < 2	2 ≤ P2 ≤ 4	P2 ≥ 5
Plant organ used: P3	Leaf, latex	Fruit	Wood, seed, bark, root, flower
Mode of collection of the organ: P4	Collection	-	Picking, cutting
Current availability: P5	Abundant	Not very abundant	Rare

(Adapted from Betti, 2001; Traoré et al., 2011).

RESULTS

Socio-demographic characteristics of interviewees

Socio-demographic characteristics of interviewees included gender, age group, and education level has been carried out (Table 2). Overall, there was a greater participation of males than females. This may be due to the fact that proportions of males participating in the survey was higher in most regions. In terms of age, the range between 41 and 50 years has a high participation rate in all regions, s followed by rates 30-40 and 51-60 age groups. Educated people were the most numerous in the survey for most regions, with higher proportions compared to uneducated people.

Diversity of species and ethnobotanical value within the three genera

The studies show that (07) seven species are used among the nineteen (19) of the three (3) genera. Genus *Albizia* has four (4) species related to *A. adianthifolia; A. laurentii; A. lebbeck; A. zygia* out of the fourteen (14) that make up the genus in Cameroon. Species related to *P. bicolor and P. biglobosa* out of the four that make up of Genus *Parkia* in Cameroon. And finally *Tetrapleura tetraptera*, the only species of the genus *Tetrapleura* recognised in Cameroon has been identified (Table 3).

Knowledge of uses of species of *Leguminosae-Mimosoideae* in Cameroon

Assessment of knowledge of uses of *Leguminosae-Mimosoideae* in Cameroon takes into account use categories of species within the genera *Albizia*, *Parkia* and *Tetrapleura*; use categories and species used by region; knowledge of uses by gender and uses and their applications.

Use categories of species within the genera *Albizia*, *Parkia*, and *Tetrapleura*

The studies identified five (5) main categories of use of Legminosae-Mimosoideae in Cameroon. These are : medicinal, food, magic-religious-cultural, cosmetics and wood for various uses.

Several species of these three (3) genera are not known, and represent 43% of the total use categories. Magic-religious-cultural use is represented at 21%. Uses such as Food, Medicinal, Wood for various purposes each account for 11% of the uses listed. Cosmetic use represents only 3%. (Figure 2).

Use categories in administrative Regions

The most cited uses of the three (3) genera in the Adamaoua region are food 48.84%, followed by wood for various uses 20.93% and medicinal 18.6%. Cosmetics and magic-religious-cultural uses represent 9.3% and 2.3% respectively.

In the Central Region, medicinal use has a citation rate of 50%. It is followed by food use and shade use, which are cited at 25% and 12% respectively. The magic-religious-cultural use represents 6.25%. Uses such as cosmetics and wood for various purposes are not cited in the Central Region. In the Eastern Region, medicinal use represents a citation rate of 25%. Food, agronomic, wood for various uses, magic-religious-cultural, ornamental and other uses each represent a citation rate of 12.5%. Cosmetics and shade use were not mentioned. The Far North Region has a citations rate for food use of 77.78%. The percentages of citation of medicinal and cosmetic uses are 16.67% and 5.55%, respectively for the only uses mentioned.

For species of the three (3) genera, two (2) categories of use were identified in the Northern Region. These are food use (45%) and medicinal use (55%). This is also the case for the Littoral region, where both uses have a citation rate of 50% each. In the North-West region, cosmetic use is cited at 61.5%, followed by food use at 30.8% and finally magic-religious-cultural use at 7.7%. In the Western Region, food use has a citation rate of 54.06%. It is followed by medicinal use with a rate of 40.54% and magico-religious-cultural use, 5.4%. In the Southern Region, the most

cited uses are those classified as other, representing 75%. The magic-religious-cultural use has a citation rate of 25%. Finally, in the South-West, the most cited use categories are food 44.4%, followed by timber and medicinal use, both 27.8% (Figure 3).

Furthermore, the statistical analysis of the Chi-square test carried out shows that the observed Chi-square value ($\chi2obs$ = 94.97) is higher than the theoretical Chi-square value ($\chi2théo$ = 50.60). This reflects interdependence between the modalities related to administrative region and plant use. Also, the Chi-square test of homogeneity revealed a significant dependence between these two modalities (p-value = 0.0001 ≤ 0.05). This means that the use of plants depends on the administrative region.

Distribution of species used in Region

The use of the seven (7) species within the three (3) genera is not uniform in the ten Cameroon.

Species of genus *Albizia* such as *A. adianthifolia*, *A. laurentii*, *A. lebbeck*, *A.zygia* are much more reported in the Central, Eastern, North-Western, Southern and South-Western Regions. Species of genus *Parkia* such as *P. bicolor* and *P. biglobosa* are reported in the Adamaoua, East, Far-North and South-West Regions. *Tetrapleura tetraptera* is reported in all Regions except the Northern part of Cameroon (Figure 4).

Use knowledge according to gender

Globally the result showed that women have more knowledge of uses than men. This is the case in Adamaoua, Centre, North-West, West and South-West regions. In contrast, for the East and North Regions, men have more knowledge of uses than women. Far North Region showed a balance in knowledge of use between males and females (Figure 5).

Furthermore, logical tests in relation to Chi-square performed reveals that the observed Chi-square value ($\chi2obs$ =5.82) is lower than the theoretical Chi-square value ($\chi2théo$

=9.48). Therefore, there is independence between the variables gender and plant use categories. However, Chi-square test of homogeneity indicated that this dependence is not significant (p-value = 0.21 > 0.05) between gender and plant use categories. Thus, plant use categories are not gender dependent.

Uses and their applications within the three genera in Cameroon

With regard to the uses and applications in different Regions, the study showed that whatever the region, medicinal use remains the most common followed by food use (Table 4). Other uses are cited to a lesser extent. This shows the interest of people in traditional plant-based medicine for primary health care firstly and for food secondly. This confirms work done by Inimbock et al. (2021) who mentioned most the important uses of numerous plants to prevent Covid-19 based on traditional knowledge by the populations of the Deng-Deng forest than other uses.

Vulnerability index of listed species

An evaluation of the species vulnerability risk index (*SVI)* based on species sollicitations, shows that none of the seven (7) species listed is at significant risk of vulnerability. *Parkia biglobosa* is the most concerned in use followed by *Tetrapleura tetraptera* (Table 5).

Marketing of collected resources and establishment of a value chain
Resources collected

Seven (07) species are used among the (19) that comprise the three (3) genera. Of these species, *Tetrapleura tetraptera* remains the most reported and the most traded (61.4%). *P. biglobosa* and *P. bicolor* have a marketing rate of 33.66% and 2.97% respectively used only in the northern area. *Albizia have a* 0% marketing rate, for the four (4) species reported as *A. adianthifolia*; *A. laurentii*; *A. lebbeck*; *A. zygia*.

Commercialization of *Tetrapleura tetraptera* in Cameroon

Unit of measurement of *Tetrapleura tetraptera*

From the place of collection in forests and agro-forests to the final use, mainly consumption, *Tetrapleura tetraptera* fruits have different units of measurement. These are bacos bags for first level collectors, 5 L or 15 L buckets for second level collectors, 50-100 kg bags for semi-wholesalers, 5 L or 15 L buckets for wholesalers, and 397 g and 70 g boxes for retailers (Figure. 6).

Selling price

In terms of the sale of *Tetrapleura tetraptera*, only fruits are self-consumed and sold by local populations. First-level collectors use bacos bags as their unit of measurement, with sales prices varying between 2,000 and 5,000 CFA francs depending on the quality of the resource. Second-level collectors sale prices vary between 4,000 CFA francs (5 L) and 10,000 CFA francs (15 L). Semi-wholesalers sell them between 50,000 CFA francs (50 kg) and 100,000 CFA francs (100 kg). Wholesalers sale prices are 8,000 CFA francs for the 5 L bucket and 30,000 CFA francs for the 15 L bucket. Retailers have 397 g tins of milk that they sell for between 500 and 700 CFA francs and 70 g tins of tomato that they sell for between 200 and 250 CFA francs (Table 6). Field observations show that five 15-litre buckets contain a 50 kg bag of the fruit. These observations show that one 15-litre bucket of *Tetrapleura tetraptera* produces 65 boxes of 397 g of milk.

In terms of money earned, studies showed that sales of *Tetrapleura tetraptera* produce a minimum return of 50,000 to 250,000 CFA francs per week for wholesalers and semi-wholesalers. The return is 1,500 to 5,000 CFA francs per week for retailers who sell in 70 g and 397 g boxes respectively.

Actors and organization of *Tetrapleura tetraptera* value chain

Value chain for *Tetrapleura tetraptera* in study areas consists of five (5) main actors. Main actors are organized as follows: at the bottom of the chain, the first-level collectors who are the main actors in the value chain. They are local people, who move from the village to the forest and stay there during seasons or periods of collection of resources. They transport them from the forest to storage points in the village. Second-level collectors who buy the resource from local people as soon as they leave the forest to build up medium to large stocks. They are traders from town. They deliver to urban semi-wholesalers and even to wholesalers. Semi-wholesalers are urban people who come to the villages to buy the resources from the second-level collectors, for transport and delivery to the wholesalers in the large towns. Semi-wholesalers are links between the second-level collectors and wholesalers. They are powerful actors in the value chain because they are mandated by the wholesalers. Wholesalers who receive resources from semi-wholesalers for delivery to retailers in different markets. Retailers receive the resources from wholesalers to sale to final users directly. He is the last actor in the chain (Figure 7).

Value chain for *Tetrapleura tetraptera* in Cameroon is simple with clear and precise steps in the process of moving the resource from the forest to the final consumers. It shows five levels of commercialization between the first level collectors and consumers. The 1rst level is between first and second level collectors, the 2nd between second level collectors and semi-wholesalers, the 3rd between semi-wholesalers and wholesalers, the 4th between wholesalers and retailers and the 5th between retailers and final consumers.

Table 2 : Socio-demographic characteristics of interviewees.

Parameters	Régions%									
	Adamaoua	Centre	East	Far North	Littoral	North	North West	West	South	South West
Gender										
Woman	53,5	87,5	12,5	50	100	41,7	38,5	54,1	0	61,1
Male	46,5	12,5	87,5	50	0	58,3	61,5	45,9	100	38,9
Age										
-30	37,2	0	0	15	0	0	7,7	17,0	0	0
30 - 40	34,9	43,8	25	10	50	41,7	0	42,9	0	27,8
41 - 50	11,6	0	37,5	25	50	16,7	30,8	17,9	75	27,8
51 - 60	9,3	25	37,5	40	0	0	46,2	7,1	25	33,3
>60	7	31,3	0	10	0	41,7	15,4	14,3	0	11,1
Level of education										
Non-informal	0	6,3	0	15	0	0	7,7	0	25	16,7
Primary	16,7	43,8	25	15	0	16,7	7,7	10,0	25	5,6
Secondary	50	18,8	75	55	0	83,3	30,8	24,3	25	50
Superior	27,8	31,3	0	15	100	0	53,8	64,9	25	27,8

Table 3: Species of ethnobotanical value within the three genera.

| Family	Genres	Species of ethnobotanical value
Leguminosae-Mimosoideae	*Albizia*	*Albizia adianthifolia* (Schumacher) W.F. Wight
		Albizia laurentii De Wildeman
		Albizia lebbeck (Linné) Bentham
		Albizia zygia (DC.) J.F.Macbr
	Parkia	*Parkia bicolor* A.Chev**.**
		Parkia biglobosa Benth.
	Tetrapleura	*Tetrapleura tetraptera* (Schum. & Thonn.) Taub
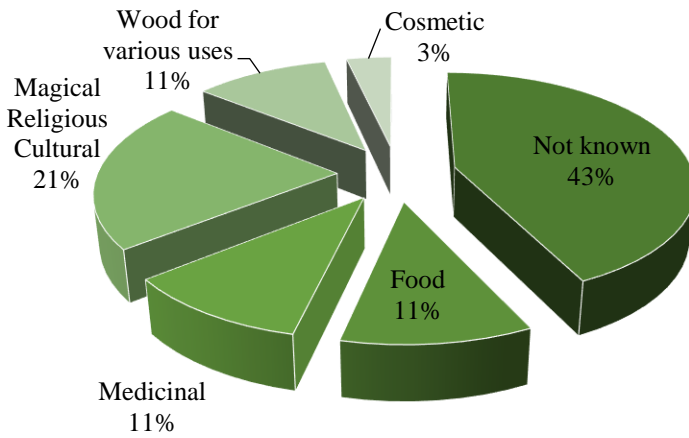
Figure 2: Use categories within genera *Albizia, Parkia* and *Tetrapleura*.
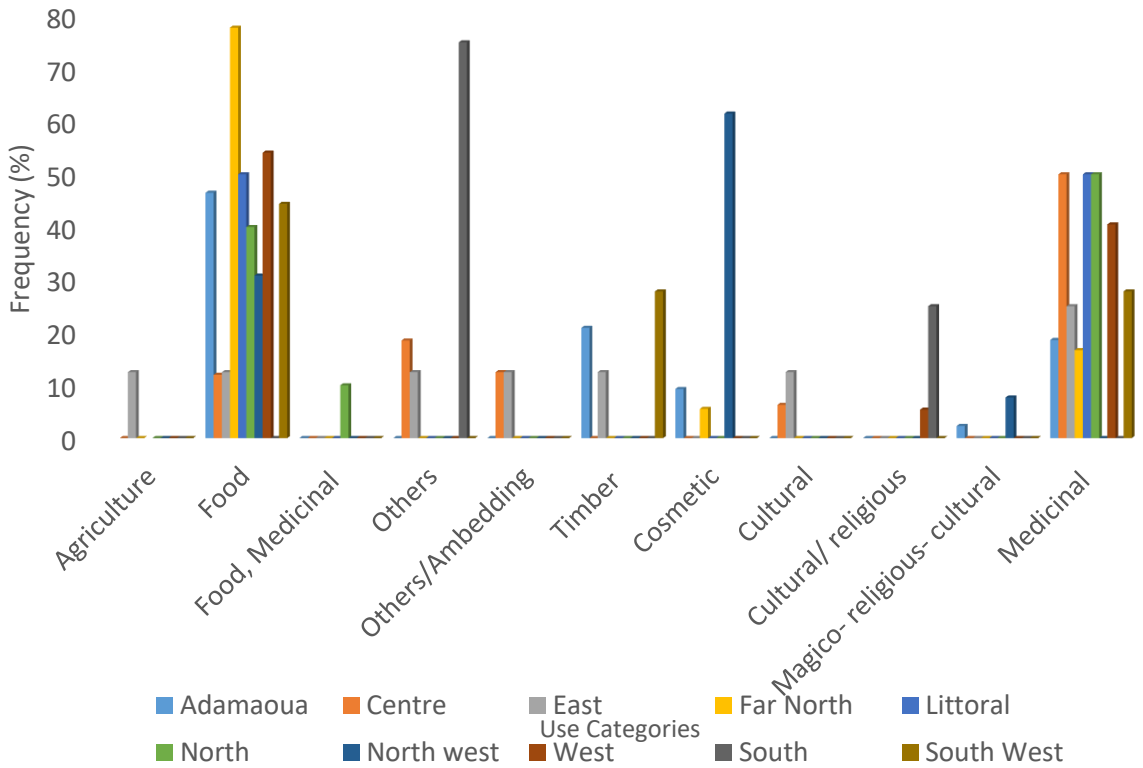
Figure 3: Categories of use according to regions in Cameroon.
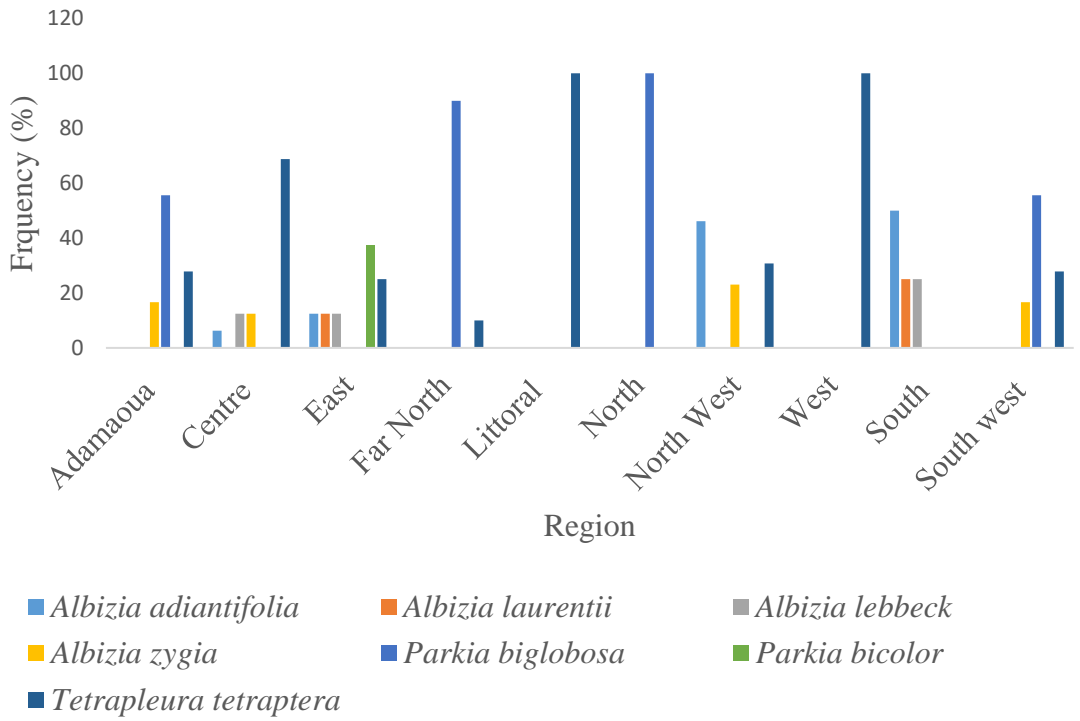
Figure 4: Species of genera used in administrative Region.
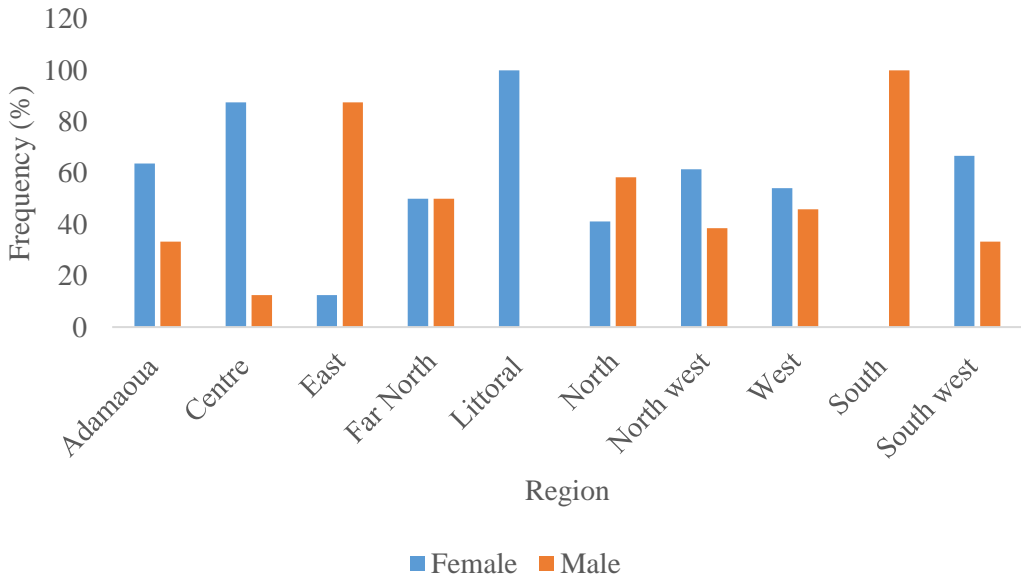
Figure 5: Knowledge of uses according to gender.

Table 4: Uses and their applications within the three genera in Cameroon Regions.

Uses/Regions Species	Food	Agriculture	Wood for various uses	Cosmetics	Magic-Religious-Cultural	Medicinal
Albizia adianthifolia			Wood for fuel and the production of poles for the construction of huts (South)			
Albizia laurentii			Manufacture of pick and axe handles (East; South)			
Albizia lebbeck		Shading for crop protection (East; South)			Ornamental tree (East; South)	
Albizia zygia				Resin production (South)		Cleansing the genitals of women and the stomachs of small children, stimulating the appetite; treatment of sinusitis (Centre)
Parkia bicolor			lumber (East)			
Parkia biglobosa	Consumption of the pulp as candy, cornice cake, porridge and the seeds as peanuts (Septentrion)	Protection of cocoa farms from squirrels (Centre, South, East))	Firewood branches and bark (Septentrion)	The bark allows the sanding of oxhide making it finer (Septentrion)/ soap making from seeds (Septentrion)		Treatment of toothache, diarrhoea and wound disinfection . from a decoction of the skin of pods and seeds (Septentrion)
Tetrapleura tetraptera	Preparation of many modern and traditional				*T.tetraptera* thrown on the roof and around	Treatment of tummy aches in women and

soups, table chilli (Centre, South, East, Littoral, North-West, South-West, West)	houses keeps owls away (Centre)	stimulation of fertility with a decoction of *Tetrapleura* fruits (Littoral, Centre, East) Treatment of myoma cysts (Littoral, West)

Table 5: Characterization of the vulnerability of the species used, of genera *Albizia*, *Parkia* and *Tetrapleura*, in Cameroon.

Species vulnerability	index (SVI)
Parkia biglobosa	3
Tetrapleura tetraptera	2,8
Albizia adianthifolia	2,6
Albizia zygia	2,4
Albizia lebbeck	2,2
Albizia laurentii	2,2
Parkia bicolor	2,2

Figure 6: Unit of measurement of Tetrapleura tetraptera for sale by 1st and 2nd level collectors (A, B), by semi-wholesalers (C, D, E) and by retailers (F, G, H).

Table 6: Units of measurement and selling price of *Tetrapleura tetraptera*.

Tetrapleura tetraptera resources	Units of measurement	Selling price
1st level collectors	Baco Bags	2.000-5.000 frs CFA
Collectors of 2nd level	5 and 15 L bucket	4.000 frs-10.000 frs CFA
Collectors of 2nd level	5 and 15 L bucket	4.000 frs-10.000 frs CFA
Semi-wholesalers	50-100 kg bags	50.000 frs-100.000 frs CFA
Wholesalers	5 and 15 L bucket	8.000 frs-30.000 frs CFA
Retailers	397 g Nestlé milk can	500 frs-700 frs CFA
	Tin of tomato 70 g	200 frs-250 frs CFA
	A fruit	100 frs CFA
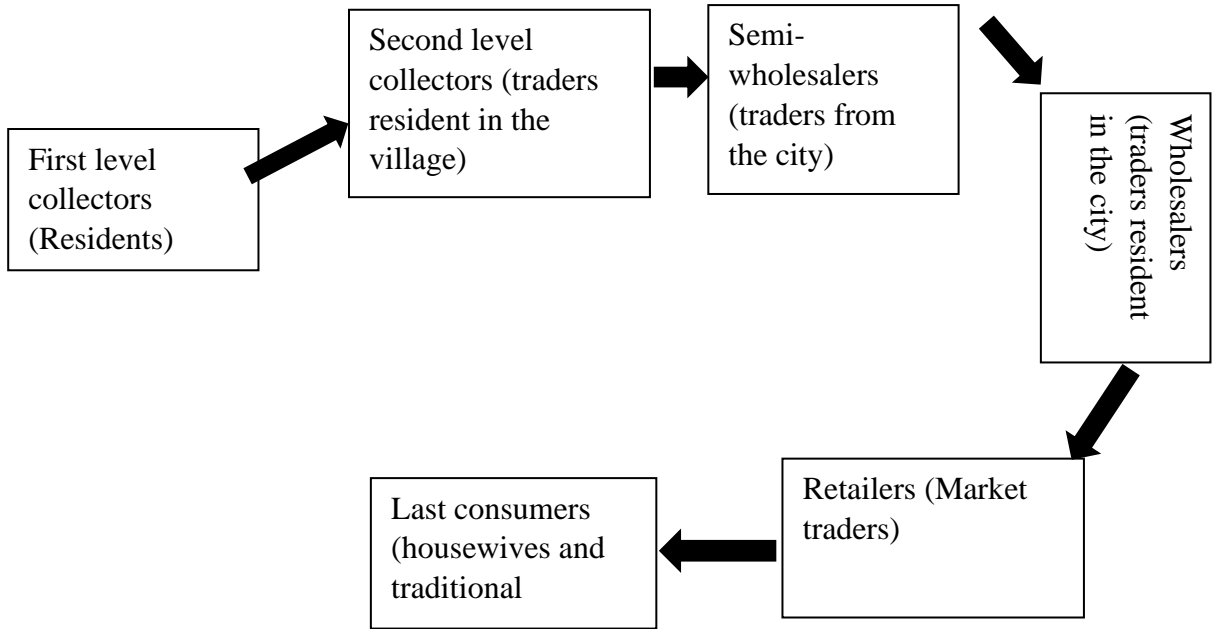
Figure 7: *Tetrapleura tetraptera* value chain in Cameroon.

DISCUSSION

Use categories of species within the genera *Albizia*, *Parkia* and *Tetrapleura*

Genera studied within this family have made possible to identify five (5) categories of use in Cameroon. These are food, miscellaneous wood, cosmetic, magic-religious-cultural, medicinal and the rest not known. These uses are the most often cited when referring to non-timber forest products (NTFPs) uses in the daily lives of rural and urban populations. Studies of Zirihi (1991); N'Guessan et al. (2009) and Piba et al. (2015), carried out on plant species used by the populations of Côte d'Ivoire, had reported similar categories of uses and even more. The present study also showed that magical-religious-cultural use represents 21% of the rate of uses, 11% for food, wood for various uses and medicinal uses, 3% for cosmetic uses and 43% for no use. These uses are the most cited among these species, and are cited within non-timber forest products. Tchatat et al. (2002) reported that non-timber forest product species are the most important sources of income for the local population and provide many products for food, medicine, construction and handicrafts, and as such are an effective tool for poverty alleviation.

Use categories by administrative Region

According to the studies, the categories of uses according to administrative regions, show a significantly higher rate of citations of food and medicinal uses than others in all administrative regions. They are followed by magic-religious-cultural and cosmetic uses. This confirms that the main use of non-timber forest products sources species is for food, as they are generally intended for family consumption, with a share for sale to local or non-native traders. This result is similar to those of Kouakou (2018) conducted in Côte d'Ivoire and Tajeukem (2017) conducted in Cameroon. It also shows the interest that people have in traditional plant-based medicine for primary health care. This is in line with OMS statistics which estimate that up to 80%

of the rural population use traditional medicine for primary health care (Adjanohoun et al., 1996; Eddouks et al., 2007) and this is increasing (OMS, 2013 ; Orch et al., 2015). Moreover, there is a significant difference (p ≤ 0.05) between administrative region and plant use. Similar observations were reported by Atakpama et al. (2012) who worked on *Sterculia setigera* in Togo. According to these authors, the use of foraging plants in a phytogeographical zone is linked not only to cultivation but also to the increased poverty line of the populations and the low urbanization of this zone. Indeed, populations in rural areas are more dependent on natural resources that they use for economic, medicinal and food purposes (Tabuti and Damme, 2012 ; Kaoma and Shackleton, 2014).

Distribution of species used in administrative Region

In the light of this study, uses of species led to a distribution by administrative region of Cameroon. Thus, species of genus *Albizia* are much more used in the Central, Eastern, North-Western, Southern and South-Western Regions. This is due to the fact that species are from forest, secondary forest and degraded forest. The latter constitute the bulk of the dense tropical lowland forests in Africa. Dupuy (1998) and White (1986) mentioned that one of the fundamental characters of African dense forests is high richness in legumes (Caesalpiniaceae and Mimosoïdeae).

Species of genus *Parkia* are more used in the Adamaoua, Far-North and North regions for *Parkia biglobosa* and in the East and South-West regions for *Parkia bicolor*. This could be explained by the fact that *P. biglobosa* is a savannah species, hence its heavy use in the northern regions where the vegetation is almost savannah. Similarly, *P. bicolor* is a dominated forest species that justifies its heavy use in East and South-West Regions. These species vegetation types are similar to those described in Volume IV of the illustrated flora of Senegal 1749-1753. It presents the two *Parkia* species described out of the 4 reported for West Africa:

the savannah *Parkia* as *P. biglobosa* and the forest *P. bicolor*.

Tetrapleura tetraptera from genus *Tetrapleura* is used in all regions except the Northern Region. This could be explained by eating habits and uses that were once restricted to certain localities and have spread throughout the territory. It is similar to a type of inter-ethnic use convergence. Inter-ethnic use convergence occurs when organs of a plant have the same specific uses among one or more ethnic groups in the study area. These results are similar to those of Issa et al. (2018) in their work on the ethnobotanical value of *Khaya senegalensis* (Desr.), A. Juss (Meliaceae) in Togo. They listed five ethnic groups representing the same specific uses of *Khaya senegalensis.*

Knowledge of use by gender

This study found that women have more knowledge of the uses of the species in these three genera than men. This is because most of the information was provided by women. The high participation of women in this study could be explained by the fact that women were much more willing to provide information on usage knowledge than men and surveys were carried out in markets in large cities mostly dominated by women. These results differ from those of Mpondo et al. (2017) and Ngoule et al. (2015) in Cameroon. The latter found a high participation of adult men in the Haut-Nyong Division department (54.55%) and in the markets of Douala East (60.41%).

In addition, this study revealed that knowledge of the uses of these plants by gender did not differ significantly (p-value = 0.21 > 0.05). In addition, knowledge of uses was higher among women than among men. This translates the fact that women could be more familiar with uses related to the species of these three genera than men. These results are in agreement with those of Alaoui et al. (2012) who noted that women have more knowledge of medicinal plants than men in a study conducted on the role of women in local

development and the preservation of forest resources.

Uses and their applications within the three genera in Cameroon

Species of genus *Albizia* were most cited in medicinal, wood for various uses and cosmetic uses. These results are similar to those of Baggnian et al. (2018) in Niger, who cited species of genus *Albizia* as medicinal plants sold in markets in central western Niger. They are also similar to those of Rafidison et al. (2019) conducted in Madagascar which reveal that genus *Albizia* is the most cited in terms of medicinal use. Results are similar to those of Treza et al. (2021) for wood of various uses which mentions that some species of genus *Albizia* are used for light construction such as poles, rafters and for carved objects such as sculptures, spoons, masks and clubs. It is also suitable for light parquetry, joinery, interior woodwork, furniture, cabinet making, shipbuilding, carpentry, toys and novelties, tool handles, baseball bats, crates, fibreboard and particle board. It is used as firewood, although it burns quickly, and is also used to make charcoal. For cosmetic use, the results obtained are similar to those obtained by Sujatha et al. (2013). For these authors the gum contained in the bark of some species of genus *Albizia* is sometimes used locally in cosmetics.

Species of genus *Parkia* have been cited in food, traditional medicine and wood for various purposes, cosmetics and agriculture. Findings are consistent considering the work of Thejangulie et al. (2017) in India, who cited species of genus *Parkia* as having very high nutritional and medicinal values. They mention that different ethnic groups in the state of Manipur have practiced the art of dyeing cloth and other items with the skin of certain fruits of *Parkia* species. The same is true of the work of Bello and Igbokwe (2013) in Nigeria, which mentions this legume as having considerable multipurpose potential in their work on germination and seedling growth of acacia senegal (l.) Willd and parkia biglobosa (jacq.) As influenced by salinity. They are used for

fodder, food, fuelwood, wood, green manure, medicines. They provide shade for fodder grasses and livestock and protect soil from heat. Species of this genus are also important in soil nutrient cycle.

Species *Tetrapleura tetraptera* of genus *Tetrapleura* was cited among food, medicinal and magico-religious-cultural uses. Findings are close to those of Tajeukem (2017), Omokhua and Ukoimah (2008), in Cameroon and Nigeria respectively who mentioned *Tetrapleura tetraptera* as one of the valuable species in Central Africa. They note fruits and seeds as parts of *Tetrapleura tetraptera* that add aroma and flavour to food, on the one hand, and have many medicinal uses on the other.

Vulnerability index of species used

Information on the demands made on species, organs harvested and method of harvesting provide evidence on the vulnerability of these resources (Traoré et al., 2011). On the basis of parameters selected, vulnerability index values do not identify any of the taxa cited as presenting a risk of vulnerability. This result seems highly contested in view of the wide range of uses of these species and their socio-economic importance, which would be very vulnerable. However, it is close to the results of national inventories, which list 38 species in the IUCN Red List (2016) and classify species the family Leguminosae-Mimosoideae as Vulnerable and Least Concern.

Marketing and value chain of collected resources Resources collected

Findings present *Tetrapleura tetraptera* as the most used and traded species among the nineteen (19) of the three (3) genera. This could be due to the fact that it is counted among priority non-timber forest products with a market value. This result is similar to that of Tajeukem (2017) on the availability and types of use of non-timber forest products in the northern periphery of Boumba-Bek National Park in South-East Cameroon, cited

Tetrapleura tetraptera as a non-timber forest product used and traded in this area.

Commercialization of *Tetrapleura tetraptera* in Cameroon

According to findings, *Tetrapleura tetraptera* fruits are consumed and sold by local people to earn economic income. Sales prices and units of measurement vary from collectors to retailers. *Tetrapleura tetraptera* produces a profit of 6,000,000 to 30,000,000 CFA francs/year for semi-wholesalers and wholesalers. This gain varies from 18,000 to 60,000 CFA francs/year for retailers. These results differ from those obtained by Ingram and Schure (2010), who in their work on the contribution of non-timber forest products to national economies, present an annual income from the sale of *Tetrapleura tetraptera* that is higher than those obtained in our work, i.e. 124,489 US Dollars, equivalent to 72,200,952.23 CFA francs/year.

Value chain

In this study, a value chain of five actors was identified for *Tatrapleura tetraptera*. These actors include collectors at the 1st and 2nd level, semi-wholesalers, wholesalers and retailers. At each level, emphasis was placed on the role of each actor in the chain. These results differ from those of Awono and Manirakiza (2008), who presented a value chain with almost the same actors, but somewhat more complex than ours, during baseline studies of *ndo'o* (*Irvingia spp.*) in the Central, Southern and Littoral regions of Cameroon. This complexity is linked to multiple stages in the process of moving non-timber forest products from the place of collection, mostly the forest, to the markets. It is also linked to multiple levels of marketing between one stage and another and throughout the chain. This complexity weakens the decision-making power of some actors in the chain.

Conclusion

The current study based assessed the use knowledge genera *Albizia*, *Parkia* and

Tetrapleura belonging to the sub-family of Leguminosae-Mimosoideae in Cameroon. It revealed the use of seven (7) species namely *Albizia adianthifolia*, *Albizia laurentii*, *Albizia lebbeck*, *Albizia zygia*, *Parkia bicolor*, *Parkia biglobosa* and *Tetrapleura tetraptera*) out of the 19 in three (3) genera. It revealed five (5) use categories within the seven species: food, medicinal, magico-religious-cultural, wood for various uses, cosmetic and the rest not known. Based on the vulnerability risk index of these species, none of the seven (7) species mentioned in the uses are at risk of vulnerability under current conditions. A value chain of five (5) actors has been established for *Tetrapleura tetraptera* as the most resource in demand by the local populations and most available on the markets. Thus, for the sake of present and future generations, it is important to improve knowledge on the uses of Leguminosae-Mimosoideae in Cameroon. This is the first commitment of the Convention on Biological Diversity, namely to "improve and document knowledge".

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

CT: Promoter of the Paper, contributed to the conception of the Paper and research protocol, data collection, processing and analysis, drafting and revision of the original and final manuscript. JMO: directed fieldwork, guided data analysis and drafting of the manuscript. AANM: Collected field data and their processing and revised the manuscript. DO: Analysed the collected data, contributed to the drafting and revision of the final manuscript. MMM: Contributed to the methodology, supervision and validation of the final manuscript.

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