Quantitative ethnobotany and vulnerability of woody plant species in Nyé'été forest, South Region of Cameroon

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Research

Abstract

Background: Despite the importance of the wild plants, the degradation of ecosystems and plant populations increase noticeably due to climate change and anthropogenic pressure. Wrong methods of harvesting do not optimize foliar and fruit productions of the trees and even can kill them. This study focused on local usefulness and the vulnerability of wild woody plant species in Nyé'été forest in South-Cameroon.

Methods: The methods of ethnobotanical inventories so called "walk-in-the-woods method" and "show and tell method" were applied to collect data. Main collected information concerned local names of useful plants, the harvested parts of the plants, the methods of harvesting and the different categories of use.

Results: In total, 75 useful species divided into 66 genera and 31 families were reported. The richest families were Fabaceae (9 species in 9 genera), Apocynaceae (6 species in 6 genera), Annonaceae (6 species in 5 genera), Malvaceae (5 species in 3 genera) and Meliaceae (5 species in 4 genera). Seven main categories of use were recognized. Traditional medicine was the most important category (76% of inventoried species and VUT = 1329.96). Wood, bark, leaves and fruits were the most useful parts of plants because the response rate of each organ was Fki > 50 %. About 31 species were very vulnerable and 20 species were moderately vulnerable (Iv ≥ 2.5 and Iv 2 ≤ Iv < 2.5). According to IUCN status, 27 species were threatened of which *Erythrophleum suaveolens* was endangered species (EN).

Conclusion: Obtained results would contribute effectively to appreciate the potentiality of useful plants of Cameroonian forests and the anthropogenic pressures to the plant resources in order to conserve them.

Keywords: Ethnobotanical inventories, ethnobotanical potentialities, anthropogenic pressure, vulnerability, Cameroon

Background

Rural populations in Sub-Saharan Africa have various relationships with wild plants depending on their uses (Ezebilo & Mattsson 2010). The Cameroonian forests contribute up to 10% of the Gross Domestic Product (GDP) and about 30% of exports (De Wasseige *et al*., 2012). Timbers are also exported to Europe, America and Asia and supply the national market, the Sahelian countries and North African countries. Domestic demand is mainly fueled by small-scale sawing (Koffi 2005).

Beside exploitation of timber, forest plant resources such as bark, roots, leaves and fruits occupy a prominent place in the lives of rural populations (Koné & Kamanzi 2006; Theilade *et al.* 2007; Awono *et al.* 2009; Zerbo *et al.* 2011; Zizka *et al*. 2015). These non-timber products are used as food, as fodder, in traditional medicine, in construction of habitations and in domestic energy. The difficulties of live conditions orientate more and more rural populations to exploit and commercialize forest products like fruits, oils, resin, etc. Indeed, indigenous edible fruits for example have enormous potential in contributing to nutrition and cash economy of small-scale farmers (Godfrey & Akullo 2004).

Despite the importance of the wild plants, the degradation of ecosystems and plant populations increase noticeably due to climate change and anthropogenic pressure. This situation contributes to the loss of these indigenous resources (Assogbadjo *et al* 2010; Dadjo 2011). It is urgent to make it a permanent concern because in the long term it will constitute a threat for the existence of the species (Dah-Dovonon 2002). Such work could make it possible, on the one hand, to identify the plant species threatened by poor management and, on the other hand, to guide conservation strategies by making available to decision-makers, conservation actors and populations the species with high potential for use and potential threats (Traore *et al.* 2011; Dossou et al. 2012). Some scientific studies have shown that the quantitative ethnobotanical approach is a good tool for the conservation of plant resources exploited by populations (Amusa *et al.* 2012).

This study focused on local usefulness and the vulnerability of wild woody plant species in Nyé'été forest in South-Cameroon. The main objective was to contribute for appreciating the potentiality of useful plants of Cameroonian forests and the anthropogenic pressures to the plant resources in order to conserve them. The specific objectives were (1) to identify all used plants in Nyé'été forest and to determine their taxonomic composition, (2) to identify categories of use and assess the ethnobotanical value of use, (3) to identify all harvested organs and to assess their response rate as well as (4) to determine vulnerability indices of each used species.

Materials and methods

Study area

The Nyé'été forest is located in Nyé'été Subdivision, and it covers 2117 Km^2. It is belonging to the Ocean division in the South Region of Cameroon (figure 1). The populations are estimated at 40894 habitants in 28 villages. The climate is a humid tropical type, characterized by four seasons, two dry seasons and two rainy seasons (Suchel, 1987). The average annual temperature is around 25 ^{0}C. Soils are mainly ferrallitic and hydromorphic (Gemerden & Hazeu, 1999). Nyé'été forest belongs to the Atlantic basin area, and it is crossed on sides by two rivers, the Kienké river in the north and the Lobé river in the south.

For this study, three forests were chosen and considered as the collection units (Adjap, Nkongo and Akome 1) related to three main different villages witch represented Nyé'été Subdivision.

Adjap forest is located in the north of Nyé'été subdivision, between 2°49' North latitude and 10°11' East longitude. Populations are dominated by Bulu ethnic group. Agriculture and exploitation of timber are the main activities of local populations. The mainly exploited timber species are *Pterocarpus soyauxii, Erythrophleum ivorense, Baillonella toxisperma*. Akom I is also located in the north of Nyé'été subdivision, near Adjap forest, but between 2°49' North latitude and 10°08' East longitude about 5 km apart from each other (Figure 1). The populations belong to Fang, Bulu, Bassa and Ngoumba ethnic groups. The main anthropogenic activities carried out by the local populations are agriculture and the exploitation of timber. They cultivate hevea (*Hevea brasiliensis*) and oil palm (*Elaies guineensis*) on small scales. They also harvest bark from certain plant species such as *Garcinia lucida* and *Alstonia boonei* intended for sale on the national and subregional markets.

Nkongo is located in the southern area of Nyé'été Subdivision (Figure 1). The populations are essentially composed by pygmies, Fang, Boulou, Bassa, Ngoumba ethnic groups and by ethnic groups originating from northern Regions of Cameroon. Intensive anthropogenic activities such as agriculture, exploitation of timber and illegal hunting are observed in the forest. Large forest areas are destroyed by oil palm, banana, plantain, and cocoa cultivation. HEVECAM Company cultivates and exploits hevea (*Hevea brasiliensis*) and oil palm (*Elaies guineensis*) on large scales.

Methods

Two methods of ethnobotanical inventories were applied during August and September 2020 in three selected villages (Adjap, Akom I, Nkongo).

The first method was the so called “walk-in-the-woods method”. It consisted of expeditions in the forest, guided by two resource persons from each village. The useful woody species were recognized and identified (local names). The main collected information from person resource concerned the local name of useful plants, the harvested parts of the plants, the methods of harvesting the parts of the plant and the different categories of use. During these expeditions, inventory of all woody plants was done in transects. Three specimens of each species were collected in order to authenticate scientific names. The floristic composition and natural regeneration of woody plants in this forest were assessed and the results were published in Todou *et al.* (2023).

The second method was the so called "show and tell method". It consisted of walk through the villages and to show the collected dried or fresh specimen to persons. A total of 120 persons over 20 years old were interviewed (40 in Adjap, 42 in Akom I and 38 in Nkongo) representing a survey rate of about 10 %. In total, 71.31% were men and 28.69 were women. The main collected information from interviewed persons was the same of the first method.

Scientific names of species and families have been given according APG III (2009) classification. Identification of the most common species was done directly in the field whenever possible. Collected specimens have permitted to authenticate scientific names in the National Herbarium of Cameroon (YA) and using some documents (Vivien & Faure 1985; Wilks & Issembe 2000) and Arbonnier 2000).

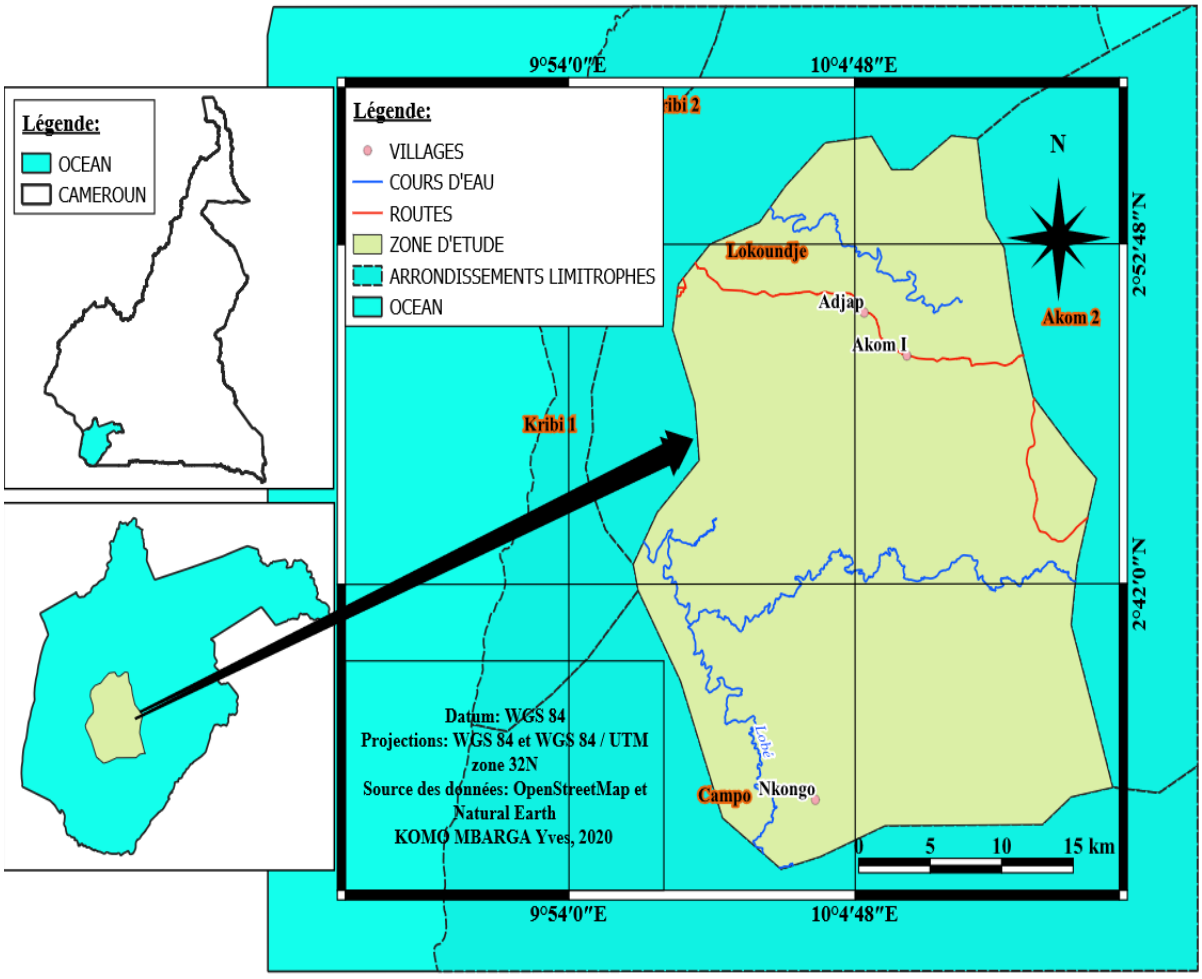

Figure 1. Study site location map (*this map was drawn in French*)

Data analysis

The taxonomic composition was evaluated by the number of species, the number of genera and the number of families. This diversity index makes possible to assess the potential of the used plants in the study site. Local names of species were assigned to each species as well as IUCN conservation status according Onana & Cheek (2011).

The local importance of each species was calculated using relative frequency of citation (Tardio & Pardo-De-Santanyana 2008).

$$\mathrm{FRCi} = \frac{NRi}{N}\ x\ 100,$$

NRi is the number of persons who mentioned the use of species i and N is the total number of interviewed persons.
The ethnobotanical value of use of a species (VUi) was calculated according to the formula used by Phillips and Gentiz (1993) and Todou *et al.* (2019):

$$\mathrm{VUi} = \frac{Ui}{N}\ x\ 100,$$

Ui is the number of persons who gave a positive response for category of use for species i and N the number of persons interviewed.

The total use value of the species i is then calculated by the sum of the values of use of this species within the different use categories (Todou *et al.* 2019). It was calculated following this formula:

$$VUT = \sum_{i=1}^{n}(VUi)$$

Organ importance was calculated based on the response rate (Fki) (Dossou *et al.* 2012; Todou *et al.* 2019).

$$\mathrm{Fki} = \frac{NOki}{N}\ x\ 100,$$

NOki is the number of persons who gave a positive response for the use of organ i of species k and N and the total number of interviewed persons.
The response rate indicates the most used organs for each species. It ranges from 0 to 100. The value 0 indicates that the organ is not used and 100 when the organ is said to be used by all respondents. The total organ response rate is therefore the sum of the frequency rates of all species for the considered organ (Todou *et al.* 2019).

The species vulnerability indices were calculated from the parameters cited by Betti (2001) and by Traoré *et al*. (2011). For this study, five parameters were considered (the frequency of use, the number of categories of use, the type of harvested organ, the method of harvesting organ and the stage of development of harvested organ (Table 1). The frequency of use (N_1) was calculated using the formula:

$$N_1 = \frac{npij}{ntpe} * 100,$$

npij = number of persons who cited species i in use j and ntpe = total number of interviewed persons.
The vulnerability index (Iv) was therefore calculated according to the following formula:

$$\mathrm{Iv} = \frac{\mathrm{N_1} + \mathrm{N_2} + \mathrm{N_3} + \mathrm{N_4} + \mathrm{N_5}}{5}$$

N_1 = frequency of use, N_2 = number of uses, N_3 = type of harvested organ, N_4 = method of harvesting organ and N_5 = stage of development of harvested organ.
The species is said to be weakly vulnerable if Iv < 2, it is said to be moderately vulnerable if 2 ≤ Iv < 2.5 and if Iv ≥ 2.5, it is said to be very vulnerability.

Results

Taxonomic composition

In total, 75 useful species divided into 66 genera and 31 families were cited by local populations of Nyé'été. The richest families were Fabaceae (9 species in 9 genera), Apocynaceae (6 species in 6 genera), Annonaceae (6 species in 5 genera),

Malvaceae (5 species in 3 genera) and Meliaceae (5 species in 4 genera). Five families were represented by two species (Ebenaceae, Combretaceae, Irvingiaceae, Sapotaceae and Urticaceae). Fifteen families were represented by only one species and were grouped under 'Others' (Figure 2).

Table 1. Codified and quantified parameters to assess vulnerability

Parameters	Quantitative scales		
	Weak (scale = 1)	(Moderate (scale = 2)	(Hight = 3)
N_1	F.U < 20%	20% ≤ F.U < 60%	F.U ≥ 60%
N_2	Nu < 2	2 ≤ Nu ≤ 4	Nu ≥ 5
N_3	Leaves ; latex	Fruit, branch	Wood, seed, bark, root, flower
N_4	Picking	-	Picking, logging
N_5	Old or senescent	Adult	Young

Ethnobotanical values of use of the species and categories of use

Among the 75 species recognized and used by local populations, *Ceiba pentandra* (VUT = 171.11), *Dacryodes edulis* (VUT = 162.22), *Baillonella toxisperma* (VUT = 155.56), *Guibourtia demeusei* (VUT = 145.55), *Mangifera indica* (VUT = 145.55), *Irvingia gabonensis* (VUT = 135.55) were the most requested species in various categories of use whose total ethnobotanical values of use were superior to 100. The least used species were *Albizia ferruginea* (VUT = 5.56), *Beilschmiedia manii* (VUT = 5.50), *B. obscura* (VUT = 3.33), *Hallea stipulosa* (VUT = 1.11), *Tabernaemontana crassa* (VUT = 5.50). Their total ethnobotanical values of use were inferior to 6 (Table 2).

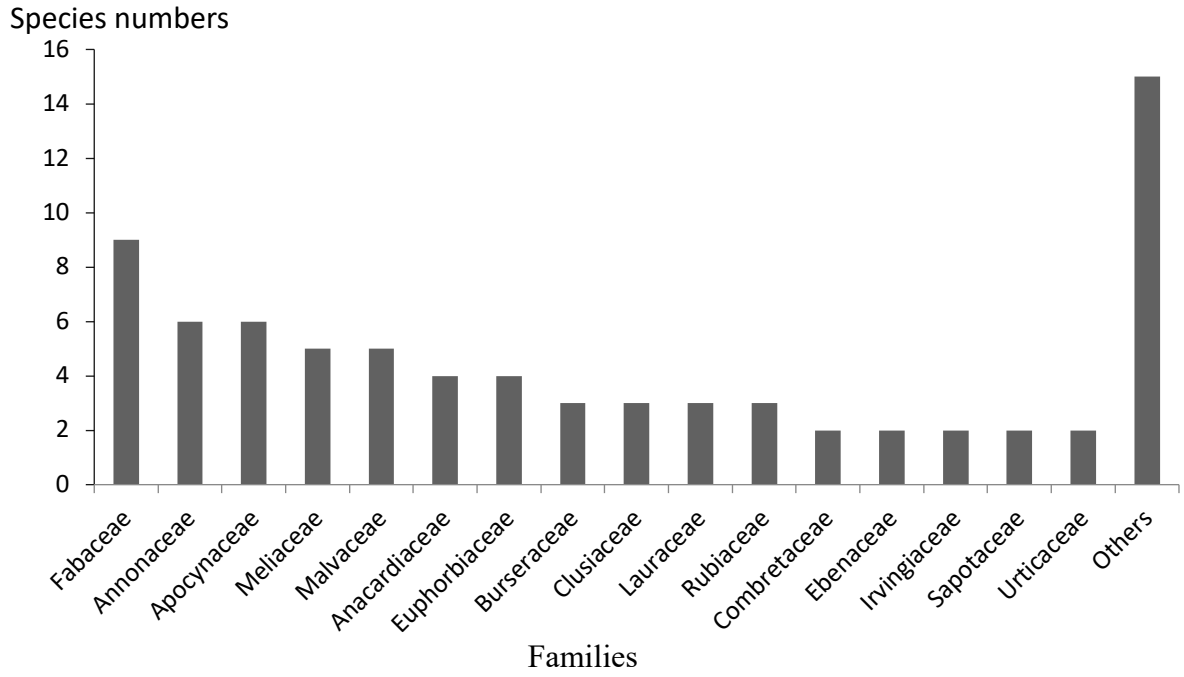

Figure 2. Abundance of the most representative Families

In total, seven main categories of use were recognized. Traditional medicine was the most important category of use. About 76% of all inventoried used species were concerned and it totalized VUT = 1329.96 of ethnobotanical values. Human food (49% of concerned species and VUT =984.4), construction of dwellings (50% of concerned species and VUT = 794.39) had important categories of use too. Few species were cited for traditional rites and arts-crafts with respectively 17% and 6% of all used species (Table 2).

Table 2. Categories of use and their ethnobotanical values of use per each species

Species	Categories of Use								VUT
	Fodd	HuFo	ArtC	ConD	FiWo	TraM	TraR	Others	
Afzelia bipindensis	0	0	0	21.11	0	0	0	3.33	24.44
Albizia ferruginea	0	0	0	5.56	0	0	0	0	5.56
Alchornea cordifolia	20	0	0	0	0	18,89	0	0	38.89
Allanblackia floribunda	0	14.44	0	34.44	0	10	0	0	58.88
Alstonia boonei	0	0	0	24.44	0	87.78	0	0	112.22
Aningeria robusta	12.22	24.44	0	0	27.78	0	0	0	64.44
Annickia chlorantha	0	0	0	18.89	5.56	70	0	0	94.45
Anonidium manii	0	6.67	0	0	0	24.44	0	0	31.11
Annona muricata	1.11	42.22	0	0	0	35.56		0	78.89
Antrocaryon klaineanum	0	27.78	0	0	47.78	34.44	21,11	0	131.11
Aucoumea klaineana	0	0	0	20	0	0	0	5.56	25.56
Baillonella toxisperma	24.44	41.11	0	36.67	10	26.67	16.67	0	155.56
Beilschmiedia mannii	0	0	0	0	0	5.55	0	0	5.55
Beilschmiedia obscura	0	0	0	0	0	3.33	0	0	3.33
Canarium schweinfurthii	0	31.11	0	13.33	0	42.22	21.11	10	117.78
Ceiba pentandra	6.67	32.22	0	53.33	8.89	28.89	25.55	15.55	171.11
Cola acuminata	0	6.67	0	10	0	12.22	8.89	0	37.78
Cola nitida	2.22	10	0	5.55	0	20	11.11	0	48.89
Cola pachycarpa	0	7.78	0	0	0	10	4.44	0	22.22
Combretum micranthum	0	0	0	0	0	12.22	0	0	12.22
Cordia platythyrsa	0	0	0	8.89	0	0	0	3.33	12.22
Coula edulis	22.22	55.55	0	3.33	0	18.89	0	0	100
Dacryodes edulis	4.44	80	0	0	38.89	38.89	0	0	162.22
Diospyros crassiflora	0	0	35.5	48.89	0	0	18.89	0	103.33
Entandrophragma candollei	0	0	0	2.22	0	7.78	0	0	10
Entandrophragma cylindricum	0	0	0	18.89	4.44	0	0	0	23.33
Eribroma oblongum	2.22	3.33	0	13.33	0	0	0	0	18.89
Erythrophleum suaveolens	0	0	31.11	35.55	0	0	0	0	66.67
Fagara macrophyla	0	11.11	0	2.22	18.89	0	0	0	32.22
Garcinia kola	0	31.11	0	0	0	35.55	30	0	96.67
Garcinia lucida	0	24.44	0	0	0	10	12.22	0	46.67
Guarea cedrata	0	0	0	0	13.33	7.78	0	0	21.11
Guibourtia demeusei	0	25.55	0	37.78	0	50	32.22	0	145.55
Hallea ciliata	0	0	0	33.33	7.78	3.33	0	2.22	46.67
Hallea stipulosa	0	0	0	1.11	0	0	0	0	1.11
Irvingia gabonensis	4.44	83.33	0	0	0	32.22	15.55	0	135.55
Khaya ivorensis	0	0	0	0	5.55	6.67	0	0	12.22
Klainedoxa gabonensis	0	20	0	0	32.22	23.33	0	0	75.55
Landolphia owariensis	0	0	0	0	24.44	0	0	0	24.44
Lophira alata	0	0	0	50	0	30	0	0	80
Lovoa trichilioides	0	0	4.44	17.78	0	5.55	0	0	27.78
Macaranga burifolia	0	0	0	4.44	0	7.78	0	0	12.22
Mangifera indica	11.11	64.44	0	0	35.55	34.44	0	0	145.55

Margaritaria discoidea	8.89	0	0	11.11	0	12.22	0	0	32.22
Markhamia lutea	0	0	0	0	0	21.11	0	0	21.11
Milicia excelsa	0	0	0	24.44	0	23.33	0	0	47.78
Monodora myristica	0	18.89	0	0	0	30	0	0	48.89
Musanga cecropioides	0	2.22	0	0	23.33	23.33	0	0	48.88
Myrianthus arboreus	0	0	0	0	28.89	13.33	0	0	42.22
Nauclea diderrichii	0	0	1.11	25.55	0	6.67	0	0	33.33
Pentaclethra eetveldeana	0	0	0	21.11	13.33	4.44	0	0	38.89
Persea americana	17.78	60	0	0	21.11	34.44	0	0	133.33
Petersianthus macrocarpus	3.33	6,67	0	12,22	14.44	30	0	0	66,67
Phoenix reclinata	13.33	17,78	0	0	0	26,67	0	0	57.78
Picralima nitida	0	0	0	36.67	0	78.89	0	0	115.55
Piptadeniastrum africanum	0	0	0	3.33	7.78	11.11	0	0	22.22
Poga oleosa	0	5.55	0	0	10	18.89	0	0	34.44
Pterocarpus soyauxii	0	0	0	35.55	0	0	14.44	0	50
Pycnanthus angolensis	0	0	0	0	12.22	16.67	0	0	28.89
Rauwolfia vomitoria	0	0	0	0	45.55	40	0	0	85.55
Ricinodendron heudelotii	12.22	61.11	0	0	0	31.11	0	0	104.44
Sacoglottis gabonensis	41.11	18.89	0	37.78	0	30	0	0	127.78
Scorodophloeus zenkeri	0	44.44	0	0	0	20	0	0	64.44
Syzygium aromaticum	0	12.22	0	0	0	12.22	0	0	24.44
Tabernaemontana crassa	0	0	0	0	5.55	0	0	0	5.55
Terminalia superba	0	0	0	27.78	0	0	0	0	27.78
Tetrapleura tetroptera	0	13.33	0	0	6.67	21.11	0	0	41.11
Trichoscypha abut	0	16.67	0	0	4.44	0	0	0	21.11
Trichoscypha acuminate	10	18.89	0	0	0	0	0	0	28.89
Triplochiton scleroxylon	0	0	5.55	12.22	0	6.67	0	0	24.44
Uapaca esculenta	0	0	0	0	0	14.44	0	0	14.44
Vitex grandifolia	2.22	14.44	0	20	0	0	0	0	36.67
Voacanga africana	0	0	0	0	27,78	18,89	0	0	46,67
Xylopia aethiopica	0	10	0	5.55	7.78	12.22	0	0	35.55
Xylopia parviflora	3.33	20	0	0	20	17.78	0	0	61.11
Total (75 species)	223.3	984.4	77.71	794.39	529.97	1329.96	232.2	39.99	

Fodd = Fodder HuFo = Human food; ArtC = Arts and craft; ConsD = Construction of dwellings; FirW = Firewood and charcoal; TraM = Traditional Medicine; TraR = traditional rituals.

Importance of harvested organs

In total, height harvested organs were recognized. Wood (Fki = 97%), bark (Fki = 83%), leaves (Fki = 65%) and fruit (Fki = 52%) were the most useful parts of plants. Their response rates were superior to 50%. The latex was the least cited by interviewed persons with Fki = 23% (Figure 3). Indeed, the wood is useful at both in arts and crafts, in the construction of dwellings and it is also used as wood energy. Bark and leaves were cited mainly for traditional medicine.

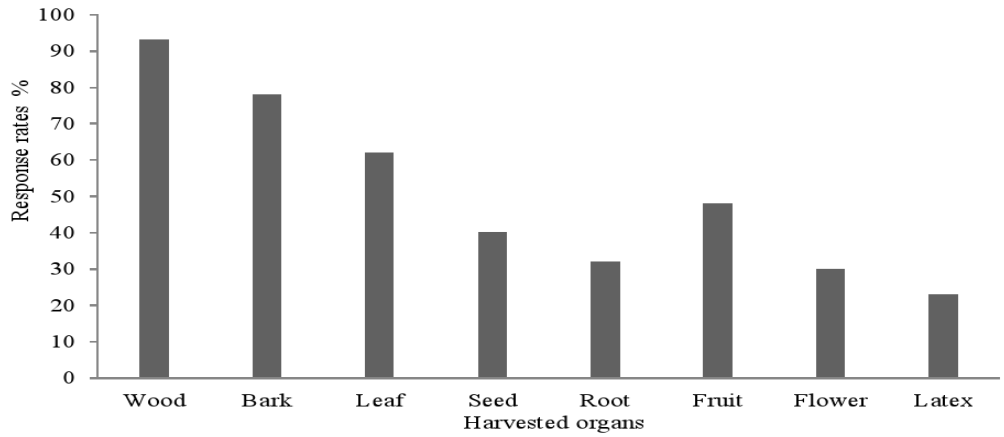

Figure 3. Response rates of harvested organs

Vulnerability and conservation status

The 75 species performed various vulnerable indices. They varied from Iv = 1 for *Beilschmiedia mannii, Beilschmiedia obscura, Guarea cedrata, Albizia ferruginea, Pycnanthus angolensis, Syzygium aromaticum, Hallea stipulosa, Eribroma oblongum* to Iv = 4 for *Antrocaryon klaineanum*. About 31 species were very vulnerable because their vulnerability index, Iv ≥ 2.5. According to the IUCN status, *Erythrophleum suaveolens* was the only endangered species (EN) but up to 26 species were vulnerable (VU) and 10 species were least concerned (LC). However the IUCN status of 26 species was not found in the documents (Table 3).

Discussion

Important floristic richness and lots of useful plants **in Nyé'été**

The importance of the preservation of biodiversity and the sustainable use of natural resources is increasingly perceived by international opinion as an ardent obligation. In Nyé'été forest, Todou *et al*. (2023) found 127 ligneous species and with about 260 trees/ha. And then, there were 75 inventoried useful species as part as of this study, about 60% of all inventoried species in the studied site (more than half). This number is not small; it reflects on the one hand, the level of knowledge of the plant resources by local populations and on the other hand, reveals the importance of these resources in the daily life of these populations. About 78% of protected or planted plants in traditional agrosystems in Mandara Mountains are useful for local populations (Todou *et al*. 2019; 2023).

The contribution of wild plants to food security and primary health care was demonstrated, in fact, more than 80% of the rural populations of sub-Saharan Africa use them on a daily basis. These populations have always drawn most of their subsistence products from nature and more particularly from wild plants through the gathering of fruits, leaves, bark, caterpillars, wood and various condiments. Height main categories of use were recognized by local populations and *Ceiba pentandra*, *Dacryodes edulis*, *Baillonella toxisperma*, *Guibourtia demeusei*, *Mangifera indicia* and *Irvingia gabonensis* were the most requested species in various categories of use. Indeed, several of these species were cited as a priority for domestication because of their usefulness for populations (Tsobeng *et al.* 2016). In Nyé'été forest, most of the species are used for traditional medicine (VUT = 1329.96), human food (VUT = 984.4) and construction of dwellings (VUT = 794.39). Used organs are mainly leaves and bark.

Table 3. List of all cited species, their vulnerability and conservation status.

Family names	Species	Iv	Vulnerability status	UICN status
Anacardiaceae	*Antrocaryon klaineanum* Pierre	4	very vulnerable	NE
	Mangifera indica L.	3.5	very vulnerable	LC
	Trichoscypha abut Engler & V. Brehm	1.25	weakly vulnerable	-
	Trichoscypha acuminata Engl.	1.5	weakly vulnerable	LC
Anisophyllaceae	*Poga oleosa* Pierre	2.5	very vulnerable	NE
Annonaceae	*Annickia chlorantha* (Oliv.) Setten & Maas	3.5	very vulnerable	NE
	Annona muricata L.	2.25	moderately vulnerable	-
	Annodium mannii (Oliv.) Engl. & Diels	1.25	weakly vulnerable	-
	Monodora myristica (Gaertn.) Dunal	2.75	very vulnerable	-
	Xylopia aethiopica (Dunal) A.Rich.	2.5	very vulnerable	LC
	Xylopia parviflora Spruce	2.5	very vulnerable	-
Apocynaceae	*Alstonia boonei* De Wild.	2.75	very vulnerable	NE
	Landolphia owariensis P. Beauv.	1.5	weakly vulnerable	-
	Picralima nitida (Stapf) T. Durand & H. Durand	2.5	very vulnerable	LC
	Rauwolfia vomitoria Afzel.	2	moderately vulnerable	LC
	Tabernaemontana crassa Benth.	2.25	moderately vulnerable	-
	Voacanga africana Stapf ex Scott-Elliot	2	moderately vulnerable	LC
Arecaceae	*Phoenix reclinata* Jacq.	2.5	very vulnerable	-
Bignoniaceae	*Markhamia lutea* (Benth.) K.Schum.	1.5	moderately vulnerable	LC
Boraginaceae	*Cordia platythyrsa* Baker	1.25	weakly vulnerable	VU
Burseraceae	*Aucoumea klaineana* Pierre	1.5	weakly vulnerable	VU
	Canarium schweinfurthii Engl.	3	very vulnerable	VU
	Dacryodes edulis (G.Don) H.J.Lam.	3	very vulnerable	-
Clusiaceae	*Allanblackia floribunda* Oliv.	1.25	weakly vulnerable	VU
	Garcinia kola Heckel	2.5	very vulnerable	VU
	Garcinia lucida Vesque	2.75	very vulnerable	VU
Combretaceae	*Combretum micranthum* G.Don	1.5	weakly vulnerable	-

	Terminalia superba Engl. & Diels	2	moderately vulnerable	VU
Ebenaceae	*Diospyros crassiflora* Hiern	2	moderately vulnerable	VU
Euphorbiaceae	*Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg.	1.75	weakly vulnerable	-
	Macaranga hurifolia Beille	1.75	weakly vulnerable	-
	Margaritaria discoidea (Baill.) G.L. Webster	2.25	moderately vulnerable	-
	Ricinodendron heudelotii (Baill.) Pierre ex Heckel	2.75	very vulnerable	NE
Fabaceae	*Erythrophleum suaveolens* (Guill. & Perr.) Brenan	2	moderately vulnerable	EN
	Albizia ferruginea (Guill. & Perr.) Benth.	1	weakly vulnerable	VU
	Piptadeniastrum africanum (Hook.f.) Brenan	2.25	moderately vulnerable	NE
	Tetrapleura tetraptera (Schum. & Thonn.) Taub.	2	moderately vulnerable	LC
	Afzelia bipindensis Harms	2.25	moderately vulnerable	VU
	Scorodophloeus zenkeri Harms	2	moderately vulnerable	VU
	Guibourtia demeusei (Harms) J.Léonard	3	very vulnerable	VU
	Pentaclethra eetveldeana De Wild. & T.Durand	2.75	very vulnerable	-
	Pterocarpus soyauxii Taub.	2	moderately vulnerable	LC
Humiriaceae	*Sacoglottis gabonensis* (Baill.) Urb.	3	very vulnerable	-
Irvingiaceae	*Irvingia gabonensis* Baill.	3	very vulnerable	NT
	Klainedoxa gabonensis Pierre ex Engl.	1.5	weakly vulnerable	NE
Lamniaceae	*Vitex grandifolia* Gürke	2.5	very vulnerable	NE
Lauraceae	*Beilschmiedia mannii* (Meisn.) Benth. & Hook.f. ex B.D.Jacks.	1	weakly vulnerable	-
	Beilschmiedia obscura (Stapf) A.Chev.	1	weakly vulnerable	VU
	Persea americana Mill.	3	very vulnerable	-
Lecythiadaceae	*Petersianthus macrocarpus* (P.Beauv.) Liben.	3.25	very vulnerable	NE
Meliaceae	*Entandrophragma candollei* Harms	2	moderately vulnerable	VU
	Entandrophragma cylindricum (Sprague) Sprague	1.75	weakly vulnerable	VU
	Guarea cedrata (A.Chev.) Pellegr.	1	weakly vulnerable	VU
	Khaya ivorensis A.Chev.	1.75	weakly vulnerable	VU
	Lovoa trichilioides Harms	2.75	very vulnerable	VU
Malvaceae	*Triplochiton scleroxylon* K. Schum.	2.75	very vulnerable	VU
	Ceiba pentandra (L.) Gaertn.	3.5	very vulnerable	VU

	Cola acuminata (P. Beauv.) Schott & Endl.	2	moderately vulnerable	-
	Cola nitida (Vent.) Schott & Endl.	3.25	very vulnerable	-
	Cola pachycarpa K.Schum.	2.25	moderately vulnerable	-
Moraceae	*Milicia excelsa* (Welw.) C.C. Berg	2	moderately vulnerable	VU
Myristicaceae	*Pycnanthus angolensis* (Welw.) Warb.	1	weakly vulnerable	NE
Myrtaceae	*Syzygium aromaticum* (L.) Merr. & L. M. Perry	1	weakly vulnerable	-
Ochnaceae	*Lophira alata* Banks ex P.Gaertn.	2.5	very vulnerable	VU
Olacaceae	*Coula edulis* Baill.	2.75	very vulnerable	-
Phyllanthaceae	*Uapaca esculenta* A.Chev. ex Aubrév. & Leandri	1.5	weakly vulnerable	-
Rubiaceae	*Hallea ciliata* Aubrev. et Pellegr.	2.75	very vulnerable	-
	Hallea stipulosa (DC.) J.-F.Leroy	1	weakly vulnerable	VU
	Nauclea diderrichii (De Wild. & T. Durand) Merr.	1.75	weakly vulnerable	VU
Rutaceae	*Fagara macrophylla* (Oliv.) Engl.	2	moderately vulnerable	-
Sapotaceae	*Aningeria robusta* (A.Chev.) Aubrév. & Pellegr.	2.5	very vulnerable	NE
	Baillonella toxisperma Pierre	3	very vulnerable	VU
Sterculiaceae	*Eribroma oblongum* (Mast.) Pierre ex A. Chev.	1	weakly vulnerable	VU
Urticaceae	*Musanga cecropioides* R. Br.	1.25	weakly vulnerable	-
	Myrianthus arboreus P. Beauv.	2	moderately vulnerable	LC

Iv = vulnerability index, NE = not evaluated, LC = least concern, VU = vulnerable, EN = endangered, NT = not threatened, - = IUCN status not found.

Need to sustainably manage Nyé'été forest and its plants species

About seven main categories of use were identified. The high proportion of woody species used in traditional medicine (About 76% of all inventoried used species), allows the treatment of several diseases including malaria, typhoid, hemorrhoids, jaundice, teeth etc. Similar results were obtained by Hadonou-Yovo *et al*. (2019) with 71% of species used by the populations were medicinal species in Mono Reserve (Benin). Human food, construction of dwellings, firewood and charcoal and fodder were not negligible categories by their use values. About 31 species were very vulnerable and 20 species were moderately vulnerable because their calculated vulnerability indices were respectively Iv ≥ 2.5 and Iv 2 ≤ Iv < 2.5. According to IUCN status, 27 species were threatened of which *Erythrophleum suaveolens* was endangered species (EN). These numbers are not small because the vulnerability index is linked to local management methods (Betti 2001; Traoré *et al.* 2011). The harvested parts of plants were wood, bark, leaves, flowers, fruits and seeds were the most harvested. These harvested parts were cited by Lougbegnon *et al.* (2011) too in the swamp forest reserve (Benin). And then debarking, pruning and slaughtering were the most commonly used techniques for organ harvesting. The concern here is that wrong organs harvesting makes the species vulnerable. According Todou *et al.* (2022), these methods of harvesting do not optimize foliar and fruit productions of the trees and even can kill them.This local management is opposed to the perspectives of sustainable management of plant resources, because the harvesting methods have a negative impact on plant species. Some authors (Zheng & Xing 2009; Koudouvo *et al.* 2011 and Guedjé 2002) proposed techniques of harvesting bark like small areas of debarking, debarking can be taken from different places along and around the stem or the tree can also be partially debarked on one side.

Conclusion

This study on the uses and vulnerability of woody species in Nyé'été forest has general objective of contributing to ethnobotanical knowledge and anthropogenic threats to the plant resources of Cameroonian forests. In this forest, there is an important floristic richness and lots of useful plants. There are about 60% of all inventoried woody species in the studied site. This reflects on the one hand, the level of knowledge of the plant resources by local populations and on the other hand, it reveals the importance of these resources in the daily life of these populations too. Wood (Fki = 97%), bark (Fki = 83%), leaves (Fki = 65%) and fruit (Fki = 52%) were the most useful parts of plants because their response rates were superior to 50%. Height main categories of use were recognized by local populations and *Ceiba pentandra*, *Dacryodes edulis*, *Baillonella toxisperma*, *Guibourtia demeusei*, *Mangifera indicia* and *Irvingia gabonensis* were the most requested species in various categories of use.

The local management of these woody plants seems to be opposed to the perspectives of sustainable management of plant resources, because the harvesting methods have a negative impact on plant species. About 31 species were very vulnerable and 20 species were moderately vulnerable because their calculated vulnerability indices were respectively Iv ≥ 2.5 and Iv 2 ≤ Iv < 2.5. Moreover, according to IUCN status, 27 species were threatened of which *Erythrophleum suaveolens* was endangered species (EN).

Obtained results on usefulness and the vulnerability of wild woody plant species in Nyé'été forest (Cameroon) and the effects of their local management would contribute effectively to appreciate the potentiality of useful plants of Cameroonian forests and the anthropogenic pressures to the plant resources in order to conserve them.

Declarations

Ethics approval and consent to participate: not applicable
Consent for publication: not applicable
Availability of data and materials: request for data can be directed to the first author
Competing interests: the authors declare that they have no competing interests.
Author contributions: Todou Gilbert and Komo Mbarga Yves collected the data, performed the experimental work and wrote the first draft while Tchobsala and Ibrahima Adamou read and corrected the manuscript.

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