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Non-Timber Forest Products use in the Gazetted Forest of Dogo-Kétou, Benin (West Africa)

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ABSTRACT

The role of Non-Timber Forest Products (NTFPs) for livelihood improvement among local communities and to support forest management has nowadays received increased attention. Although knowledge about the importance of NTFPs is not new, their consideration in the management plans of several protected forests in Benin has been poor. This study aimed at assessing the socio-cultural importance of NTFPs in sustaining livelihood of adjacent local communities to the Dogo-Ketou forest in order to help forest managers to enhance strategies for NTFPs valorisation in this forest management. Data on popular NTFPs were collected through structured interviews administered to 254 households. A total of 78 plant species were harvested by the local people. About 66.53% of households were mostly dependent on Dogo-Ketou forest for medicine, food, firewood and construction. Food use was the NTFPs category of high consensus (ICF_{Food} = 0.98). *Khaya senegalensis* (RFC = 0.73) represented the most important local plant species used for medicinal purposes. High cultural significant index was recorded for *Elaeis guineensis* (CSI = 33.81). NTFPs harvest was significantly influenced by households' size, average monthly income, gender and distance to forest and households' home ($p<0.05$). This research suggests key species which can be promoted by the forest managers in order to sustain the adjacent communities' livelihoods and to enhance their participation in forest conservation.

Keywords: Food plant, medicinal plant, NTFP, Cultural Significant Index, Dogo-Kétou forest.

INTRODUCTION

In recent decades, much research highlighted the economic, social, cultural and ecological importance of Non-Timber Forest Products (NTFPs) to local communities which rely on NTFPs as the main source of subsistence (Angelsen et al., 2014; Diarra et al., 2016). According to several reports (Olsen, 2005; Betti et al., 2011), a high proportion (80%) of the developing world population depends on NTFPs for their primary healthcare and nutritional needs. Forest resources especially NTFPs have always made an important contribution to livelihoods of forest dwellers in the world (Angelsen et al., 2014). In Africa, about two-thirds of the continent's people rely on forest products including a wide range of NTFPs, either for subsistence use or as income-generating activity (Sunderlin et al., 2005).

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However, their availability is increasingly compromised by overexploitation, deforestation and climate change. Therefore, the promotion of sustainable extraction of NTFPs are regarded as a strategy to poverty reduction and biodiversity conservation in the developing world especially in rural communities (Saha and Sundriyal, 2012; Angelsen et al., 2014). Protected areas are one of the most frequently used conservation strategies and should play a role in sustaining livelihood of adjacent local communities (Vodouhê, et al., 2010).

In most African countries such as Benin, NTFPs contribute significantly to the livelihoods of households living around the natural forests and protected areas (Vodouhê, et al., 2010; Heubach et al., 2013) by providing subsistence goods such as food, medicines, fuelwood and building materials, and form a safety cushion in times of economic hard-ship (Heubach et al., 2011; Madjimbe et al., 2018).

In Benin, some studies (Vodouhê et al., 2010; Heubach et al., 2011, 2013; Ahossou et al., 2017; Kafoutchoni et al., 2018) were already carried out on NTFPs collection and utilisation. However, with the increasing growth of local populations and the high demand of NTFPs for commercialisation, the conservation of most used species remains nowadays questionable. Therefore, serious consideration of the exploitation of NFTPs in and around protected forests has become an urgent issue in the management of these forests. Unfortunately, logging is still largely dominant in most forests and NFTPs are poorly considered in their management plans despite sustainable use of NFTPs being considered as an effective strategy to promoting the sustainable conservation of natural resources and enhancement the livelihoods of local population. This paper attempts to analyse the NPTFs used by local population with a focus on seven villages around the Gazetted Forest of Dogo-Kétou (GF-DK) area in southern of Benin. It aimed at assessing the socio-cultural importance of NTFPs in sustaining livelihoods of adjacent local communities of GF-DK for sustainable management of forest biodiversity. Specifically, our objectives were (i) to identify the major NTFPs of GF-DK that contribute to livelihood survival of the adjacent local communities (ii) to identify the factors influencing the engagement of households in the collection of NTFPs (iii) to assess household perception of NTFPs abundance as well as the procurement modes of these NTFPs per use category. Study results will increase the understanding of the role of NTFPs to rural livelihoods around protected area. These findings will also provide policy-makers a decision support tool for a participatory forest management in order to enhance local livelihood and plant species conservation.

MATERIALS AND METHODS

Study area

This study was carried out close to local communities around the GF-DK in Idigny district situated in the township of Kétou in the south of Benin (West Africa). The GF-DK has an area of 42,850 hectares (El hadj Issa and Kakpo, 2009). It is located between longitudes 2°34' 26" and 2°42' 35" of east; 7°32' 9" and latitudes 7°41' 23" of north (Figure 1). The climate is tropical with two rainy seasons (mid-March to mid-July: the long rainy season and mid-September to mid-November: the short rainy season) and two dry seasons (mid-November to mid-March: the long dry season and to mid-July to mid-September: the short dry season). The mean annual rainfall in the study area varies approximately between 1100 and 1200 mm and the mean temperature is 25 °C (ASECNA, Unpubl. data). The vegetation of GF-DK is characterised by a mosaic of shrubby fallow, gallery forest, woodland, tree and shrub savannas. The population within the study area is 46,444 (INSAE, 2013) that largely depends on forest resources like NTFPs use for their livelihood sustenance. Holli, Fon, Yoruba, Nago and Peuhl ethnic groups are the major inhabitants of the study area (INSAE, 2013). The belief systems of these different ethnic groups are based on a broad range of religions including Christianity, Islam and traditional religions. The local communities' main economic activities are agriculture and

NTFPs harvesting. Other livelihood sources included fishing and animal breeding.

Sampling procedure

A preliminary investigation was carried out across nine villages representing the different socio-cultural groups around the Gazetted Forest of Dogo-Kétou (GF-DK) in order to estimate the proportion p of households using NTFPs. The villages were mainly chosen based on their proximity to the forest, which is an integral component to their livelihood sustenance. In the surveyed villages, 30 randomly selected households were asked if they used any NFTPs. Using the binomial approximation law of Dagnelie (1998), the sample size *n* was computed based on the proportion *p* of positive answers as follow:

$$n = \frac{U^2_{1-\alpha/2} \times p(1-p)}{d^2}, \quad (1)$$

where $U_{1-\alpha/2}(\alpha = 0.05) = 1.96$; d the margin error fixed at 0.05 and p = 0.79 (proportion of households that provide positive responses to the question "Do you use any NFTPs from GF-DK?"). Using the above formula (1), a total of 254 households were randomly selected in the targeted villages (Table 1). This sample included women, men, olds, adults and youngs.

Data collection

Data was collected from the sampled households in the targeted villages using a structured questionnaire. Heads of the households, particularly the husband or wife were selected as respondents. Although the questionnaire was in French, the interviews were conducted in local languages. Prior to each interview, the respondents were given a detailed explanation to clarify the the purpose of the survey. Data collected were related to the local names of NTFPs used and its use category (food, medicinal, fuelwood, construction materials, handicraft, fodder, beverage and ceremony), used parts, abundance (declining, stable, or increasing), use preference, use frequencies and harvest pattern. Other data included socio-demographic characteristics of the respondents (age, education level, ethnic group, gender, household size, average monthly income and religion) were also collected. Voucher specimens were collected with the aid of local people for all quoted plant species for their identification in literature. Herbariums of plant species were prepared on field for identification. Preliminary identification of the collected voucher specimens was done using the analytic Flora of Benin (Akoegninou et al., 2006) and Flora of Benin (De-Souza, 2008) as reference materials. The expertise of a specialist of the National Botanical Garden of the University of Abomey-Calavi was solicited for comparison and confirmation of the field plants identification.

Data analysis

Calculation of indices

Local knowledge on NTFPs utilisation was assessed through calculation of relative frequency of citation (RFC), cultural significance index (CSI) and informant consensus factor (ICF).

- Relative frequency of citation (RFC)

Local importance of NTFPs plant species was calculated based on the relative frequency of citation (Tardio and Pardo-De-Santayana, 2008). The RFC was calculated as follows: number of households who mentioned the use of the NTFPs plant species (Fc), divided by the total number of informants (N).

$$\mathrm{RFC} = \frac{\mathrm{Fc}}{\mathrm{N}} = \frac{\sum_{i=i_1}^{iN} UR_i}{N} \quad (2)$$

- Cultural significance index (CSI)

In order to identify the most culturally important plant species, the cultural significance index (CSI) was computed using the following formula (Silva et al., 2006).

$$\mathrm{CSI} = \sum_{i=1}^{n} (\mathrm{I} * \mathrm{E} * \mathrm{C}) * \mathrm{CF} \quad (3)$$

where,

I = species management [1= non-managed; 2 = managed]; E = use preference [1 = not preferred 2 = preferred]; C = use frequency [1= rarely used; 2 = used frequently]

CF = correction factor [number of citations for a given species divided by the number of citations for the most-mentioned species].

- Informant consensus factor (ICF)

In this study, informant consensus factor (ICF) was calculated to test the agreement of

the households on the use reported for a particular NTFP category. The ICF was computed as follows: number of use citation in each category (N_{uc}) minus the number of species used (N_t), divided by the number of used citations in each category minus one (Heinrich et al., 1998)

$$ICF = \frac{N_{uc} - N_t}{N_{uc} - 1} \quad (4)$$

Statistical analysis

Household data on the number of plant species used per category of use was analyzed using Pearson's Chi-Squared test. Pearson's Chi-Squared test was also used to test if households' dependency on NTFPs collection and use is influenced by the distance between their home and the GF-DK as to investigate the effects of socio-demographic characteristics (age, sex, instruction level, household size, monthly income, religion and ethnic group) on household NTFPs use or collection.

Furthermore, in order to measure the extent to which communities have NTFP plant species in common or vice versa across the study area, a range of binary similarity coefficient (Sørensen similarity test) was used.

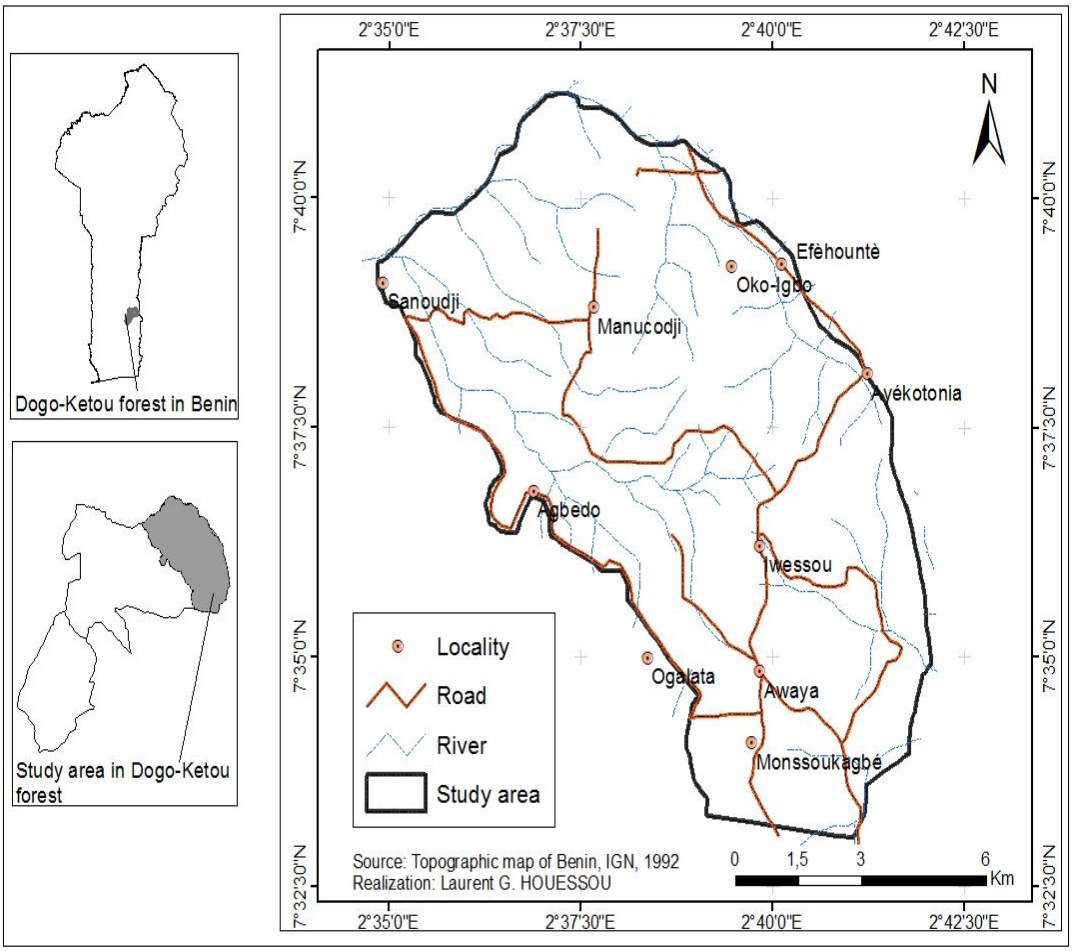

Figure 1: Map of the study area.

Table 1: Profile of surveyed villages.

Villages	Distance to the forest	Sample size	Proportion (%) in sample size
Efèhountè	Less than 1.5 km	41	16.14
Iwessou		36	14.17
Ayékotonian		31	12.20
Manoukodji		28	11.02
Agbedo		23	9.05
Awaya		33	13.0
Sanoudji		19	7.42
Oko-Igbo	More than 1.5 km	21	8.27
Monsoukagbé		22	8.66
Ogalata			
Total		**254**	**100**

RESULTS

Households' profiles

Household respondents were elderly with an average age of 43 years (25-80 years) and 56.29 % were females. The population within the study area comprised of five major ethnic groups i.e. Holli (20.80%), Fon (18.80%), Yoruba (24.40%), Nago (23.60%) and Peulh (12.40%). The mean of household size was 8 persons (4-15 persons) and the majority of the household respondents (62.80%) had not attained any formal education. About 38% of the household had a mean monthly income of USD 58.08 ± 26.40.

Diversity and consumption of NTFPs

This study recorded 78 plant species belonging to 72 genera in 33 plant families which respondents harvested regularly or occasionally from the forest (Table 2). These species are used in 8 categories of NTFPs in the study area. Most (66.66%, n = 52) of the species were used as medicine source. About 30.76% (n = 24) were mentioned for food use. Only 3.84% (n = 3 species) were reported for the category of ceremony use (Figure 2). The most mentioned species was *Khaya senegalensis* (F_c = 183) for medicinal purposes. This species is followed by *Elaeis guineensis* (F_c = 182) used for food and beverage needs. For use in construction, fuelwood and fodder, *Afzelia africana* (F_c = 179), *Pterocarpus erinaceus* (F_c = 179) and *Tectona grandis* (F_c = 129) were the most mentioned species. The less mentioned species was *Dennettia tripetala* for ceremonial use category (the species stem is used as whip by the local divinity named Oro). Regarding the life forms of the harvested plant species, the majority were trees (60.26%) followed by shrubs (26.92%), herbs (8.97%) and lianas (3.85%).

Local and cultural importance of NTFPs plant species

In this study, *Khaya senegalensis* (RFC = 0.73) represented the most important local plant species used for medicinal purposes. *Elaeis guineensis* (RFC = 0.72) and *Vernonia amygdalina* (RFC = 0.72) emerged as the most important food plant for local population (Table 2). *Afzelia africana* (0.71) and *Pterocarpus erinaceus* (0.71) were mostly used for timber, construction, handicraft and fodder purpose. Insignificant relative frequency of citation was recorded for the species *Dennettia tripetala* and *Cola nitida* (RFC = 0.01 each) for ceremonial use.

Regarding the culturally important plant species, results also showed that *Elaeis*

guineensis was culturally the most important plant species according to the CSI value (CSI = 33.81). High cultural significance index was also recorded for *Parkia biglobosa* (CSI = 21.45), *Pterocarpus erinaceus* (CSI = 19.56), Khaya senegalensis (CSI = 17.50), and *Vernonia amygdalina* (CSI = 15.82). Otherwise, the species *Dennettia tripetala* and *Cola nitida* were those of lowest cultural significant index value (CSI = 0.01).

Differentiation of NTFP use across villages in the study area

Among the eight resources identified across all studied villages, seven were reported in all the surveyed villages (Table 3). Ceremonial use category was only reported in the Efèhountè, Ayékotonian, Manoukodji, Awaya and Monsoukagbé villages. Overall, most widely collected NTFPs in the study area were used for medicinal purposes (100 %) followed by firewood (95.0 ± 8.0) and food use (94.0 ± 7.0). In term of the most prevalently used NTFPs per study site, medicinal, food and construction were used by more than 80% of households in all studied villages while construction category were also used by more than 80% of households but only in three villages i.e. Iwessou, Ayekotonian and Manoukodji (Table 3).

Regarding household's dependency on GF-DK, about 66.53% [95% CI: 65.82–67.24] of the households were substantially reliant on this forest for livelihood sustenance in the sampled villages. On the other hand, 18.50% [95% CI: 17.87–19.13] and 19.20% [95% CI: 18.10–20.30] of the households were moderately and less dependent on the GF-DK respectively. However, the household attitudes toward forest resources vary depending on distance to forest. Most (74%) of the households from the villages (Efèhountè, Iwessou, Ayékotonian, Manoukodji, Agbedo, Awaya and Sanoudji) closer to the GF-DK (distance less than 1.5 km) were highly dependent on the forest resources for livelihood sustenance compared to those (30%) from the villages (Oko-Igbo and Monsoukagbé) that are far from the forest more than 1.5 km (χ^2 = 37.198; p = 0.000).

Informant consensus on NTFPs use

Informant consensus on NTFPs used ranged from 0.33 to 0.98 (Figure 3). High consensus was recorded for NTFP category for food purposes (ICF_{Food} = 0.98; 1597 use reports; 24 plant species). The species *Elaeis guineensis* (182 citations), *Vernonia amygdalina* (181 citations), *Vitex doniana* (172 citations), and *Parkia biglobosa* (151 citations) primarily recorded high consensus among informants for the food use category. The second NTFP category the highest consensus among informants ranking was medicinal use ($ICF_{Medicinal}$ = 0.97; 1987 use reports; 52 plant species). In this category, the most mentioned plant species that contributed to the high consensus were *Khaya senegalensis* (183 citations), *Sarcocephalus latifolius* (178 citations), *Tamarindus indica* (128 citations), *Zanthoxylum zanthoxyloïdes* (93 citations), *Entada africana* (88 citations). The lowest informant consensus was observed for the ceremonial use category ($ICF_{Ceremony}$ = 0.33; 4 use reports; 3 plant species). *Cola nitida* (1 citation) and *Dennettia tripetala* (2 citations) were observed to be the species responsible for the low consensus in this NTFP category.

Factors influencing household NTFPs collection and use

Statistical analysis with the Chi-square test revealed that household use of NTFPs were not influenced by the variables age (χ^2 = 7.376; p = 0.287), education level (χ^2= 0.777; p = 0.990), religion (χ^2 = 4.913; p = 0.961) and membership to ethnic group (χ^2 = 0.874; p = 0.990).

However, a significant difference difference was observed in use of NTFPs according to household size (χ^2 = 35.223; p = 0.000). Indeed, most (66.60%) of the recorded plant species were recorded for households with size of more than five persons compared to 33.40% for households with size of less than 5 persons. In addition, the average monthly income (χ^2 = 38.153; p = 0.000) had influence on the use of NTFPs. Only 39.74% of species were mentioned by households with high average monthly income more than or equal to

household mean monthly income of USD 58.08 compared to 60.26% of species mentioned by households with a low average monthly income (<USD45.00). In the same way, use or collection of NTFPs was influenced by gender (χ^2 = 17.162; p = 0.009). Majority (63.33%) of the NTFPs were mentioned by women compared to 36.67% of those mentioned by men. Therefore, it was deduced that NTFPs use or collection in the study area varies with household size, average monthly income and gender.

Household procurements of NTFPs

Across all the study sites, the majority of household (69.2 %) [95%CI: 68.50–69.90] indicated that they procure NTFPs through self-collection. Furthermore, in most cases, they had reported that for medicinal, fuelwood, fodder, handicraft, ceremony and construction purposes, NTFPs were frequently procured through self-collection. In this study, ceremonial use represented the NTFP category which was only procured by self-collection in (Figure 4). However, other households (30.80%) [95%CI: 29.77–31.83] affirmed to procure NTFPs by purchasing them from the market or traders selling within the village.

A significant difference was observed with respect to households' procurement of NTFPs per study site (χ^2 = 39.940; p = 0.000). Results showed that most of households in Ayékotonian (94%), Iwessou (90%) and Sanoudji (88%), procured NTFPs mainly through self-collection compared to households in Oko-Igbo (46%) and Efèhountè (42%) that procured NTFPs through purchasing.

Similarity degree of NTFPs plants species used among ethnic groups

Results displayed significant degree of similarity (SSI >0.5) between all the enquired ethnic groups regarding household NTFPs used (Table 4). Nago and Yoruba (SSI = 0.94) were the ethnic groups with high degree of similarity followed by Holli and Nago (SSI = 0.75) ethnic groups. Therefore, households across the different ethnic groups valued approximately the same important plant species in each NTFPs category.

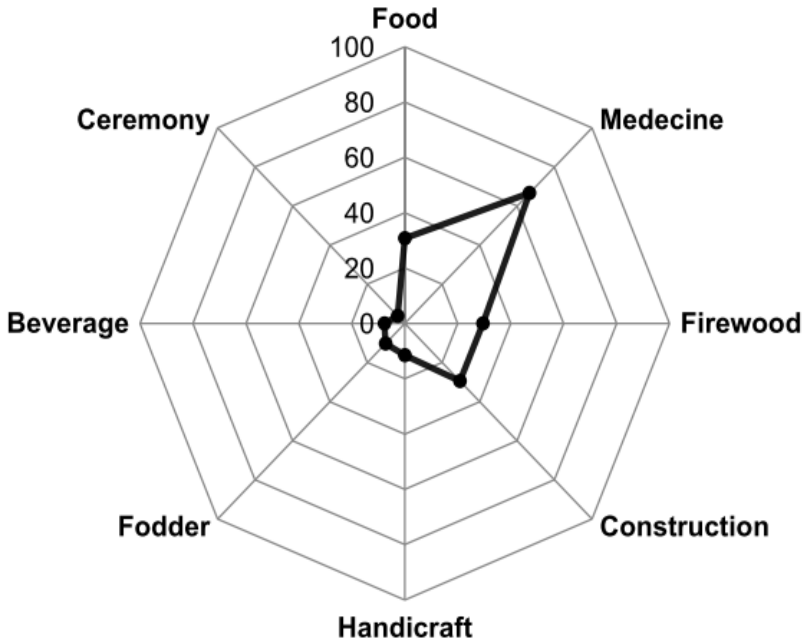

Figure 2: Respondents' involvement (%) in different NTFPs collection in the study area.

Table 2: List of NTFPs used among adjacent local communities of the Gazetted Forest of Dogo-Kétou (GF-DK).

Famillies	Species	Local name	Fc	Life form	NTFPs use	Used parts	RFC	CSI
Anacardiaceae	*Mangifera indica* L	Manga[c], Mangoro[a,c,d]	139	T	Fo/Fw/Me/Fd	Bk/Fr/Wo	0.55	13.67
	Anacardium occidentale L	Kajou[a,b,c,d]	128	T	Fo/Co/Be	Bk/Le/Fr/Wo	0.51	11.20
	Spondias mombin L	Votin[b]	121	T	Fo/Me	Fr/Le	0.47	11.24
	Lannea acida A. Rich.	Akounou[a,c,d], Chabi[e]	68	T	Fo/Me	Bk	0.26	0.74
	Lannea barteri (Olïv.) Engl.	Zouzou[b]	61	T	Me/Fw/Co	Bk/Le	0.24	1.32
Annonaceae	*Annona senegalensis* Pers.	Abo[a], Doukoï[e],Yinglo[b]	177	S	Fo/Me	Le/Bk/Fr/Rt	0.70	2.90
	Annona muricata L	Ebo[a]	72	S	Fo/Me	Le/Bk/Fr	0.30	0.75
	Uvaria chamae P. Beauv.	Ahounjou[d], Zoukokoe[b]	77	S	Fo/Fd	Fr	0.30	0.84
	Dennettia tripetala Baker f	Igberi[c]	1	T	Ce	St	0.00	0.01
Arecaceae	*Cocos nucifera* L.	Agontin[b]	87	T	Fo/Be	Fr/Rt	0.34	2.48
	Elaeis guineensis Jacq.	Detin[b], Ekpê[a,d], Okpè[c]	182	T	Fo/Fw/Be	Fr/Le/Wo	0.72	33.81
Asclepidaceae	*Calotropis procera* (Aiton) W.T.Aiton	Kpamon[a,c,d] Badabi[e]	85	S	Me	Le	0.33	1.86
Asteraceae	*Vernonia amygdalina* Delile	Alloma[b], Alouba[a,c], Ewouro[a,c]	181	S	Fo/Me	Le	0.72	15.82
	Tridax procumbens L.	Folo[b]	33	H	Me	Le	0.14	0.72
	Chromolaena odorata (L.) R. M. King	Agatou[a,b,c,d]	22	H	Me	Le	0.09	0.48
Bignoniaceae	*Stereospermum kunthianum* Cham.	Adjadin[a]	18	T	Me/Fw	Le/St/Wo	0.07	0.78
	Newbouldia laevis (P.Beauv.) Seemann ex Bureau,	Kpatin[b], Désrégué[b], akoko[c,d]	3	S	Ce	Bk	0.01	0.06

Bombacaceae	*Adansonia digitata* L	Kpassatin[b], Boki[e]	127	T	Fo/Be	Le/Fr	0.50	2.43
	Ceiba pentandra (L.) Gaertn.	Araba[a], guedehounsou[b]	84	T	Hc	Wo	0.33	4.13
Caricaceae	*Carica papaya* L	Aguidi[c,d], Ibakpè[a], Kpintin[b]	69		Fo/Me	Fr	0.27	69
Cesalpiniaceae	*Afzelia africana* Sm.	Kpakpa guidé[b], Akpa[a,c,d], Kaohi[e]	179	T	Co/Hc/Fd	Le/Wo	0.71	11.74
	Senna siamea (Lam.) H.S.Irwin & Barneby	Akassia[b], Kassia[a,c,d]	122	T	Me/Fw/Co	Le/Rt/Bk	0.48	6.67
	Burkea africana Hook.	Adjassikakê[b], Atakpa[a]	104	T	Fw/Me/Co	Fr/Wo	0.41	1.14
	Tamarindus indica L.	Diami[e], Djêvitin[b]	128	T	Me/Fo/Be	Fr/Wo	0.51	3.38
	Daniellia oliveri (Rolfe) Hutch. & Dalziel	Igi iya[a,c,d], Iya[a,c,d], Zatin[b]	99	T	Co/Hc/Fd	Le/Wo	0.39	4.33
	Isoberlinia doka Craib & Stapf,	Babo[a,c,d]	97	T	Fw/Co	Wo	0.38	2.65
	lsoberlinia tomentosa (Harms) Craib & Stapf	Babo rlinia[a,c,d] , Kpakpa lolo[b]	88	T	Fw/Co	Wo	0.35	2.40
	Detarium microcarpum Guill. & Perr.	Kponglozio[b]	57	S	Fw	Wo	0.22	1.25
	Piliostigma thonningii (Schumach.) Milne-Redh	Abafè[d], Barkehi[e]	33	S	Fw	Bk/Wo	0.13	0.72
Combretaceae	*Anogeissus leiocarpus* (DC.) Guill. & Perr	Ayin[a], Hlinhon[b], Karki[e]	77	T	Fw/Co	Le/Bk/Wo	0.30	1.26
	Terminalia superba Engl. & Diels	Azinii[b], idigbo/afan[a,c,d]	64	T	Co	Wo	0.25	1.40
	Combretum collinum Fresen.	Ayahoui[b]	55	S	Fw	Le/Wo	0.22	1.16
	Terminalia glaucescens Planch.ex Benth.	Allotoun[b], Idi ordan[a,d]	33	T	Me/Co	Bk/Wo	0.13	1.44

Commelinaceae	*Commelina diffusa* Burm. f.	Hanwi hanwi[b]	11	H	Me	Le	0.04	0.24
Curcubitaceae	*Luffa acutangula* (L.) Roxb	Roko[a]	11	C	Me/Hc/Co	Le/Wo	0.04	0.26
Ebenaceae	*Diospyros mespiliformis* Hochst. ex A. DC.	Kinwi[b], Oodou[a]	65	T	Fo/Me/Fw/Co	Fr/Wo	0.25	3.58
Euphorbiaceae	*Bridelia ferruginea* Benth	Honsoukokoé[b], Acha[c,d]	83	S	Me	Le/Bk	0.33	1.81
	Flueggea virosa (Roxb. ex Willd.) Voig	Hétré[b]	63	S	Me	Fl	0.24	1.37
	Hymenocardia acida Tul	Sotivê[b]	47	S	Me	Bk/Wo	0.18	1.03
	Jatropha curcas L	Botouyê[c,d]	37	S	Me	Le	0.14	0.40
	Croton lobatus L.	Iwelé[a]	9	H	Me	Fr	0.03	0/05
Fabaceae	*Pterocarpus erinaceus* Poir.	Agbannaï[e]o Kozo[b], Akpékpé[a]	179	T	Me/Fw/Co/Hc/Fd	Le/Bk/Wo	0.71	19.56
	Pericopsis laxiflora (Benth. ex Baker) Meeuwen	Sedon[b]	13	S	Fw	Wo	0.05	0.28
	Tephrosia vogelii Hook.f.	Igou[c,d], Igoun[c,d]	13	H	Me	Le	0.05	0.28
Loganiaceae	*Anthocleista vogelii* Planch	Dagbatin[b]	17	T	Fw	Le/Wo	0.07	0.37
	Usteria guineensis Willd	Akporo[a]	11	S	Me	Le	0.04	0.06
Malvaceae	*Sida acuta* Burm. f. ssp. carpinifolia (L.f.) Borss.Waalk	Alê ordana[,a,c,d]	37	H	Me	Le	0.14	0.81
Melastomataceae	*Dissotis fruticosa* (Brenan) Brenan & Keay	Aakpo[a]	22	T	Fw	Bk	0.08	0.48
Meliaceae	*Khaya senegalensis* (Desr.) A.Juss.	Aganwo[d],Aguinho[c], Dalehi[e]	183	T	Me/Co/Fd/Hc	Le/Bk	0.73	17.50
	Azadirachta indica A.Juss	Kininin[a], Kininou[b]	93	T	Me/Fw/Co	Le/St/Wo	0.36	2.54
	Pseudocedrela kotschyi	Dokpé[b], Emè[a]	7	T	Me/Co	Bk/Wo	0.03	0.19

	(Schweinf.) Harms							
Mimosaceae	*Parkia biglobosa* (Jacq.) R.Br.ex Benth.	Ahouatin[b], Chami[e], Orgba[c,d]	151	T	Fo/Me	Fr/Wo	0.60	21.45
	Prosopis africana (Guill. & Perr.) Taub	Akakanyi[a,c,d], Kakê[b]	127	T	Fw/Co	Fr/Bk	0.50	1.21
	Entada africana GuilI. & Perr.	Yêyihouètin[b]	88	T	Me	Bk	0.35	2.78
Moraceae	*Antiaris toxicaria* Lesch. ssp. Welwitschii (Engl.) C.C.Berg	Ooro[a]	53	T	Co/Hc	Wo	0.21	1.16
	Ficus umbellata Vahl	Ereré[c,d]	39	T	Me/Fd	Le	0.15	0.85
	Milicia excelsa (Welw.) C.C.Berg	Iroko[a,c,d]	26	T	Me/Co/Hc	Le/Wo	0.10	0.57
	Ficus sur Forssk.	Okpoto[a]	9	T	Me	Bk	0.06	0.05
Ochnaceae	*Lophira lanceolata* Tiegh. ex Keay	Egui agbarajou[a]	41	T	Fo	Le/Wo	0.16	0.22
Opiliaceae	*Opilia amentacea* Roxb	Yinya[b]	21	C	Me	Le	0.08	0.50
Poaceae	*Panicum maximum* Jaeq.	Igbè[a,c d]	19	H	Fd	Wo	0.07	0.42
Rubiaceae	*Sarcocephalus latifolius* (Sm.) E.A.Bruce	Bakouré[e], Igbesso[a]	178	S	Me	Rt	0.71	4.0
	Gardenia ternifolia Schumach. & Thonn. ssp. ternifolia	Awo bala[a], Dakplatin[b], Ewé gbayan[c]	73	S	Me	Le	0.29	1.60
	Gardenia erubescens Stapf & Hutch.	Anoui[a], wouobalé[c,d], Dakplatin assou[b]	39	S	Me	Le	0.15	0.85
	Mitragyna inermis (Willd.)	Aïkpon[a]	29	T	Me	Le/Bk	0.11	0.63

	Kuntze							
Rutaceae	*Citrus sinensis* Osbeck	Ossan[a,c,d]	136	S	Fo/Be	Fr	0.54	7.43
	Xylopia aethiopica (Dunal) A.Rich.	Ero[a]	127	T	Fw/Co	Fr/Bk/Wo	0.50	11.10
	Zanthoxylum zanthoxyloïdes (Lam.) Zepernick & Timler	Ata[c], Hêtin[b], Itanan[a]	93	S	Me	Rt	0.36	4.06
Sapindaceae	*Blighia sapida* König	Egui ichin[a,c,d], Lissêtin[b]	172	T	Fo/Me	Fr	0.68	3.75
	Aphania senegalensis (Juss. ex Poir.) Radlk	Oro[a]	17	S	Fo	Fr	0.07	0.37
Sapotaceae	*Vitellaria paradoxa* C.F.Gaertn. ssp. paradoxa	Emi[a,c], Emi guidi[a]	99	T	Fo/Me	Fr/Bk	0.39	4.32
Sterculiaceae	*Cola gigantea* A.Chev. var. gigantea,	Akporou/Akpowou[a,c,d]	52	T	Fw	Bk	0.20	0.28
	Sterculia tragacantha Lindl	Tossolo[b]	13	T	Fo/Hc	Wo	0.05	0.57
	Cola nitida (Vent.) Sebott & EndI.,	Gbanja, Golo[b]	2	T	Ce	Fr	0.01	0.01
Verbenaceae	*Tectona grandis* L.f.	Tètitin[b], tèki[a,c,d]	129	T	Co/Fw	Le/Wo	0.51	7.05
	Gmelina arborea Roxb	Fofitin[b], Malaïnan[a]	71	T	Fw/Co	Le/Wo	0.27	2.33
	Vitex doniana Sweet	Ewe owi[c], Fontin[b], Ori[a]	172	T	Fo	Le/Fr	0.68	3.75
Vitaceae	*Cissus populnea* Guill. & Perr.	Assankan[b], Barguigui[e]	9	C	Fo/Be	Fr/Wp/St	0.03	0.20

Legend: [a] = Holli language, [b] = Fon language, [c] = Yoruba language, [d] = Nago language, [e] = Peulh language, T= Tree, S= Shrub, H = Herb; Fo = Food, Fw = Firewood, Me = Medicinal, Co = Construction, Ce= Ceremony, Fd = Fodder, Hc=Handicraft; Be= Beverage, Bk = Bark, Le = Leaves, Fl= Flower, Fr = Fruit, St = Steams, Rt = Roots, Wo=Wood, RFC = Relative frequency of citation, CSI = Cultural significance index, NTFPs= Non-Timber Forest Products.

Table 3: Informant proportion (%) using NTFP per surveyed villages.

NTFPs categories	Studied villages difference									
	Efèhountè (n = 41)	**Iwessou (n = 36)**	**Ayékotonian (n = 31)**	**Manoukodji (n = 28)**	**Agbedo (n = 23)**	**Awaya (n = 33)**	**Sanoudji (n = 19)**	**Oko-Igbo (n = 21**	**Monsoukagbé (n = 22)**	**Mean ± SD**
Food	95.0	100.0	94.0	96.0	100.0	100.0	89.0	86.0	82.0	94.0 ± 7.0
Medicinal	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0 ± 0.0
Firewood	100.0	100.0	100.0	96.0	96.0	100.0	100.0	81.0	82.0	95.0 ± 8.0
Construction	68.0	89.0	97.0	89.0	74.0	64.0	68.0	38.0	27.0	68.0 ± 23.0
Handicraft	27.0	29.0	35.0	57.0	30.0	21.0	16.0	24.0	14.0	28.0 ± 13.0
Fodder	46.0	29.0	61.0	39.0	35.0	21.0	16.0	24.0	27.0	33.0 ± 14.0
Beverage	27.0	33.0	26.0	11.0	35.0	18.0	5.0	10.0	18.0	20.0 ± 11.0
Ceremony	2.0	0.0	3.0	4.0	0.0	3.0	0.0	0.0	4.0	2.0 ± 2.0

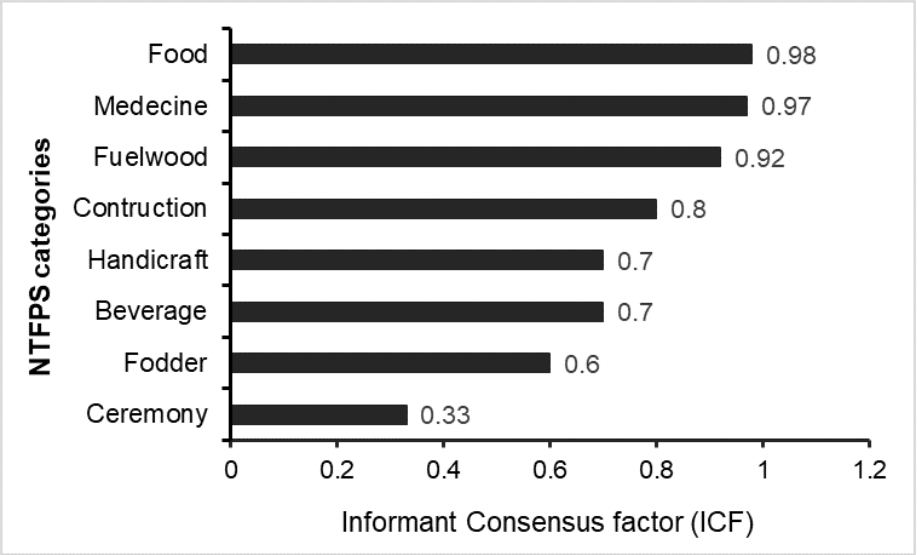

Figure 3: Informants consensus on NTFPs used.

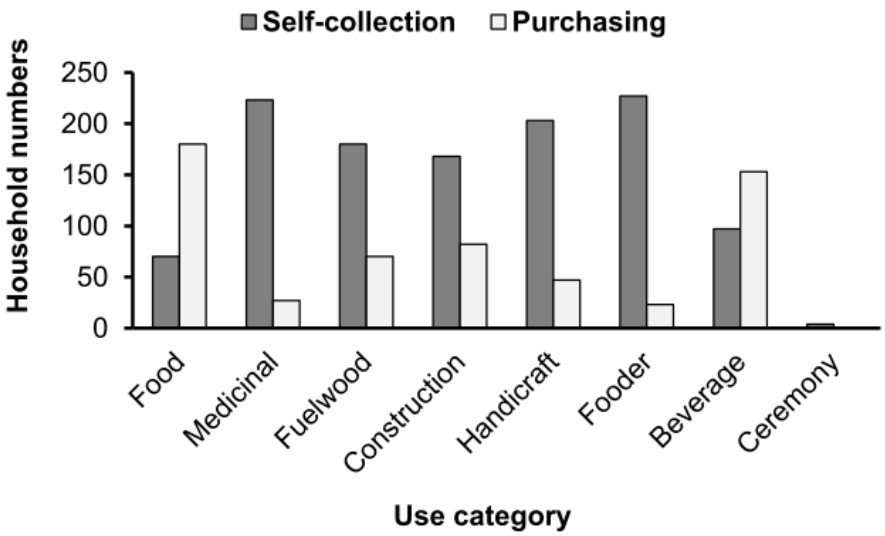

Figure 4: Household procurements of NTFPs per use category.

Table 4: Household NTFPs used between ethnic groups.

Ethnic groups	Fon	Holli	Nago	Yoruba	Peulh
Fon		0.65	0.59	0.53	0.52
Holli			0.75	0.66	0.51
Nago				0.94	0.59
Yoruba					0.52
Peuhl					

DISCUSSION

Households NTFPs utilisation

This study reported 78 species are useful in the study area of which the majority (n = 52 species) were used for medicinal purpose followed by food use (n = 24 species). Consequently, household dependence on GF-DK was higher for medicinal followed by food needs. This result showed that forest resources like NTFPs are the primarily source of health care and subsistence in developing world especially in forest dwellers (Olsen, 2005; Betti et al., 2011; Ahossou et al., 2017; Kafoutchoni et al., 2018). In this study, only 1.6% of the households mentioned the category of ceremonial use. Furthermore, few species (3 species) were cited in this category. This might be explained by the fact that in Sub-Saharan Africa as well as others developing parts of the world, knowledge of many species used for ceremonial or ritual purposes is often held by relatively few people such as traditional healers. Similar observation was made by Vodouhê et al. (2010) in Pendjari Biosphere Reserve dwellers in northern Benin. In their study, authors found that people listed species used as medicine and food earlier and more frequently than other use categories like ceremonial use. Since a large part of the household depend on NTFPs to sustain their livelihood, it could be valuable to integrate NTFPs in the forest management strategies. This might help to increase their involvement in the forest protection. It is well known that if local communities draw substantial benefits, they will engage themselves in forest conservation (Vodouhê, et al., 2010). In view of this, many species emerged as important to be promoted in the GF-DK forest management. The promotion of the species should consider the multiple needs of the local communities and not only focus on timber species plantation as it is currently done by forests managers.

Household consensus, local and cultural importance of NTFPs

In this study, high household consensus on NTFP use was recorded for the categories related to food, medicinal and fuelwood use. Such results may indicate that there is a well-defined plant selection criterion for these use categories among households (Srithi et al., 2009; Yetein et al., 2013). On the other hand, low household consensus on NTFPs was recorded for the category of ceremonial use. Low value of ICF indicates the disagreement of selection of taxa between informants for this category (Ragupathy et al., 2008; Xavier et al., 2014). In others words, such a value could explain that species are chosen randomly or there is no exchange of information about their use among households (Srithi et al., 2009; Yetein et al., 2013). In similar work, Kafoutchoni et al. (2018) found in their study led in Soudano-Guinean zone of Benin that informants presented high agreement regarding the use of wild spices in food use category (ICF = 0.98, with 434 use reports for 10 plant species) followed by medicinal use (ICF = 0.96, 304 use reports, 14 species); and least agreement was also found between respondents for wild spices use for ceremony purpose (ICF = 0.72, with 26 use reports, 8 species).

The species having the highest relative frequency of citation (RFC$\geq$0.5) constitute those that are the most important for local communities in the study area (Signorini et al., 2009). About 22% of the total recorded plant species were of high relative frequency of citation in this study. The most mentioned species in all study villages are also those with the highest cultural significant index (CSI) value. Such results displayed that local communities in the study area might have a common cultural background. It can be viewed that many of the species were locally and culturally important. The importance of NTFPs preservation, is therefore, fundamental to the maintenance and continuation of traditional ways of life. Therefore, species such as *Khaya senegalensis, Afzelia africana, Pterocarpus erinaceus, and Tectona grandis* can be promoted as timber species while species such as *Vernonia amygdalina, Blighia sapida, Annona senegalensis, Vitex doniana, Parkia biglobosa, Tamarindus indica, Adansonia digitata* as food species. With

regard to less mentioned species, *Dennettia tripetala* (CSI = 0.01) mentioned for ceremonial use by men only (2 citations recorded) was the species having the lowest cultural significant index. This observation is due to the fact that in Benin, especially in the study area, the species *Dennettia tripetala* is used in the divine traditional ceremony named ''Oro'' (Akoègninou et al., 2006) that is only that is only practiced by men. This suggests that men had more knowledge on this species utilisation in the category of ceremonial use. Likewise, our results found that the rest of the species (*Newbouldia laevis*, *Cola nitida*) for ceremonial use were only mentioned by the men. This suggested that in traditional societies, the role of rite chief or ceremony master is generally devoted to men. Consequently, this makes them more knowledgeable in this use category due to the fact that they were mostly engaged in ceremonial or ritual activities (Kafoutchoni et al., 2018).

Factors influencing NTFPs use or collection

This study showed that NTFPs utilisation may be influenced by household characteristics. Larger households were found to rely more on NTFPs compared to smaller households in the present study. Large families mostly rely on forest resources like NTFPs to increase their income or to meet their basic needs. Similar observations were also recorded in several studies (Fonta and Ayuk, 2013; Adam and El Tayeb, 2014; Mujawamariya and Karimov, 2014; Tugume et al., 2015; Dash and Behera, 2016, Sulieman et al., 2017). These studies reported that large households tend to depend more on forest resources to increase their income or to meet their primary needs. Moreover, larger families are more likely to undertake NTFPs collection and utilisation since these activities often are labour-intensive.

Household levels of income showed a positive association with NTFPs use. This suggests that households with higher monthly income are less likely to participate in forest activities such as fuelwood collection and non-timber forest products than those with limited income opportunities (Vedeld et al., 2007; Bhandari and Jianhua, 2017; Zhu et al., 2017).

Distance of households from forests is an important indicator of the communities' potential to depend on forest resources. Our study revealed that distance between the forest and study villages had a significant effect on households' collection and use of NTFPs. The more distant the forest is, the less likely are households to engage in NTFPs collection and use. Similar observation was made by several studies (Mujawamariya and Karimov, 2014; Zhu et al., 2017; Sulieman et al., 2017) who reported in their study that household's engagement in NTFPs business was influenced by the distance between the forest resource and home. This suggests that the development of activities to enhance the income of communities close to the forest can help to lessen pressure on the forest resources.

Conclusion

This research suggests that local communities adjacent to the GF-DK are highly reliant on forest products like NTFPs for their livelihood support. The findings showed that NTFPs play a critical role in rural livelihoods. Households' socio-demographic characteristics such as gender, households' size, monthly income and the distance between the forest to the households' home were found to be significant factors in the collection and use of NTFPs in this study. In addition, local communities have a significant consensus on the use of the most locally and culturally important species for a wide range of NTFP use categories. This finding suggests the maintenance and growing of the most used species in the communities and community forests around villages in order to reduce pressure on these species in natural forest. In other words, there was a need to take into account of these NTFPs in the management and conservation strategies in the study area. The results of this research could provide policy-makers a decision support tool for a participatory forest management for maintenance and continuity of traditional ways of life.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to the realization of this work and to the preparation of the manuscript.

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