

# Methodological priorities in assessing wild edible plant knowledge and use – a case study among the Baka in Cameroon.

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2 **Running title:** Assessing wild edible plants knowledge

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7

8 **Keywords:** Ethnobotany, Hunter-gatherers, Freelisting, Dietary Recall, Walk-in-the-woods, Wild  
9 food plants.

## 10 **Abstract**

11 Freelisting and dietary recalls are frequently used methods in ethnobotany to assess wild edible plant  
12 (WEP) knowledge and use. Though these *ex-situ* interviewing methods are practical to perform and  
13 may yield large datasets in a short time, they are known to be limited by the informant's memory and  
14 cognitive bias. Alternatively, the much more laborious walk-in-the-woods method may be used, in  
15 which informants point out edible plants *in-situ*. Few studies, however, examine quantitatively how  
16 these different methods influence results. In this study, we assessed how these methods capture the  
17 diversity of wild edible plant knowledge and use among the Baka, a group of forager-horticulturalists  
18 from southeastern Cameroon. We show that within a single population, and when data on  
19 consumption frequency are collected simultaneously, the walk-in-the-woods method results in more  
20 detailed information of WEP knowledge and use than do freelisting or dietary recalls. Our *in-situ*  
21 method yielded 91 species of WEP, much more than the *ex-situ* methods of freelisting (34 spp.) and  
22 dietary recalls (12 spp.). Our results imply that previous studies based only on *ex situ* surveys may  
23 have underestimated the importance of WEP for local communities. We propose that future studies  
24 on WEP knowledge and use frequency should rely on mixed methods, taking an *in-situ* method as the  
25 starting point of their approach.

## 26 **Introduction**

27 The value of local ecological knowledge in informing conservation and environmental management  
28 is well established (Chazdon et al., 2009; Pandey & Tripathi, 2017; Pardo-de-Santayana & Macia,  
29 2015). Local knowledge on useful plants may be especially valuable in this regard (Cummings &  
30 Read, 2016). For example, in an ethnobotanical study in Rio Formoso, Northeastern Brazil, Da  
31 Cunha and De Albuquerque (2006) found that the main product harvested from over half of the  
32 useful plant species was wood, indicating the need for conservation initiatives to provide an  
33 alternative for this source of fuel and construction material. Additionally, ecological knowledge is

34 also crucial for local people, especially those who intimately depend on their surrounding natural  
35 resources for their subsistence and who have developed through generations a substantial expertise  
36 on the use of wild plants and animals for food, shelter and medicine (Reyes-García, 2015). However,  
37 the access and availability of natural resources central for dietary diversity and food security of these  
38 societies are challenged by natural resources exploitation, such as mining and selective logging,  
39 commercial harvesting and hunting, especially in areas where the biodiversity is high such as tropical  
40 rainforests (Baudron et al., 2019; Wasseige et al., 2012). These pressures on local resources has led to  
41 a decrease in local people access to the important wild plants and game that contribute to their diet  
42 and medicine (Rist et al., 2012). Therefore, considering the different potential conflict of use among  
43 wild resources, accurate assessments of the use of wild plants are necessary in order to evaluate the  
44 effects of overall global changes affecting both biodiversity and local livelihoods.

45 Local knowledge and use of plants are assessed through different ethnobotanical methods, of which  
46 the interview is the most widely used. Different interview methods are deployed based on the  
47 research question addressed and vary considerably between studies (Thomas et al., 2007). Freelisting  
48 is a frequently-used method, in which informants are asked to list all items they know within a given  
49 category (Martin, 2010). This technique reveals cultural salience and variations in individuals'  
50 topical knowledge (Quinlan, 2005), and results in a shortlist of highly valued plants (Ghorbani et al.,  
51 2012; Mengistu & Hager, 2008). As freelisting allows the collection of data from a large number of  
52 informants in a limited amount of time (De Sousa et al., 2016), this method is frequently used as a  
53 starting point for studying traditional plant knowledge. Plants listed during the interviews are  
54 collected and identified afterwards. The resulting dataset is then used to draw conclusions about plant  
55 knowledge of a certain group of people and/or the potential contribution of wild plants to their diet  
56 (Fongnzossie et al., 2020; Mengistu & Hager, 2009; Termote et al., 2011). Organizing field trips to  
57 collect herbarium specimens of species mentioned during freelisting exercises is often (inaccurately)  
58 called the 'walk-in-the-wood method' (Lulekal et al., 2013; Termote et al., 2011). However, this  
59 technique, first coined by Phillips and Gentry (1993), implies that participants are encouraged to  
60 actively lead field trips and point out all useful plants they know and/or use (Thomas et al., 2007),  
61 instead of only searching for specimens that appear on the list of local names derived from  
62 interviews.

63 Data elicited from freelisting appear to be specific to the context in which they were collected (e.g.,  
64 in the village), creating an unintended but significant bias in this type of ethnobotanical research (De  
65 Sousa et al., 2016; Martin, 2010; Paniagua Zambrana et al., 2018). Gathering the data *ex-situ* (away  
66 from the ecological context in which people collect their plants) may result in lists of only the most  
67 salient plant species. Furthermore, the success of freelisting depends on the informants' correct  
68 understanding of the category or cultural domain (e.g., wild food plants) under discussion (Da Cunha  
69 & De Albuquerque, 2006; Quinlan, 2005; Quiroz et al., 2016; Gallois et al. 2020).

70 In societies that undergo rapid socio-economic changes, people become more integrated into the  
71 market economy, change their lifestyle and adopt cultivated or processed substitutes for wild plants  
72 in their diet (Kuhnlein, 2009). This creates a gap between people's ethnobotanical knowledge and  
73 their actual use of plants (De Albuquerque, 2006; Reyes-García et al., 2005). A discrepancy between  
74 the number of useful species known and those actually used indicates that elders who still know how  
75 plants were used in the past do not practice this any longer, and infrequently transfer their skills to  
76 the next generation (Reyes-García et al., 2005). Freelistig exercises often focus on peoples  
77 knowledge (Reyes-García et al., 2005) while recall surveys, developed by social anthropologists for  
78 understanding time allocation (Gross, 1984), lead informants to enumerate what they have done  
79 during a specific period of time. Recently, recall surveys were introduced in ethnobotanical approach

80 to assess local uses of plants. For instance, dietary recall surveys have been developed to estimate the  
81 proportion of different food items in people's diet (e.g., Munger et al. (1992); Friant et al. (2019);  
82 Reyes-García et al. (2019)), while income recall survey have been used for assessing the contribution  
83 of the sale of different forest products in local livelihood (see for instance Levang et al., (2015)).  
84 Although many studies reported a high diversity of wild edible plant species worldwide (Bharucha &  
85 Pretty, 2010; Delang, 2006), research relying on dietary recalls has also resulted in surprisingly low  
86 numbers of wild species actually being consumed (do Nascimento et al., 2013; Ogle, 2001).

87 In the highly biodiverse context of the Central African Congo Basin, a wide variety of wild edible  
88 plant species has been reported by Bantu-speaking farmers (Ingram & Schure, 2010; Termote et al.,  
89 2011; van Dijk, 1999) but especially among hunter-gatherers that infrequently practice agriculture  
90 (Bahuchet, 1992; Dounias, 1993; Ingram & Schure, 2010; Terashima & Ichikawa, 2003; Yasuoka,  
91 2012). Dietary recalls carried out in the Democratic Republic of the Congo, however, showed that  
92 wild plants did not contribute substantially to rural and urban women diets (Termote et al., 2012).  
93 Likewise, dietary recalls held among the Baka people in Cameroon resulted in only 15 wild edible  
94 species being reported (Gallois et al., 2020), which is in stark contrast to the extensive wild plant  
95 knowledge reported earlier by Bahuchet (1992) and Dounias (1993) for the same ethnic group. Like  
96 freelisting, dietary recalls are limited by the subject's memory (Grandjean, 2012) and may therefore  
97 underreport plant use. In this study, we explore how different ethnobotanical methods capture the  
98 diversity of wild edible plant knowledge and use among a community of Baka forager-  
99 horticulturalists in southeastern Cameroon. We aimed to answer the following questions:

100 1) Which wild edible plant species (WEP) are reported by the Baka during freelisting, dietary recalls,  
101 income recalls, and walk-in-the-woods methods?

102 2) How do the results differ between these methods?

103 3) What are the general characteristics of the WEP known and consumed by the Baka?

104 4) How do conclusions based on the results obtained by the four methods differ in terms of the  
105 potential conflicts in use among local consumption, logging, and trade?

106 We hypothesized that walk-in-the-woods would result in a larger number of plant species than the  
107 other three methods, but that all four methods would identify the species most frequently consumed  
108 by our informants. We also predicted that the list of plants given through freelisting, and dietary and  
109 income recalls would underestimate the potential conflicts in use of edible plants.

110

## 111 **Methods**

### 112 Study site

113 Data were collected around the villages of Le Bosquet (3°07'38''N13°52'57''E) and Kungu  
114 (3°02'40"N 14°06'57"E), located in the Haut Nyong division, southeastern Cameroon. The  
115 communities are located at least eight hours by car from the capital Yaoundé, of which four hours are  
116 on unpaved logging roads. The accessibility of this area highly depends on the weather, as the road  
117 quickly deteriorates during the rainy season. The area is covered by a mixture of evergreen and moist  
118 semi-deciduous forest within altitudinal ranges of 300–600 m. (Letouzey, 1985). In populated areas,  
119 the forest cover is largely removed in favor of settlements, cocoa plantations, logging activities and

120 small-scale agriculture. This creates a mosaic of dense primary forest, selectively logged primary  
121 forest, secondary forest and agricultural fields, interspersed with trails. The climate of the region is  
122 tropical humid, with a major rainy season between late-August and late-November and a major dry  
123 season between late-November and mid-March. The annual precipitation reaches about 1500 mm and  
124 the average temperature is 25°C (Leclerc, 2012).

125 The area is populated by two main ethnic groups: the Nzimé, Bantu-speaking farmers, and the Baka,  
126 Ubangian-speaking forager-horticulturalists. Until roughly 50 years ago, the Baka were nomadic  
127 foragers, relying on hunting, fishing, gathering, and the exchange of non-timber forest products  
128 against agricultural crops with their farming neighbors. Since the 1960s, the Baka have been facing  
129 several changes in their livelihood. Due to a government program of sedentarization (Leclerc, 2012),  
130 they have progressively left their forest camps and settled in villages along the logging roads.  
131 Nowadays, their livelihood is mostly based on the combination of foraging activities, agricultural  
132 work in their own fields and wage labor for the Nzimé or for logging companies (Gallois et al.,  
133 2020).

134

### 135 Data collection

136 We used a combination of four different datasets, obtained from freelisting, dietary recalls, income  
137 recalls, and ethnobotanical field surveys. Data collection took place in both villages in three different  
138 fieldwork periods: February-March 2018 (major dry season), October-November 2018 (major rainy  
139 season), and April-May 2019 (minor dry season) to cover variations in wild fruit availability. The  
140 freelisting data were gathered during the first fieldwork period, income recall data during the two  
141 first fieldwork periods, and dietary recall data during all three fieldwork periods. The walk-in-the-  
142 wood surveys were carried out during the last fieldwork period. Before data collection, Free Prior and  
143 Informed Consent was obtained from all participants. This study adheres to the Code of Ethics of the  
144 International Society of Ethnobiology (2006), received approval from the ethics committee of  
145 Leipzig University (196-16/ek), and the Ethical Committee from the Ministry of Health of Cameroon  
146 (n°2018/06/1049/CE/CNERSH/SP).

147

148 We conducted freelisting exercises among 55 Baka individuals of 18 years and older (24 men and  
149 31 women), during which we asked our interviewees to report all wild edible plants they knew  
150 (Gallois et al., 2020). We gathered data on the importance of wild plants in Baka diet by conducting a  
151 dietary recall protocol that was adapted from the FAO Guidelines for Assessing Dietary Diversity  
152 (Kennedy et al., 2011). Informants were asked to list all items they had consumed within the previous  
153 24 hours, and to mention the origin of each food item (from the wild, from agricultural fields or  
154 bought at the market). A total of 143 dietary recall interviews were conducted among 83 informants  
155 (35 men and 48 women): 42 individuals were interviewed once, 22 twice and 11 three times. Finally,  
156 we also collected data on wild edible species that were traded as timber and as non-timber forest  
157 products. We conducted a 14-day recall survey on the income received through sale, asking our  
158 interviewees to list all the items they had sold during this time period. A total of 114 interviews were  
159 conducted over 34 individuals in le Bosquet and 39 in Kungu (in total 43 women and 30 men): 32  
160 were interviewed once and 41 twice.

161 From the local names of wild edible plants mentioned during the different interview methods, we  
162 constructed a preliminary database of species consumed by the Baka, with tentative scientific names

163 from literature on Central African wild food plants (e.g., (Bahuchet, 1992; Betti et al., 2013; Brisson,  
164 2010; Dounias, 1993; Yasuoka, 2012) Finally, for our walk-in-the-woods trips, we asked the  
165 community to suggest several people of different ages and gender that were knowledgeable on wild  
166 edible plants and would agree to join us on our collection trips as informants. We worked with one to  
167 four informants on each collection day. In total, we employed 20 informants (10 women, 10 men,  
168 aged between 29 and 80 years). Nine informants had also participated in the previous *ex-situ*  
169 interviews (dietary and income recalls: 2; free listing: 2; all three methods: 5). During 14 collection  
170 days into the area surrounding Le Bosquet and Kungu we asked our informants to point out any  
171 edible plant they saw. We also searched for the species on our preliminary list of wild food plants.  
172 When a wild edible plant was encountered, herbarium material was collected using standard  
173 botanical methods (Martin, 2010). For most specimens collected, we asked our informants for 1) the  
174 local name in Baka (or French /Nzimé if known); 2) plant part(s) used; 3) preparation and application  
175 methods; 4) when they had last consumed the plant; 5) whether a part of the plant was sold;6)  
176 whether it was commercially logged. To analyze conflicts between commercial timber harvesting and  
177 the availability of wild food plants for the Baka, we documented the local names and we also counted  
178 the number of logged tree trunks along the forest trails and on logging trucks passing through the  
179 village.

180 Duplicates of voucher specimens were deposited at the National Herbarium of Cameroon (YA) and  
181 Naturalis Biodiversity Center (L). A third voucher was used in the study site to discuss local names  
182 and uses with Baka villagers. Plant identification took place at Naturalis, using Central African  
183 herbarium specimens and literature (e.g., Harris & Wortley (2018); Hawthorne & Carel Jongkind  
184 (2006); Hutchinson & Dalziel (1958); Royal Botanic Gardens Kew (1931-1973); MNHN (1963-  
185 2018)). This literature was also used to verify the vegetation types in which these WEP occurred  
186 naturally. For species that were difficult to identify, we consulted botanical experts at Naturalis and  
187 abroad. Scientific names were updated using the portal of Plants of the World Online<sup>1</sup>.

188

## 189 Data analysis

190 In order to assess the differences in results coming from the different methods, we compared the total  
191 number of wild edible species encountered during the walk-in-the-woods, freelisting and dietary  
192 recalls. To assess whether the full potential of the methods had been utilized, species accumulation  
193 curves (Peroni et al., 2014) were produced for each of them by calculating the cumulative number of  
194 species that were reported after a certain amount of collection days (walk-in-the-woods method) and  
195 after interviewing a certain number of informants (freelisting and dietary recalls). Contrary to usual  
196 practice, data were not randomized before producing the curves, as several relevant features of the  
197 data would have been lost. As the income recalls were only used to assess commercialized WEP, a  
198 subset of all wild edible plants, we did not produce a species accumulation curve. To assess the  
199 general characteristics of wild species consumed by the Baka, information on life form, part used,  
200 habitat and commercial timber was categorized in a Microsoft Excel table, after which bar graphs  
201 were produced to show the distribution of these traits.

202 To analyze the actual use of WEP reported during the walk-in-the-wood trips, we first categorized  
203 the information of last consumption for each species according to Gallois et al. (2020) in the  
204 following categories: 1) today/yesterday; 2) within the week, 3) within the month; 4) within the year;

<sup>1</sup> (<http://plantsoftheworldonline.org/>).

205 5) 1-2 years ago; 6) > 2 years ago; and 7) never. A bar chart was produced to visualize the ranking of  
206 the most recently consumed species and comparison of the results of walk-in-the-woods with the  
207 dietary recalls. We also compared the commercialized WEP reported during the income recall  
208 surveys to the plants said to be sold during the forest trips. Finally, we cross-referenced the species  
209 said to be cut for commercial timber and the CITES appendices<sup>2</sup> and IUCN Red List<sup>3</sup> to assess their  
210 current conservation status. Trade names of timber species were identified through vouchers  
211 specimens and the International Tropical Timber Organization's website<sup>4</sup>.

212

## 213 **Results**

### 214 Capturing the diversity of edible plants: comparison between methods

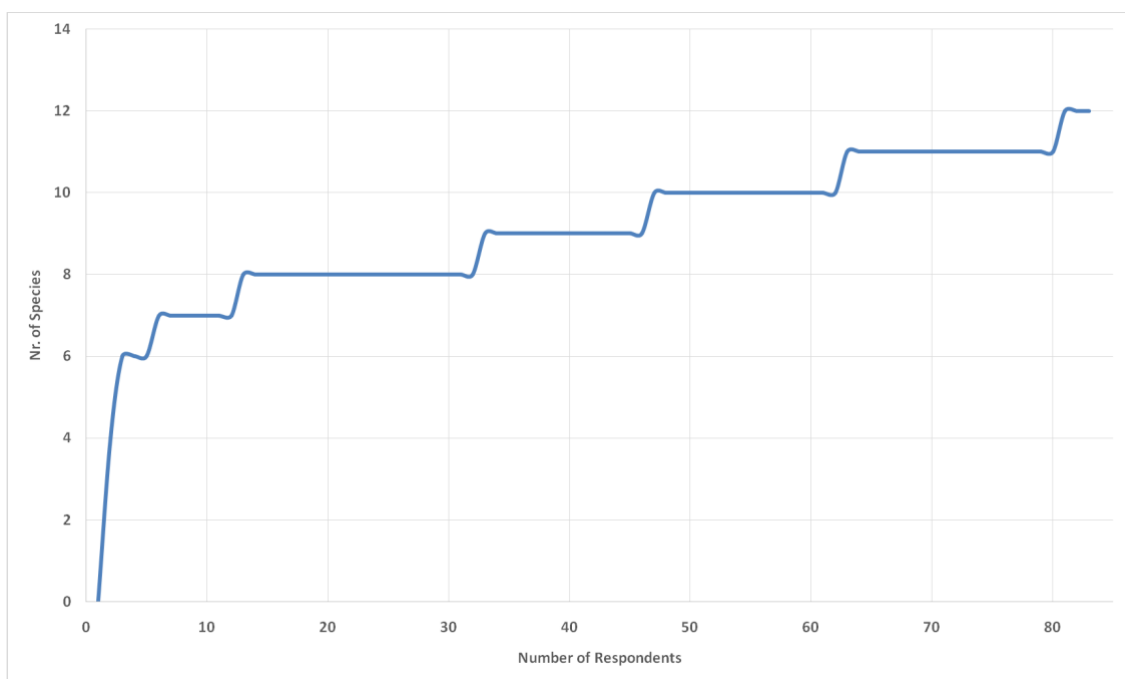
215 The dietary recalls and freelisting resulted in 12 and 38 wild edible plant species respectively.  
216 Initially, 51 local names were identified through freelisting, but 13 of those were later excluded  
217 because they were either synonyms of Baka plant names that had already been mentioned (three  
218 names) or they referred to wild mushrooms (two names), types of honey (six names) or cultivated  
219 plants (two names). Two species that emerged from the dietary recalls (*Amaranthus dubius* Mart. ex  
220 Thell. and *Raphia* sp.) were not found through free listing. During the walk-in-the-woods method, we  
221 collected 94 wild edible plant specimens that corresponded to ca. 91 species, which included all  
222 species mentioned during the dietary recalls and freelisting methods. The exact number of wild edible  
223 species is unclear, as eight vouchers could only be identified at the genus level and for several West-  
224 and Central African *Dioscorea* species (wild yams), the taxonomic species delimitation is not clear  
225 (Magwé-Tindo et al., 2018). Moreover, the Baka recognize different forms within individual yam  
226 species and thus some local names refer to the same botanical taxon. For instance, in the case of *D.*  
227 *minutiflora*, the Baka distinguish three distinct types: "njàkàkà", "bálOkO" and "kuku", all with  
228 different leaf and tuber morphology. All local and scientific names of each wild edible species, used  
229 parts, preparation methods, consumption frequency and the method(s) through which they were  
230 recorded are listed in Supplementary Material.

231 Over the 83 individuals interviewed during dietary recalls, only 69 reported wild edible plants. The  
232 species accumulation curve for the dietary recall method approached the asymptote after interviewing  
233 83 people (Figure 1). Between respondents 46 and 83, only three new species were mentioned, which  
234 suggests that interviewing more respondents would not have led to many more wild edible plant  
235 species being identified. Therefore, the dietary recall appeared to have captured most of the WEP  
236 diversity that was possible with this method.

<sup>2</sup> <https://www.cites.org/eng/app/appendices.php>

<sup>3</sup> <https://www.iucnredlist.org>

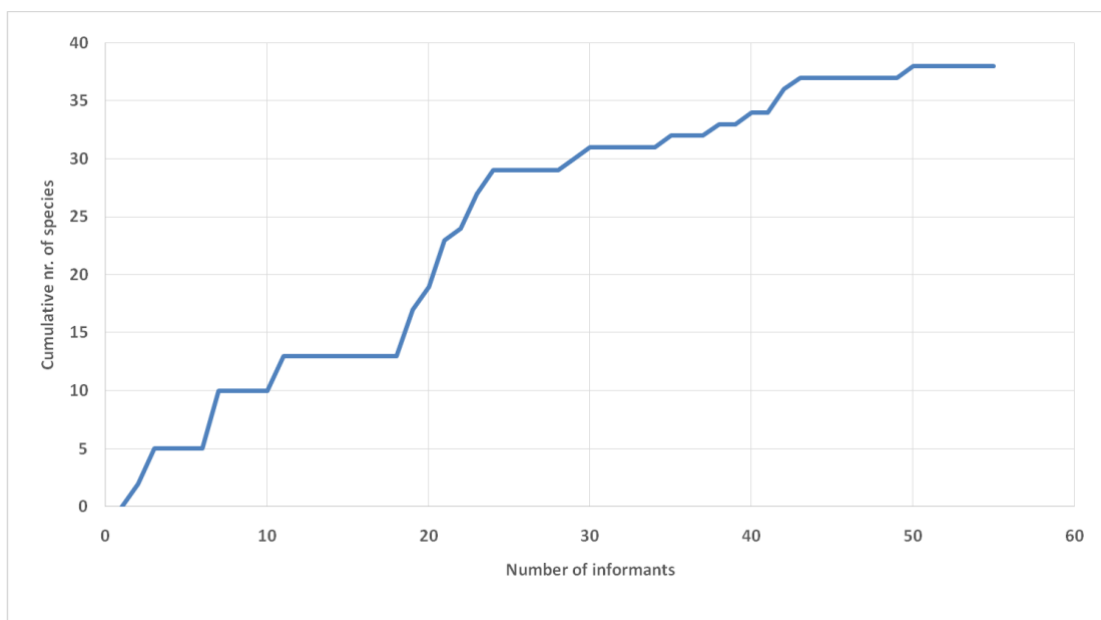
<sup>4</sup> <https://www.itto.int/>



237

238 Figure 1. Species accumulation curve of wild edible plants mentioned during the 83 dietary recalls in  
239 Le Bosquet and Kungu, southeast Cameroon, 2018.

240 The species accumulation curve of the freelisting methods approached the asymptote after  
241 interviewing 55 individuals, with a total of 38 WEP species reported (Figure 2). This indicates this  
242 method also efficiently captured the requested information, at least within its limitations. Typically,  
243 14 of the 55 respondents reported not knowing any wild edible plants, which resulted in several flat  
244 sections in the curve.

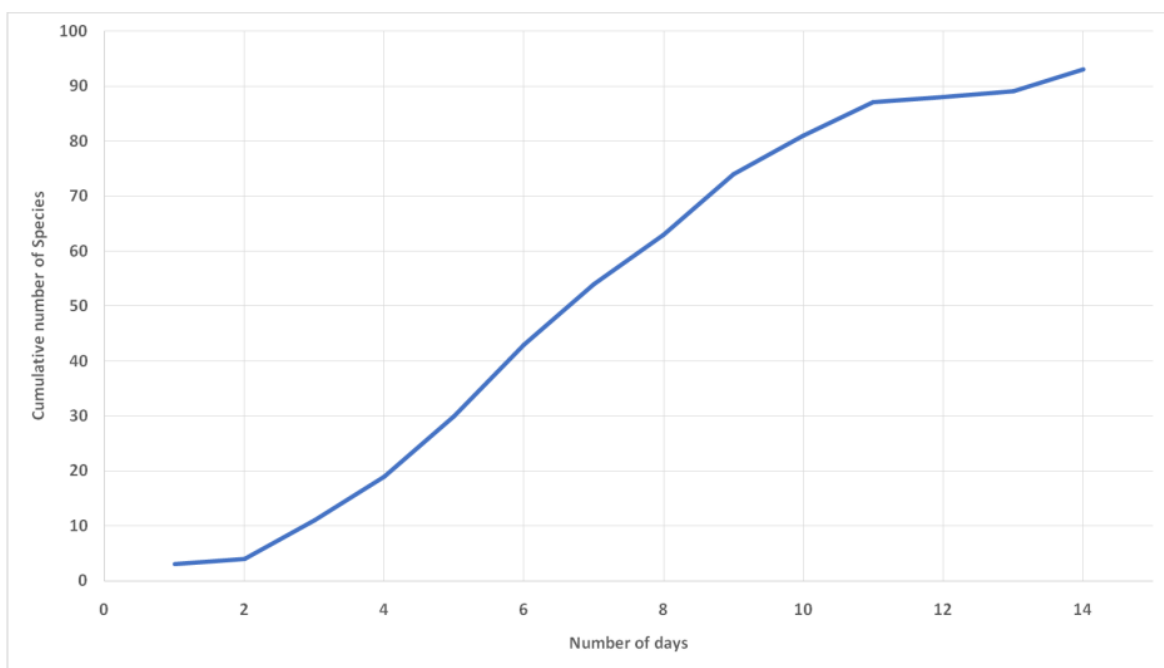


245

246 Figure 2. Species accumulation curve of wild edible plants mentioned during the 55 freelisting  
247 interviews in Le Bosquet and Kungu, southeast Cameroon, 2018.

248 The species accumulation curve for the walk-in-the-woods method flattened somewhat after 11 days,  
249 but not completely (Figure 3). This suggests that more WEP would have been recorded if fieldwork  
250 had continued. Our Baka informants indeed mentioned that there were additional rare species that  
251 could only be found after walking for hours in the forest. We know that at least four other species  
252 could have been found if we had more time to walk further into the forest. From their Baka names  
253 and the literature (Brisson 2010), we assume that these WEP were the African mammee apple  
254 (*Mammea africana* Sabine) with large edible fruits, a species of *Azizelia*, of which the red arils around  
255 the seeds are eaten, a species of *Raphia* palm tree of which the sap is fermented into palm wine, and  
256 the African walnut tree (*Coula edulis* Baill.) that produces highly valued nuts.

257



258

259 Figure 3. Species accumulation curve of wild edible plants mentioned during 14 days of walking in  
260 the forest with 20 informants around Le Bosquet and Kungu, southeast Cameroon, 2019.

261

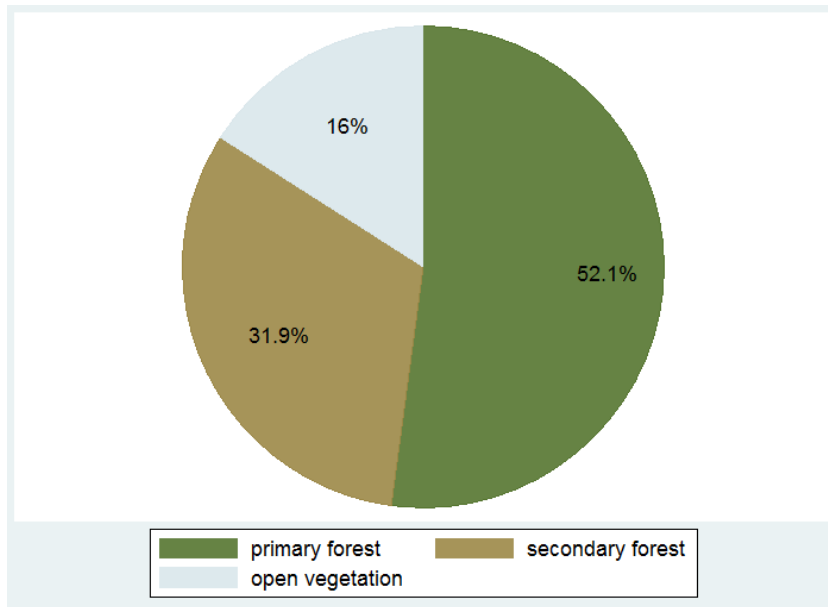
### 262 Species characteristics

263 The 91 wild edible plant species belonged to 43 different plant families, of which the best represented  
264 were Dioscoreaceae (ca. 9 species of wild yams), Irvingiaceae (8 spp.), Anacardiaceae (5 spp.,  
265 including 4 species of *Trichoscypha* fruits) and Zingiberaceae (5 spp. of *Aframomum*).

266 Most wild edible plant species collected by the Baka naturally occur in primary forest (Figure 4). We  
267 encountered very little primary forest that was untouched by loggers: the only patch of forest that did  
268 not show signs of commercial timber harvesting was dominated by *Gilberiodendron dewevrei* (De  
269 Wild.) J. Leonard, located at ca. two hours walking distance from Le Bosquet. The selectively logged  
270 primary forest, however, contained the majority of the fruit and seed producing primary trees and  
271 lianas sought after by the Baka.



## Assessing wild edible plants knowledge



272

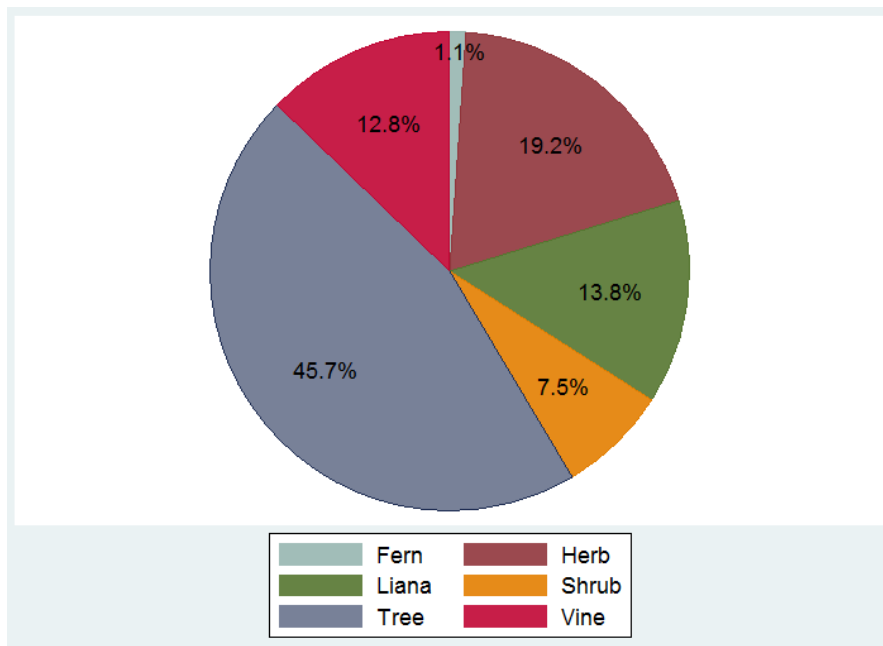
273

274 Figure 4. Distribution of the natural habitats of the wild edible plants (94 taxa) that were reported  
275 through the walk-in-the-woods method.

276

277 Most WEP-producing species were trees, followed by climbers; including both woody lianas and  
278 non-woody vines (Figure 5). Fruits (37%) and seeds (27%) were the most frequently mentioned  
279 edible plant parts, followed by leaves (19%), tubers (12%), bark (5%) and exudate (1%).

280



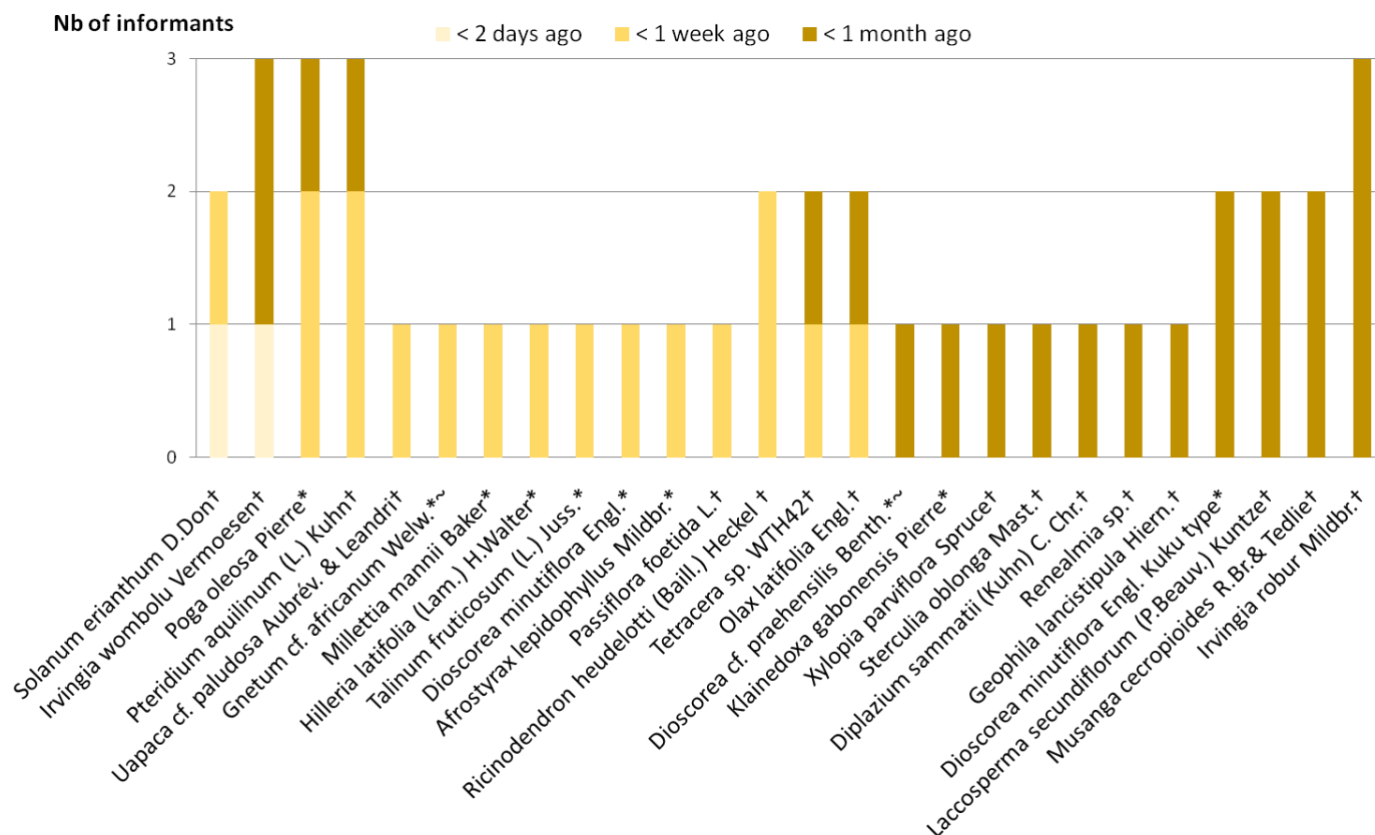
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282 Figure 5. Distribution of the life forms of the species collected (94 species). Data collected through  
283 walk-in-the-woods method.

284 Differences in WEP consumption data according to methodology

285 Of the 82 WEP species for which we had information on last consumption, 26 species were eaten  
 286 within the last month by at least one of our 20 informants participating to the walk-in-the-wood  
 287 expeditions (Figure 6), while 36 species were eaten within the last 12 months, 11 species between  
 288 one and two years ago, eight species more than two years ago and one species was never eaten by  
 289 any of our 20 informants.

290



291

292 Figure 6. Wild edible species that our 20 informants consumed within the past month.

293 \* Species also reported through freelisting; ~ species also reported through dietary recalls, † species  
 294 not reported either in freelisting or dietary recalls.

295

296 Only ten of the 26 species mentioned as recently consumed during the walk-in-the-woods method  
 297 were reported during the freelisting and only three of these species also emerged through the dietary  
 298 recalls, although the number of people interviewed during the last two methods was substantially  
 299 higher. In other words, 23 recently consumed species would not have been identified with dietary  
 300 recalls only, and 16 would have been missed if only the freelisting and dietary recalls would have  
 301 been performed. These 16 species were two edible ferns (*Pteridium aquilinum* (L.) Kuhn and  
 302 *Diplazium sammatii* (Kuhn) C. Chr.); three spices (*Xylopia parviflora* Spruce, *Oxal latifolia* Engl.,  
 303 and *Ricinodendron heudelottii* (Baill.) Heckel); four fruits (*Passiflora foetida* L., *Solanum erianthum*  
 304 D. Don, *Musanga cecropioides* R.Br. ex Tedlie and *Uapaca cf. paludosa* Aubrév. & Leandri); one  
 305 inner stem (*Laccosperma secundiflorum* (P.Beauv.) Kuntze); three seeds (*Sterculia oblonga* Mast.,  
 306 *Irvingia robur* Mildbr. and *I. wombolu* Vermeoesen); one tuber (*Renealmia* sp. WTH64); one

307 drinkable water from the stem (*Tetracera* sp. WTH42) and one edible leaf which was eaten as a luck  
308 charm (*Geophila lancistipula* Hiern) (See Figure 6).

309 The most frequently mentioned WEP during the dietary recall was *Gnetum africanum* Welw., of  
310 which the leaves had the highest consumption during the major dry season, followed by several  
311 species of wild yams (*Dioscorea* spp.) and bush mango kernels (*Irvingia* spp.). Typically, the WEP  
312 most recently consumed by the participants during the forest surveys was the weedy shrub *Solanum*  
313 *erianthum*, of which the bitter fruits were boiled with wild garlic bark (*Afrostryrax lepidophyllus*) and  
314 (cultivated) hot pepper (*Capsicum frutescens*) and taken as a hot drink to wake up in the morning.

315

### 316 Conflicts between wild fruit collection and commercial logging

317 During our forest walks, we identified six WEP of which the wood was observed as logged or said to  
318 be logged by the Baka (see Table 1). Three of these species were considered as vulnerable by the  
319 IUCN but none appeared on the CITES Appendixes I or II (Table 1). If only using ex situ interviews,  
320 we would have missed four species that are eaten by the Baka and also logged. Indeed, only two of  
321 these WEP-producing commercial hardwoods were mentioned in the freelisting interviews  
322 (*Baillonella toxisperma* and *Chrysophyllum lacourtianum*), while only one of them was recorded  
323 through the dietary recalls (*B. toxisperma*).

324 Table 1. Commercial hardwood tree species producing edible fruits and/or seeds consumed by the  
325 Baka, trade names and current conservation status.

326

Scientific name	Baka name	Commercial trade name	Nr. logs observed in 14 days	IUCN status
<i>Baillonella toxisperma</i> Pierre	Mabe	Moabi	9	Vulnerable
<i>Chrysophyllum lacourtianum</i> De Wild.	Bambu	Longhi, Abam		Not evaluated
<i>Diospyros</i> cf. <i>crassiflora</i> Hiern	Lembe	(Gabon) Ebony	2	Vulnerable
<i>Trichoscypha</i> cf. <i>abut</i> Engl. & Brehmer	Agbo	-		Least concern
<i>Desbordesia insignis</i> Pierre	Ntuo	Alep		Not evaluated
<i>Sterculia oblonga</i> Mast.	Egboyo	Eyong		Vulnerable
<i>Azelia</i> sp.	Tanda	Doussier	3	

327

328 According to our informants, the moabi tree (*B. toxisperma*), highly valued by the Baka for their  
329 fresh fruits and seed oil, was on the most sought after by the logging companies operating in the  
330 Baka territory. Our informants mentioned that only trees exceeding 1 meter in diameter were felled,  
331 so several smaller individuals were still present. Other species that we observed as felled trunks,  
332 either along forest trails or on trucks in the 14 days were *Entandrophragma cylindricum* (Sprague)  
333 Sprague (four trunks), *Pterocarpus soyauxii* Taub. (five), *Piptadeniastrum africanum* (Hook.f.)  
334 Brenan (four), *Cylicodiscus gabunensis* Harms (one), *Rodognaphalon brevicuspe* (two) and  
335 *Triplochiton scleroxylon* K.Schum. (six). Although these are inedible species, they have several uses  
336 in (ritual) medicine, and *E. cylindricum* commonly hosts edible caterpillars, an important food for the  
337 Baka. During the forest walks, we also observed several (smaller) trees cut down by the Baka

338 themselves, mostly to obtain fresh leaves of *Gnetum cf. africanum* lianas, to harvest honey, and once  
 339 to collect the bitter bark of *Garcinia kola* Heckel., which is added to *Raphia* palm wine as a flavoring  
 340 agent.

341 Commercial Non-Timber Forest Products revealed through the different methods

342 During the walk-in-the-wood surveys, the Baka pointed out 24 different WEP species that they sold  
 343 to middlemen, mostly in the form of fruits, seeds, or the oil from seeds (Table 2). During the earlier  
 344 conducted interviews on the general income from sale over 14 days, only six different taxa were  
 345 reported to have been sold.

346 Table 2. Data on wild food plant products sold by the Baka, retrieved through different methods.

347 \*Only “tondo”, the general Baka term for *Aframomum* sp. was reported in the income survey.

348

Species	Plant parts	Walk in the woods	Income survey	International or domestic trade
<i>Afrostryax lepidophyllus</i> Mildbr.	bark	y	y	Ingram et al. (2010)
<i>Irvingia gabonensis</i> (Aubry-Lecomte ex O'Rorke) Baill.	fruits, seeds	y	y	Ingram et al. (2010)
<i>Panda oleosa</i> Pierre	oil from seeds	y		Hoare (2007)
<i>Gnetum cf. africanum</i> Welw.	leaves	y	y	Ingram et al. (2010)
<i>Dioscorea cf. praehensilis</i> Benth.	tuber	y		No data
<i>Baillonella toxisperma</i> Pierre	fruits, oil from seeds	y	y	Oil (Hoare, 2007)
<i>Pentaclethra macrophylla</i> Benth.	oil from seeds	y	y	Hoare (2007)
<i>Garcinia kola</i> Heckel	bark	y		Ingram et al. (2010)
<i>Piper guineense</i> Schumach. & Thonn.	fruits	y		Eyog Matig et al. (2006)
<i>Parinari excelsa</i> Sabine	firewood	y		No data
<i>Xylopia parviflora</i> Spruce	fruits	y		Ingram et al. (2010)
<i>Irvingia robur</i> Mildbr.	seeds	y		No data
<i>Ricinodendron heudelotii</i> (Baill.) Heckel	seeds	y		Ingram et al. (2010)
<i>Cola acuminata</i> Schott. & Endl.	seeds	y		Ingram et al. (2010)
<i>Tetrapleura tetraptera</i> (Schum. & Thonn.) Taub.	fruits	y		Ingram et al. (2010)
<i>Laccosperma secundiflorum</i> (P.Beauv.) Kuntze	stem (crafts)	y		No data
<i>Aframomum cf. longipetiolatum</i> Koechlin	fruits	y	y*	Ingram et al. (2010)
<i>Aframomum subsericum</i> (Oliv. & D. Hanb.) K. Schum.	fruits	y	y*	No data
<i>Aframomum daniellii</i> (Hook.f.) K.Schum.	fruits	y	y*	No data
<i>Aframomum sceptrum</i> (Oliv. & D. Hanb.) K. Schum.	fruits	y	y*	Ingram et al. (2010)
<i>Trichoscypha</i> sp. WTH25	fruits	y		Eyog Matig et al. (2006)
<i>Monodora myristica</i> (Graertm.) Dunal	fruits	y		Eyog Matig et al. (2006)
<i>Piper umbellatum</i> L.	fruits	y		No data
<i>Solanum erianthum</i> D. Don	fruits	y		No data

349 The most frequently sold species was *Gnetum* cf. *africanum*, followed by the seeds and oil of  
350 *Irvingia gabonensis*, *B. toxisperma*, *Pentaclethra macrophylla*, *Afrostryax lepidophyllus* bark and the  
351 fruits of several unspecified *Aframomum* species. In the same line, of these 24 commercial NTFP,  
352 only six species were reported in the dietary recalls, and eight during the freelisting. Of the 24  
353 commercial species that appeared during the forest surveys, 13 are commonly sold on the  
354 international market (Eyog Matig et al., 2006; Hoare, 2007; Ingram & Schure, 2010). The importance  
355 of these NTFP for the Baka livelihood, either for home consumption or (inter-) national trade would  
356 have been missed when our research methods had been limited to *ex-situ* interviews, the 14 day  
357 income recalls. The extraction of large moabi trees (*B. toxisperma*) by commercial timber companies  
358 must affect the amount of fruits and seeds that remain available for the Baka's subsistence and cash  
359 income.

360

## 361 Discussion

362 Although our research was performed among a relatively small population, our results show that  
363 different methods resulted in substantial differences in the collected data. *Ex-situ* interviews did not  
364 capture the full diversity of wild edible plants known, used and sold by the Baka. This may be partly  
365 due to the fact that not every participant understood the concept of "wild edible plant", as this does  
366 not have a literal translation in Baka language, and the phrasing "food from the forest excluding  
367 game, honey and mushrooms" had to be used (Gallois et al., 2020). Wild food plants play an  
368 important role in Baka livelihood (Bahuchet, 1992; Dounias, 1993) and knowledge related to edible  
369 plants is acquired early during childhood (Gallois et al., 2017). Therefore, it seems unlikely that the  
370 Baka adult informants who did not report any WEP during the freelisting did not know any; they  
371 probably did not understand the domain.

372 During the walk-in-the-woods method, the researcher can directly exclude items pointed out by  
373 informants that fall outside the domain 'wild edible plant', such as fungi, animal products and  
374 cultivated plants, although the latter category can be challenging due to the presence of wild species  
375 under various degrees and types of human management and intervention through to domestication  
376 (Bharucha & Pretty, 2010). The advantage of assessing plant knowledge within the ecological  
377 context is that many species are encountered that do not pop-up quickly in people's minds during a  
378 (shorter) interview outside the forest. When walking through the natural environment where edible  
379 plants occur, it is easier to remember them because of the amount of visual references to this  
380 knowledge at that moment (Miranda et al., 2007).

381 Our walk-in-the-woods method resulted in a higher number of wild edible species (even with a small  
382 sample size of only 20 informants) and elicited 12 recently consumed species that did not appear  
383 through the dietary recalls. We speculate that these were plants that were easily forgotten (e.g.,  
384 spices, condiments, small fruits), species that people might feel ashamed of eating (e.g., ferns, weedy  
385 plants), or items that were previously missed due to misinterpretation of the term "wild edible plant"  
386 (e.g., drinking water from lianas, edible latex, ritual food plants) during the free listings.  
387 Additionally, our botanical inventory through forest walks revealed that some general terms for local  
388 taxa mentioned during interviews actually included several species. In the case of the Baka, the local  
389 name 'tondo' may refer to three different species of *Aframomum*, the term 'bokoko' to two species of  
390 *Klainedoxa*, and 'payo' to different species of *Irvingia* (see also Gallois et al., under review). The  
391 walk-in-the-woods method, however, is laborious to perform and requires additional botanical  
392 collection, as more rare species will be encountered that are hard to identify, for which the help of

393 taxonomic specialists and support from herbaria is needed. The number of informants that can be  
394 taken into the field is also limited, while freelisting exercises can be organized in a short time among  
395 larger numbers of people (Paniagua Zambrana et al., 2018). On the other hand, *ex-situ* interview  
396 methods (including freelisting and dietary recalls) are known to assess the most salient useful plants  
397 among a large group of people in a relatively short time, as these techniques are limited by their  
398 spatio-temporal context (De Sousa et al., 2016; Paniagua Zambrana et al., 2018).

399 The implications of studies based solely on *ex-situ* interviews can be serious, as they lead to an  
400 underestimation of wild edible plants known, consumed, and commercially exploited, either by the  
401 local population or by outsiders. Results of such studies may not be representative for the situation on  
402 the ground, as trade in NTFP or conflicts between wild fruit collection and logging of fruit-producing  
403 trees may remain invisible. Moreover, the assessment of the contribution of wild plants to local diet  
404 and nutrition may be inaccurate. Several studies based on dietary recalls have concluded that WEP do  
405 not play an important role in local diets. For instance, Termote et al. (2012:8) were “confident to  
406 provide a fair representation of the dietary contribution of WEP on a population level in our sample”;  
407 even though their botanical collection was limited to finding specimens to match the local names  
408 mentioned during their dietary recalls and freelisting interviews. In Brazil, Do Nascimento et al.  
409 (2013: 337) stated after their freelisting and dietary recall surveys that “The low consumption of wild  
410 species [...] is notable, which suggests that, in practice, these foods contribute little to contemporary  
411 dietary enrichment”. Such data could be misused by policy makers, who may conclude that rural  
412 communities do not need the forest that much as previously thought which seriously underestimates  
413 their use and dependency of forest resources.

414 Considering the importance of wild plants for food security and for providing nutrients that are not  
415 present in other foods (Ong & Kim, 2017), and the fact that children are major consumers of wild  
416 fruits but hardly recruited as interviewees (Guinand & Lemessa, 2000; Setalaphruk & Price, 2007), it  
417 is crucial to draw the most accurate overview of the diversity of wild food items used by local  
418 people. The various direct and indirect effects of logging and trade in NTFP may impact not only  
419 human food resources, but the entire ecosystem. Many of the oily seed producing trees in Central  
420 Africa are ecological keystone species that are crucial for the survival of local wildlife (Beaune et  
421 al., 2013), on which forest-dwelling groups such as the Baka rely on for meat.

422

## 423 **Conclusion**

424 As expected, our walk-in-the-woods method resulted in a much higher number of wild edible plant  
425 species than the dietary recalls and freelisting methods, but species reported as most frequently  
426 consumed differed between the three methods. Our hypothesis that the list of plants generated by  
427 freelisting and recalls methods (either dietary or income) underestimated (conflicting) uses of edible  
428 plants proved to be correct. Our mixed methods approach shows the importance of cross-referencing  
429 data, not only between different types of interviews, as recommended by Paniagua-Zambrana et al.  
430 (2018), but also between interviews and direct observation during forest trips, for a better assessment  
431 of the diversity, consumption frequency and conflictive uses of wild edible plants. We therefore  
432 recommend that wild plant knowledge and use should be assessed through an “open” walk-in-the-  
433 woods method, in which informants are encouraged to mention any useful plant they know or  
434 randomly encounter, after which they are asked when they last used it. Employing the walk-in-the-  
435 woods technique merely to supply specimens for previously composed lists of useful plants from  
436 literature or interviews limits the capacity of this powerful technique to assess wild plant knowledge

437 and use. Freelisting and dietary recalls can be used afterwards to supplement the walk-in-the-woods  
438 results with additional quantitative data, but they should not limit it, especially in the case when  
439 biased conclusions may have large implications for people's future wellbeing.

440

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452

#### 453 **Author Contributions Statement**

454 SG, AGH and TVA designed the study, SG, WTH and TVA collected the data. WTH conducted the  
455 first analysis and wrote the first manuscript for his Msc thesis. All the authors then elaborated the  
456 current manuscript, from data analysis to writing the final version.

457

#### 458 **Conflict of Interest Statement**

459 The authors declare that the research was conducted in the absence of any commercial or financial  
460 relationships that could be construed as a potential conflict of interest.

461

#### 462 **Contribution to the Field Statement**

463 Many small-scale human societies rely on their access to natural resources for their daily diet. Due to  
464 globalization and forest degradation, many of them are undergoing a nutritional transition, in which  
465 there is an increase of fat- and sugar-rich processed foods, at the expense of wild plants. To assess the  
466 wild edible plants known and consumed by local people, several studies have used *ex-situ* interview  
467 methods, such as freelisting and 24h dietary diversity recalls. In our study, we compared four  
468 different methods (freelisting, dietary recalls, income recalls and the walk-in-the-wood method) to  
469 explore how they differed in results with regard to the diversity, consumption frequency and  
470 conflictive uses of wild edible plants. Working with Baka forager-horticulturalists in southeastern  
471 Cameroon, we showed that dietary recalls and freelisting strongly underestimate people's knowledge  
472 and consumption of wild plants. These insights raise questions on what can be interpreted from *ex-*  
473 *situ* interviews, as well as the possible scientific and political consequences of misinterpreting data  
474 on the wild food resources for forest-dwelling people.

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