

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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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). Freelisting 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 Online¹.

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;

¹ (<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 appendices² and IUCN Red List³ 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 website⁴.

212

213 **Results**

214 Capturing the diversity of edible plants: comparison between methods

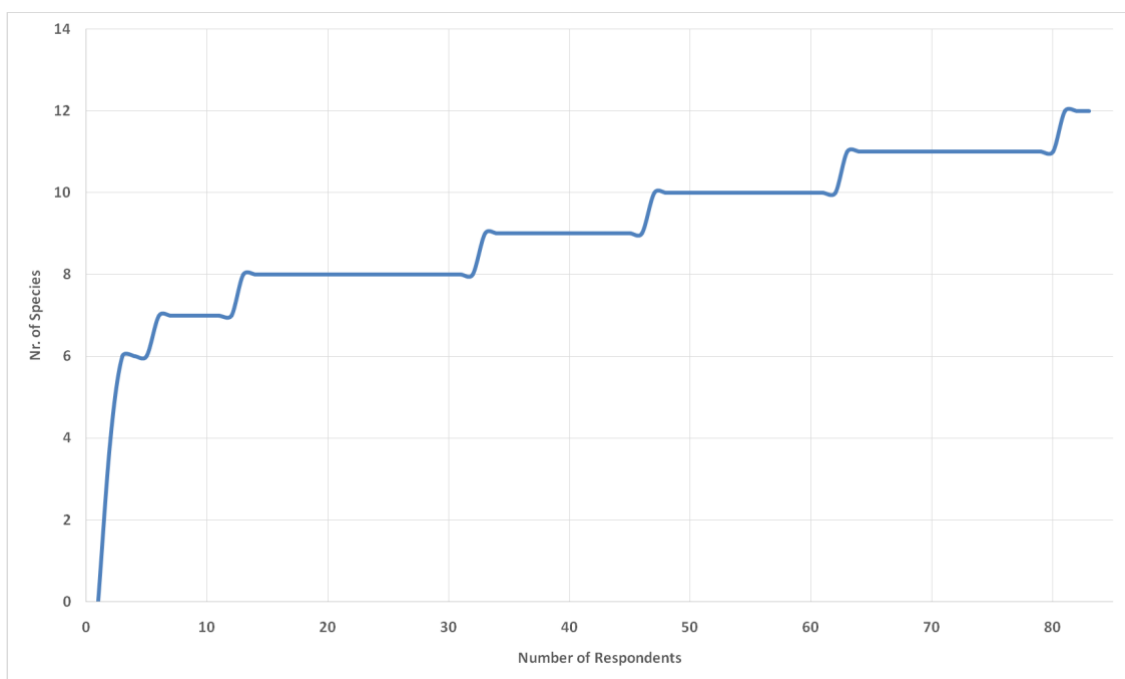
215 The dietary recalls and freelisting resulted in 12 and 38 wild edible plant species respectively.
216 Initially, 51 local names were identified through freelisting, but 13 of those were later excluded
217 because they were either synonyms of Baka plant names that had already been mentioned (three
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.

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

³ <https://www.iucnredlist.org>

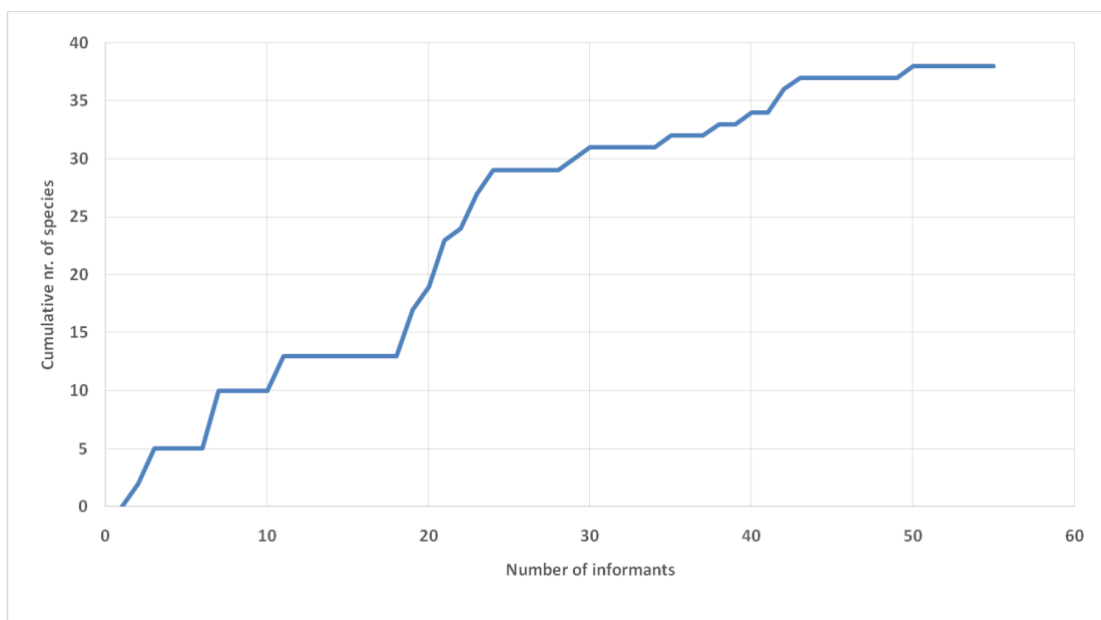
⁴ <https://www.itto.int/>



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.

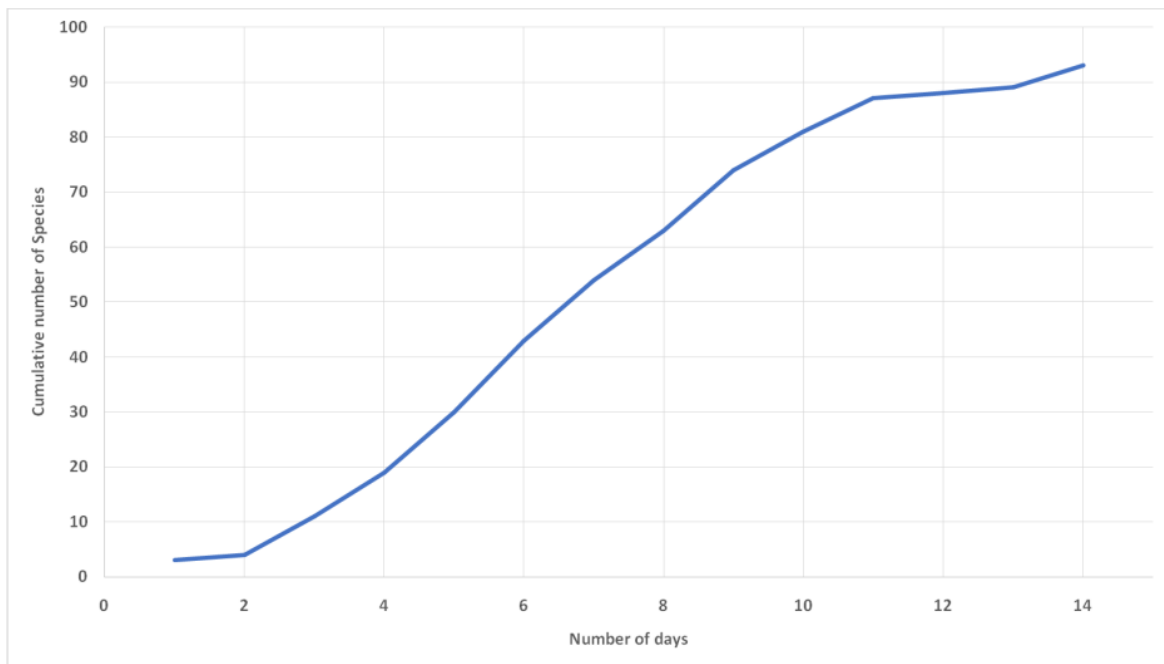


245

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.

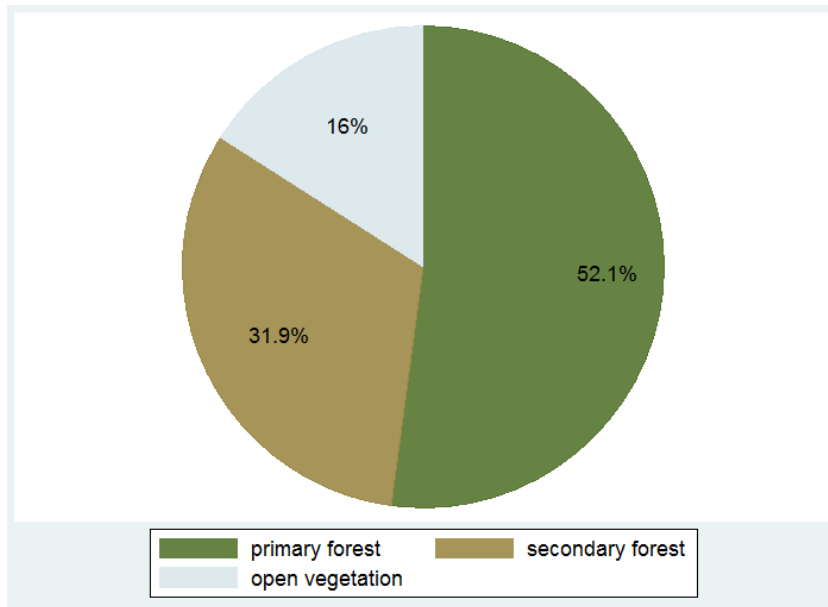
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262 Species characteristics

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

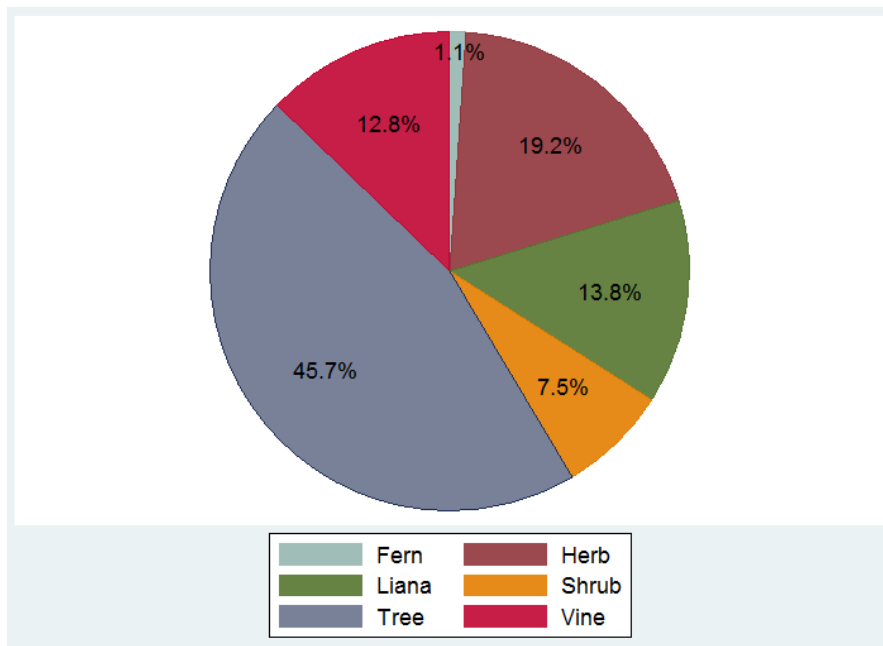
273

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



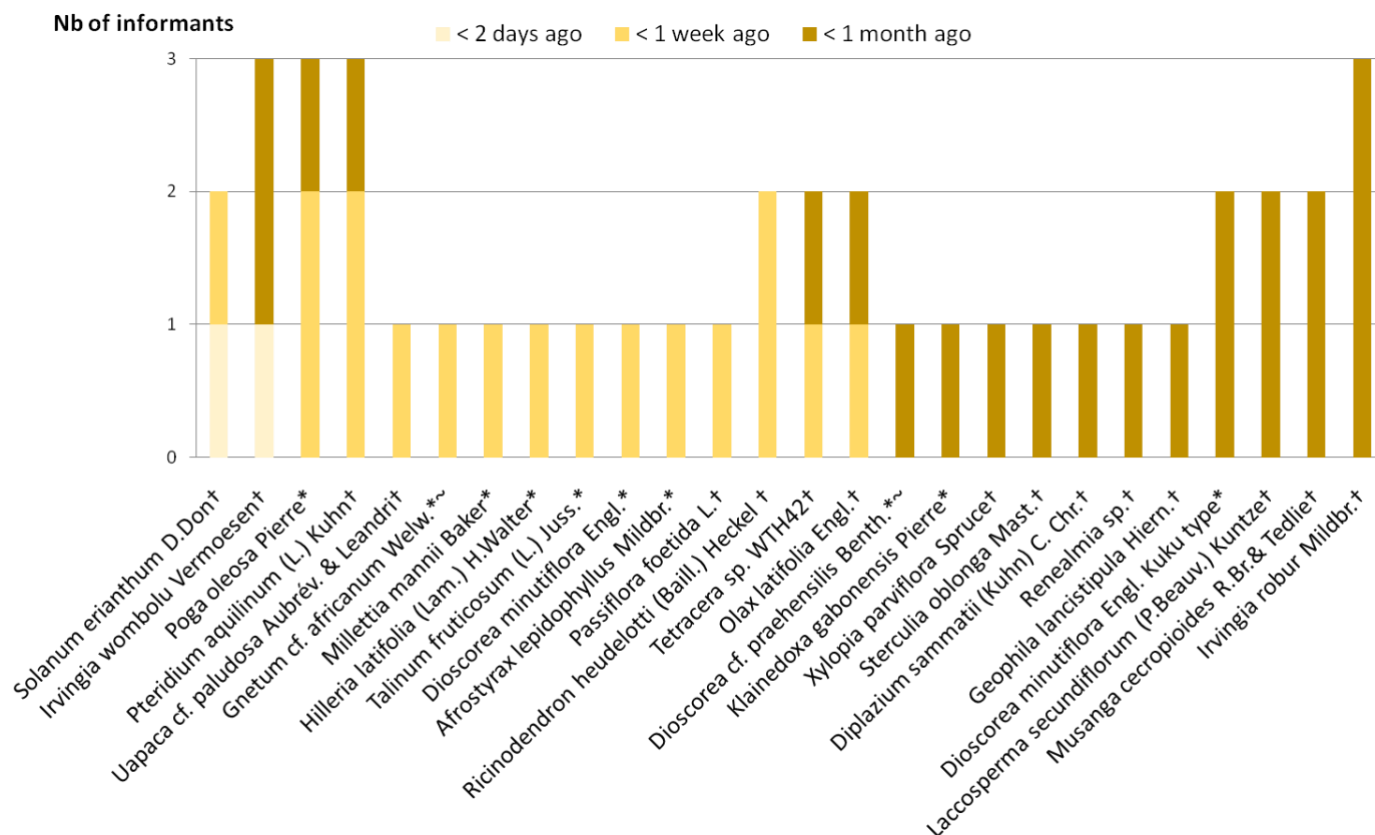
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282 Figure 5. Distribution of the life forms of the species collected (94 species). Data collected through
283 walk-in-the-woods method.

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*, *Afrostryrax 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 keystones 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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