



## Use of Raffias' species (*Raphia* spp.) and its impact on socioeconomic characteristics of harvesters in Benin (West Africa)

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### Abstract

Raffias' species are used in handicrafts, constructions, food processing etc. But in Benin, any quantitative ethnobotanical study was not evaluated for their use and socioeconomic impact of uses on average income. This study investigated the importance of use of raffias' species and the impact of socioeconomic characteristics of informants on the household income. Ethnobotany quantitative approach was used and data on use, products prices and the quantity sold were collected using a semi-structured questionnaire administered during an interview. The result showed that raffias' species in Benin are used principally for craft (CI = 1.41 for *R. hookeri* and 1.68 for *R. sudanica*), but *R. hookeri* was most important for people in Guinean zone than those in soudanian and soudano-guinean zones. The frequently uses were the beds, mats, baskets and roofs. The most part of the plant used is the rachis for both species and the less used is the nut. Education level, gender and main activities were socioeconomic variable which influenced the annual income from exploitation of raffias species. The uneducated, men and farmers took more income from raffias' species than others. Also, the development level of areas where the species are found, influence the income from their exploitations. To evaluate better the contribution of raffias' species to regional and national gross product, it will be necessary to study the value chain of the main products, but also take into account the informant categories defined in this study regarding operators.

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## Introduction

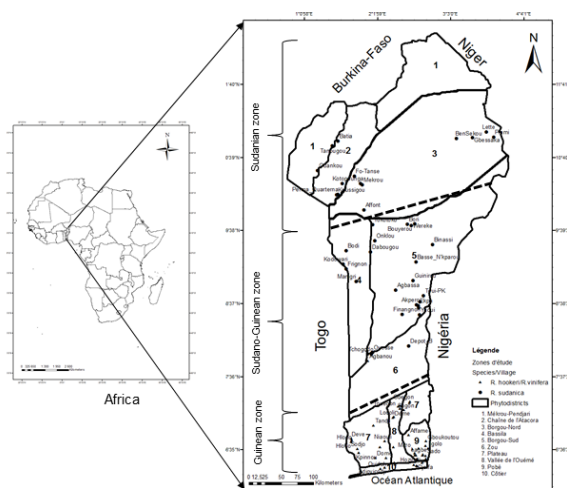
Non-timber forest products (NTFP) worth billions of dollars throughout the tropical countries and are extracted by millions of people in the world (Hegde *et al.*, 1996). However, little is known about the impact of extraction on local, regional, or national economies. Quantitative data on the rates of extraction and economic returns realized by local communities who are NTFP dependent, are lacking. This is the case for raffia species in Benin. In developing countries, including Benin, majority of rural household depends on NTFPs to meet some parts of their nutritional, health, construction material and income from selling these products. Elsewhere, NTFPs are one of sources of income for the local communities. Therefore, NTFPs form an integral part of the rural economy where the majority of the rural populations live especially around the forest resource base. Also, the NTFPs value vary from site to site (Kar and Jacobson, 2012) and from specie to specie. This reality warrants site-specific and specie-specific investigations. The idea of linking NTFP harvest with livelihoods of forest-dependent communities, as an alternative to deforestation, has become a widely accepted conservation paradigm (Hegde *et al.*, 1996). Biological factors are not the only factors that determine the ecological consequences of NTFP management. The consequences of management for NTFP are also determined by the political and socio-economic context in which such management occurs. Many studies have contributed to the understanding of subsistence economy and concluded that NTFP could bring significant benefits to poor rural people (Adger *et al.*, 1995). In other cases scientists are more skeptics (Gram, 2001). In addition, the results are rather difficult to compare because of biological and socioeconomic differences between the study areas. Then the value of NTFPs depends not only on socioeconomical conditions of areas where these are harvested but also on type of NTFP. In Benin, many studies examined the contributions of NTFP to household income of several NTFPs such as *V. paradoxa*, *T. indica*, *P. biglobosa*, *S. birrea*, etc. (Fandohan *et al.*, 2010; Gouwakinnou *et al.*, 2011;

Vodouhe *et al.*, 2009) except raffias species. Palm trees (Areaceae) are the most diverse in tropical and subtropical regions with more than 2,400 wild species. These wild palms like any other NTFPs contribute to the household economy and strengthen food security by harvesting spine, sap and stipe. In Benin we have thirty (30) wild palm species such as *Raphia hookeri*, *Raphia vinifera* and *Raphia sudanica* used by people for food, construction and craft industry (Akoègninou *et al.*, 2006). The raffia's are monocarp species, single-stemmed and are subservient to temporary or permanent water-logging habitats. The exploitation of organs such as nuts and palm wine associated with habitat loss cause decline of these species. Then *Raphia sudanica* was listed on the IUCN Red List in the "data deficient" category (Ouedraogo, 2010). In addition, Akoègninou *et al.* (2006) showed that among the species highly consumed by populations in the sudanian region, there appears *Raphia sudanica* whose uses and conservation status are unknown and are not quantified. Dan *et al.* (2009) found that in swamp forest of Lokoli in South-Benin, 2664 feet of *Raphia hookeri* were mainly harvested for wine and rachis in two months. In this locality, the exploitation of *Raphia hookeri* was the main income generating activity by 79.1% of respondents. The authors didn't estimate the income from exploitation of *R. hookeri* and the socioeconomic factors which influenced this income. But, Alladatin (2013) reported that the transformers of organs of *R. hookeri* of Hlanzoun village in south of Benin, took 63937.16 \$US from it exploitation and these transformers had free access to the resource. This income is greater than income from other activities done in Benin. In this case, it is important to investigate several sites where raffias' species are used and to take in account the socio-economic characteristics of informants. The aim of this study was to examine the value of raffias' products traded in markets, as well as how they are influenced by socio-economic factors in communities adjacent to the gathering sites. In this paper, the diversity in the use of raffia's species in Benin has been evaluated and their impact on socioeconomics characteristics of informants.

## Materials and methods

### Study area

The study was carried out in nine phytodistricts (Fig. 1) areas spread over the three (03) climatic zones (Guinean, Sudano-Guinean and Sudanian) from north to south of Benin (Adjanooun, 1989; Adomou *et al.*, 2006; White, 1983). Benin covers 114,763 km<sup>2</sup> and is located between the latitudes 6° 30' N and 12° 30' N and the longitudes 1°E and 3° 40' E (Insaë, 2013). The mean annual rainfall varies from 900 to 1300 mm. Its lowest values are recorded in the south-western most section and in the far north (900-950 mm). The highest precipitation (1200-1300 mm) is confined to Southeast Benin as well as the tract Bassila-Djougou. The mean annual temperatures range from 26 to 28°C and may exceptionally reach 35-40°C in northern localities such as Kandi and Malanville. The annual temperature amplitude is low in the southern part (5-10°C) while it is higher (11-13°C) in the northern part (from the latitude 8°N northwards). As in most West-African countries, the climate is primarily determined by the annual cycle of the “Inner Tropical Convergence Zone” (ITCZ) (Adomou *et al.*, 2006). Estimated at 878,000 inhabitants in 1910, Benin's population was 9,983,884 inhabitants (87 inhabitants/km<sup>2</sup>) in 2013 (Insaë, 2013).



**Fig. 1.** Study area.

Legend: The points which indicate the presence of species are also those that indicates study areas.

### Sampling design

Data on raffia's uses in Benin were collected in nine phytodistrict areas spread over the three (03) climatic zones of Benin (West Africa). In each phytodistrict area, nine (09) villages were randomly selected while ensuring the presence of the species. People (women, men) were interviewed on presentation of raffia species images. If species were recognized, the identification of them was made in its natural habitat and geographic coordinates of the settlement of the individuals was taken using 60x GPS (Global Positioning System). Data collection began with a presentation of the objectives of study to political and administrative authorities (mayor, head of district/village), agricultural and forestry technicians, etc. After the random selection of study areas, a randomly sample of 100 people in each locality was used to determine the proportion  $p$  of informants who exploit raffia. Thus, the size  $n$  of the sample was determined using the normal approximation of binomial distribution (Dagnelie, 1998; Dagnelie, 2006) :

$$n = \frac{U_{1-\frac{\alpha}{2}}^2 p(1-p)}{d^2}$$

In above formula,  $n$  is sample size in each locality;  $p$  the proportion of informants who use raffia;  $U_{1-\alpha/2}$  (which is 1.96) is the value of the normal distribution related to  $1-\alpha/2$  probability value with  $\alpha=5\%$ ;  $d$  is the margin error of the estimate which was 8% in this article (Assogbadjo *et al.*, 2011). After determining the sample size, the informants were chosen randomly to include all social level (men, women, young, old, etc.) and age classes. A semi-structured questionnaire was administered to informants and the main themes were: 1) identification of the informant and his village; 2) the knowledge, attitudes and uses (food, religion, culture, traditional medicine, banned, ceremonies or rites and trade) of raffia; 3) the seasonal availability of organs used; 4) local names; 5) the local perception of raffias' population dynamic, quantity of products sold per year, price of each product, etc. In the case of non-mastery of local language, the questionnaire was translated by a local collaborator.

To ensure reliability of data, questionnaires were previously tested in an exploratory study. During data collection, 6 photos of raffia, with two pictures by specie, were presented to informants to ensure they provide reliable informations on raffia found in their locality. In order to obtain data on household income from raffias' uses and to determine the effect of household variables on this income, data on price were collected on both informants and market. Socioeconomic factors most commonly identified affecting the level of dependency of rural populations on raffia's species were age, sex, education and main activity for *Raphia hookeri* and plus gender for *Raphia sudanica* (Donou Hounsodé *et al.*, 2016).

#### Data analysis

Different measures of raffias 'uses and importance were calculated and statistically tested for all species encountered in the course of the survey (Table 1). In addition, different measures of the informants' knowledge of palm uses were calculated per category of informants. Multiple Correspondences Analysis

(MCA) was performed on socioeconomics variables in order to categorize the informants. Multiple proportions test (Khi-square test) was performed to assess differences in frequencies of informant categories per phytodistrict area. The income per socioeconomics variables and informant categories were computed and ANOVA was performed to evaluate the difference between their averages. A Shapiro–Wilk test was performed to test whether income could be regarded as a sample of a normally distributed population and Levene test helps test whether the variances of samples are equal. When the assumptions of normality and equality of variance didn't verify, the non-parametric test as Kruskal–Wallis test was performed on the incomes. The income was computed like that:

$$R_{ik}=Q_{ijk} * P_{ij}$$

Where  $R_{ik}$  is income of informant  $i$  of category  $k$ ,  $Q_{ij}$  the annual quantity of  $j$  product sold by informant  $i$  of category  $k$  and  $P_{ij}$  is mean of price given by informant  $i$  which product  $j$  was sold. All analyses were performed using R version 3.2.3 (Team, 2013).

**Table 1.** Measures of importance and use of raffias' species calculated to determine which aspects of raffias' use contribute to the importance accorded to raffias by local people in Benin (West Africa)

Measures	Calculation	Description	Source
Use Value (UVs)	$UV_s = \sum U_{ijs} / n$	$U_{ijs}$ is the number of uses of the species $s$ reported by the informant $i$ in the use category $j$ . $j$ was also used as product, plant part or informant categories. $n$ = total number of informant for specie $s$ or for category $j$ . It measures the average number of uses informants know for a species.	
Use Equitability value (EUVs)	$UEV_s = UD_s / UD_{smax}$ $UD_s = 1 / \sum P_u^2$	$UD_s max$ = maximum possible use diversity value (UDs) for a species $s$ with uses occurring in a given number of categories. UEVs measures how evenly the different uses contribute to the total use of a species independent of the number of use categories. Values range between 0 and 1. $s$ was also used as informant categories. $P_u$ = contribution of use category $u$ to the total utility of a species $s$ (=number of times species $s$ was mentioned within each use category, divided by the total number of reports of use of species $s$ across all use categories).	(Byg and Balslev, 2001; Hoffman and Gallaher, 2007)

Measures	Calculation	Description	Source
Informant Diversity Value (IDVs)	$IDVs = 1/\sum P_i^2$	<p><math>P_i</math> = contribution of informant <math>i</math> to the total knowledge pool of species <math>s</math> (number of reports of use of species <math>s</math> by informant <math>i</math> divided by the total number of reports of use of species <math>s</math>). <math>s</math> was also used as informant categories.</p> <p><math>U</math> = use category, <math>nc</math> = number of use categories, <math>UR_{Ui}</math> = number of use-reports for each species in use category <math>u</math> by informant <math>I</math> and <math>N</math> is number of informants. This additive index takes into account not only the spread of the use (number of informants) for each species, but also its versatility, i.e., the diversity of its uses. The theoretical maximum value of the index is the total number of different use-categories (NC), reached in the unlikely case that all the informants would mention the use of the species in all the use-categories considered in the survey. In the case of species with only one use, this index would be equal to RFC (dividing the number of informants who mention the use of the species, also known as frequency of citation (FC), by the number of informants participating in the survey (N).</p> <p>Another important property of the CI index is that each addend is a measure of the relative importance of each plant use.</p> <p>It is a value given for a specific plant part. It is equal to the ratio between the number of total uses reported for each plant part (<math>RU_{[Plant Part]}</math>) and the total number of reported uses for the specie <math>s</math>.</p>	
Cultural Importance Index (CIIs)	$CIIs = \sum_{U=U1}^{U_{nc}} \sum_{i=i1}^{iN} UR_{Ui}/N$	<p>Organs (plant part) showing high values of PPV are the most often used parts of the species by informant from a given use category. The sum of all categories gave the value for each plant part.</p>	(Tardio and Pardo-de-Santayana, 2008)
Plant Part Value (PPVs)	$PPVs = \sum RU_{[Plant Part]}/RU$		(Avocèvou-Ayisso <i>et al.</i> , 2012)

## Results

### *Use and ethnobotanics values of raffias' species*

During the interviews 36 and 31 uses were reported respectively for *R. hookeri* and *R. sudanica* and distributed among sept (07) use categories (Table 2 and 3). The both species were principally used for handcraft (CI = 1.41 for *R. hookeri* and 1.68 for *R. sudanica*) with an average number of use known by informants which didn't differ significantly

(P-value = 0.79) for both species (UV = 27.72 for *R. hookeri* and UV = 27.68 for *R. sudanica*). The use categories with small number of uses known by informants were firewood (UV = 0.56) for *R. hookeri* and worship (UV = 0.03) for *R. hookeri*. The rachis (PPV = 1.56 for *R. hookeri* and PPV = 1.38 for *R. sudanica*) was the plant part most frequently used in all use categories except food and construction categories where sap and leaves are respectively used.

The rachis was used to make bed, mat, basket, etc (Photo 1). The nut is the least used by informants. In construction, handicraft, raw materials, tools, food, worship and firewood the principals' uses were

respectively roof, bed/mat, rachis, fishing-rod, wine, batchè (in local language "Fon" means small mat used for worship ceremonies) and bundle (Table 2 and 3).

**Table 2.** Uses categories of *R. hookeri*

Uses categories	Uses	Number of citation	Plant Part Value (PPV)					Use Value (RUV)	Use Value (EUV)	Cultural Importance Index (CI)
			Bough	Leaf	Nut	Rachis	Sap			
Construction		138	0.02	0.23	0.00	0.10	0.00	3.83	0.30	0.35
	Ceiling	34	0.00	0.00	0.00	0.09	0.00	0.94	0.07	0.09
	Enclosure	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Hut	4	0.00	0.00	0.00	0.02	0.00	0.12	0.00	0.02
	Roof	99	0.02	0.23	0.00	0.00	0.00	2.75	0.21	0.25
Handicraft		560	0.19	0.01	0.01	1.00	0.20	15.57	1.20	1.41
	Armchair	4	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.01
	Bag	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Basket	63	0.06	0.00	0.00	0.10	0.00	1.75	0.14	0.16
	Bed	105	0.00	0.00	0.00	0.27	0.00	2.92	0.23	0.27
	Broom	11	0.03	0.00	0.00	0.00	0.00	0.31	0.02	0.03
	Cage of Bird	9	0.00	0.00	0.00	0.02	0.00	0.25	0.02	0.02
	Chair	43	0.00	0.00	0.00	0.11	0.00	1.19	0.09	0.11
	Curtain	2	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.01
	Fish-trap	5	0.00	0.00	0.00	0.01	0.00	0.14	0.01	0.01
	Horse-box	9	0.00	0.00	0.00	0.02	0.00	0.25	0.02	0.02
	Key-ring	3	0.00	0.00	0.01	0.00	0.00	0.08	0.01	0.01
	Lounge	57	0.00	0.00	0.00	0.14	0.00	1.58	0.12	0.14
	Mat	77	0.02	0.00	0.00	0.18	0.00	2.14	0.17	0.19
	Necklace	2	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.01
	Placing-TV	4	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.01
	Rope	36	0.08	0.01	0.00	0.00	0.00	1.00	0.08	0.09
	Shelf	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Sideboard	2	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.01
	Sap	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Sodabi <sup>1</sup>	80	0.00	0.00	0.00	0.00	0.20	2.22	0.17	0.20
	Stool	8	0.00	0.00	0.00	0.02	0.00	0.22	0.02	0.02
	Table	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Top	36	0.00	0.00	0.00	0.09	0.00	1.00	0.08	0.09
Raw Material		120	0.00	0.00	0.00	0.30	0.00	3.33	0.26	0.30
	Rachis	120	0.00	0.00	0.00	0.30	0.00	3.33	0.26	0.30
Tools		26	0.00	0.00	0.00	0.07	0.00	0.72	0.06	0.07
	Fishing-rod	22	0.00	0.00	0.00	0.06	0.00	0.61	0.05	0.06
	Paddle	4	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.01
Food		110	0.00	0.00	0.00	0.00	0.28	3.06	0.24	0.28
	Wine	110	0.00	0.00	0.00	0.00	0.28	3.06	0.24	0.28
Worship		24	0.03	0.00	0.00	0.03	0.00	0.67	0.05	0.06
	Batchè <sup>2</sup>	13	0.00	0.00	0.00	0.03	0.00	0.36	0.03	0.03
	Bough	8	0.02	0.00	0.00	0.00	0.00	0.22	0.02	0.02
	Ghost Clothes	3	0.01	0.00	0.00	0.00	0.00	0.08	0.01	0.01
Firewood		20	0.00	0.00	0.00	0.05	0.00	0.56	0.04	0.05
	Bundle	20	0.00	0.00	0.00	0.05	0.00	0.56	0.04	0.05
Global		998	0.24	0.24	0.01	1.56	0.48	27.72	-	2.53

<sup>1</sup> «Sodabi» local name of food alcohol from wine of raffias

<sup>2</sup> Small mat used for worship ceremonies

**Table 3.** Uses categories of *R. sudanica*

Use categories	Uses	Number of citations	Plant Part Value (PPV)					Use value	Equitability Use Value (EUV)	Cultural Importance Index (CI)
			Bough	Leaf	Nut	Rachis	Sap			
Handicraft		762	0.41	0.03	0.00	1.24	0.00	24.58	1.00	1.68
	Armchair	15	0.00	0.00	0.00	0.03	0.00	0.48	0.02	0.03
	Bag	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Broom	15	0.00	0.03	0.00	0.00	0.00	0.48	0.02	0.03
	Basket	8	0.00	0.00	0.00	0.02	0.00	0.26	0.01	0.02
	Bed	143	0.00	0.00	0.00	0.32	0.00	4.61	0.19	0.32
	Bench	11	0.00	0.00	0.00	0.02	0.00	0.35	0.01	0.02
	Bird Cage	19	0.00	0.00	0.00	0.04	0.00	0.61	0.03	0.04
	Bracelet	3	0.01	0.00	0.00	0.00	0.00	0.10	0.00	0.01
	Chairs	36	0.00	0.00	0.00	0.08	0.00	1.16	0.05	0.08
	Cord	173	0.38	0.00	0.00	0.00	0.00	5.58	0.23	0.38
	Curtain	2	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
	Door	8	0.00	0.00	0.00	0.02	0.00	0.26	0.01	0.02
	Fan	4	0.01	0.00	0.00	0.00	0.00	0.13	0.01	0.01
	Fish-trap	8	0.00	0.00	0.00	0.02	0.00	0.26	0.01	0.02
	Hat	6	0.01	0.00	0.00	0.00	0.00	0.19	0.01	0.01
	Mat	236	0.00	0.00	0.00	0.52	0.00	7.61	0.31	0.52
	Sodabi	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Stool	45	0.00	0.00	0.00	0.10	0.00	1.45	0.06	0.10
	Table	28	0.00	0.00	0.00	0.06	0.00	0.90	0.04	0.06
Construction		29	0.00	0.00	0.00	0.06	0.00	0.94	0.04	0.06
	Ceiling	12	0.00	0.00	0.00	0.03	0.00	0.39	0.02	0.03
	Enclosure	7	0.00	0.00	0.00	0.02	0.00	0.23	0.01	0.02
	Frame	7	0.00	0.00	0.00	0.02	0.00	0.23	0.01	0.02
	Hut	3	0.00	0.00	0.00	0.01	0.00	0.10	0.00	0.01
Food		27	0.00	0.00	0.00	0.00	0.06	0.87	0.04	0.06
	Wine	27	0.00	0.00	0.00	0.00	0.06	0.87	0.04	0.06
Medicine		2	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
	Oil	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Pulp	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Raw-material		15	0.00	0.00	0.00	0.03	0.00	0.48	0.02	0.03
	Rachis	15	0.00	0.00	0.00	0.03	0.00	0.48	0.02	0.03
Tools		20	0.00	0.00	0.00	0.04	0.00	0.65	0.03	0.04
	Ladder	2	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
	Palette	14	0.00	0.00	0.00	0.03	0.00	0.45	0.02	0.03
	Yoke	4	0.00	0.00	0.00	0.01	0.00	0.13	0.01	0.01
Worship		1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
	Amulet	1	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Global		856	0.41	0.04	0.00	1.38	0.06	27.61		1.89

**Photo 1.** Uses of raffias' species.

Legend: (a) Pulp (yellow color) used as laxative, (b) stool used by women for cooking, (c) bed inside hospital and (d) basket manufacturing

#### Categorization of raffias' users

The socioeconomics variables which influenced the use of *R. hookeri* were age classes, education level and main activities of informants. In addition of these socioeconomics variables, there are gender as regard to *R. sudanica*. These variables were used to categorize the informants and it showed six (06) categories for *R. hookeri* and four (04) for *R. sudanica* (Fig. 2 and Fig. 3). The result of the multiple correspondence analysis (MCA) performed on socioeconomics variables that motivated the use of raffia's species showed that the first three components explained more than 50% (59.09) of the observed variation (Fig. 2). But as regard to

*R. sudanica* the first two (02) components explained more than 50% (52.18%) of the observed variation (Fig. 3) Therefore, these dimensions were used to categorize the raffias' users. To describe the MCA components, only variables which were significantly represented with them at a probability level of 0.05 were kept (Table 4 and 5). The analysis of socioeconomics variables significantly represented on components showed that the variable with positive estimates were positively represented on given component contrary to those with negative estimates (Table 4 and 5). On the first dimension (Table 4), the young were often from primary or secondary school and farmers or did others activities except

exploitation of raffia species. Contrary to Adults and Aged ones who were not educated but gather raffias organs as main activity. Afterwards, on the second dimension, young and olds persons were often farmers or transformers of raffias' organs in contrary to adults who were from secondary school and did others activities except agriculture and exploitation of raffias' species. At last, on third dimension, young and old informants were often from secondary school and exploited raffias' species or did others activities except agriculture in contrary to adults who were farmers and from primary school or not educated (illiterate).

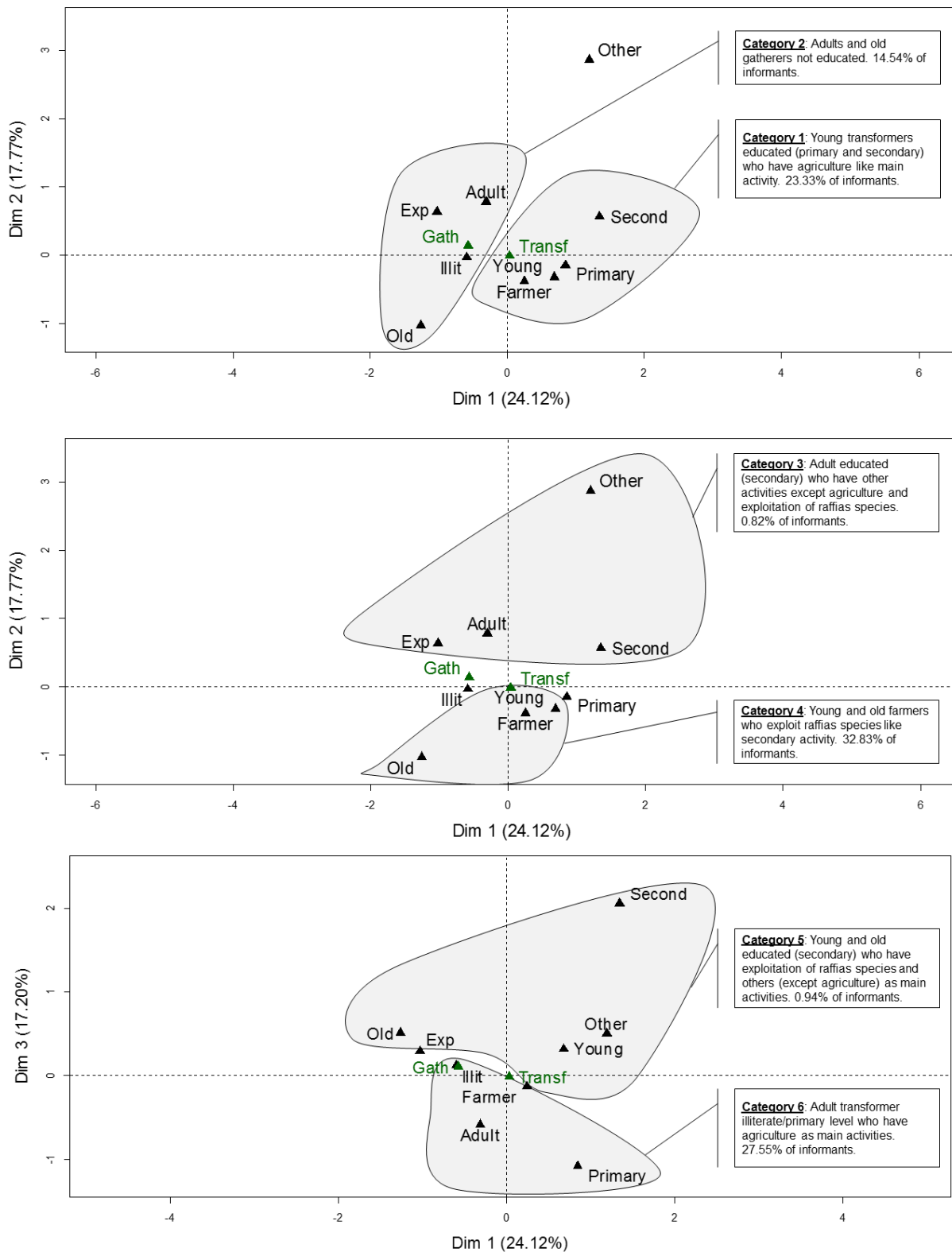
**Table 4.** Description of the MCA dimensions by socioeconomics variables most represented about ethnobotany of *R. hookeri*

Variables	Modalities	Dimension 1		Dimension 2		Dimension 3	
		Estimate	P-value	Estimate	P-value	Estimate	P-value
Age	Young	0.68	5.34E-45	-0.08	0.00	0.14	0.00
	Adult	-0.01	8.24E-07	0.58	0.00	-0.39	0.00
	Old	-0.67	5.52E-31	-0.50	0.00	0.25	0.00
Education	Illiterate	-0.78	9.02E-77			-0.14	0.00
	Primary	0.22	1.90E-28			-0.85	0.00
	Secondary	0.56	6.71E-22	0.26	0.00	0.99	0.00
Main activities	Farmer	0.07	8.68E-17	-0.85	0.00	-0.21	0.00
	Exploitation of raffias	-0.81	1.33E-33	-0.24	0.00	0.04	0.00
	Other activities	0.73	1.38E-07	1.09	0.00	0.17	0.03
Type of informant	Transformer	0.21	5.91E-03				
	Gatherer	-0.21	5.91E-03				

**Table 5.** Description of the MCA dimensions by socioeconomics variables most represented about ethnobotany of *R. sudanica*

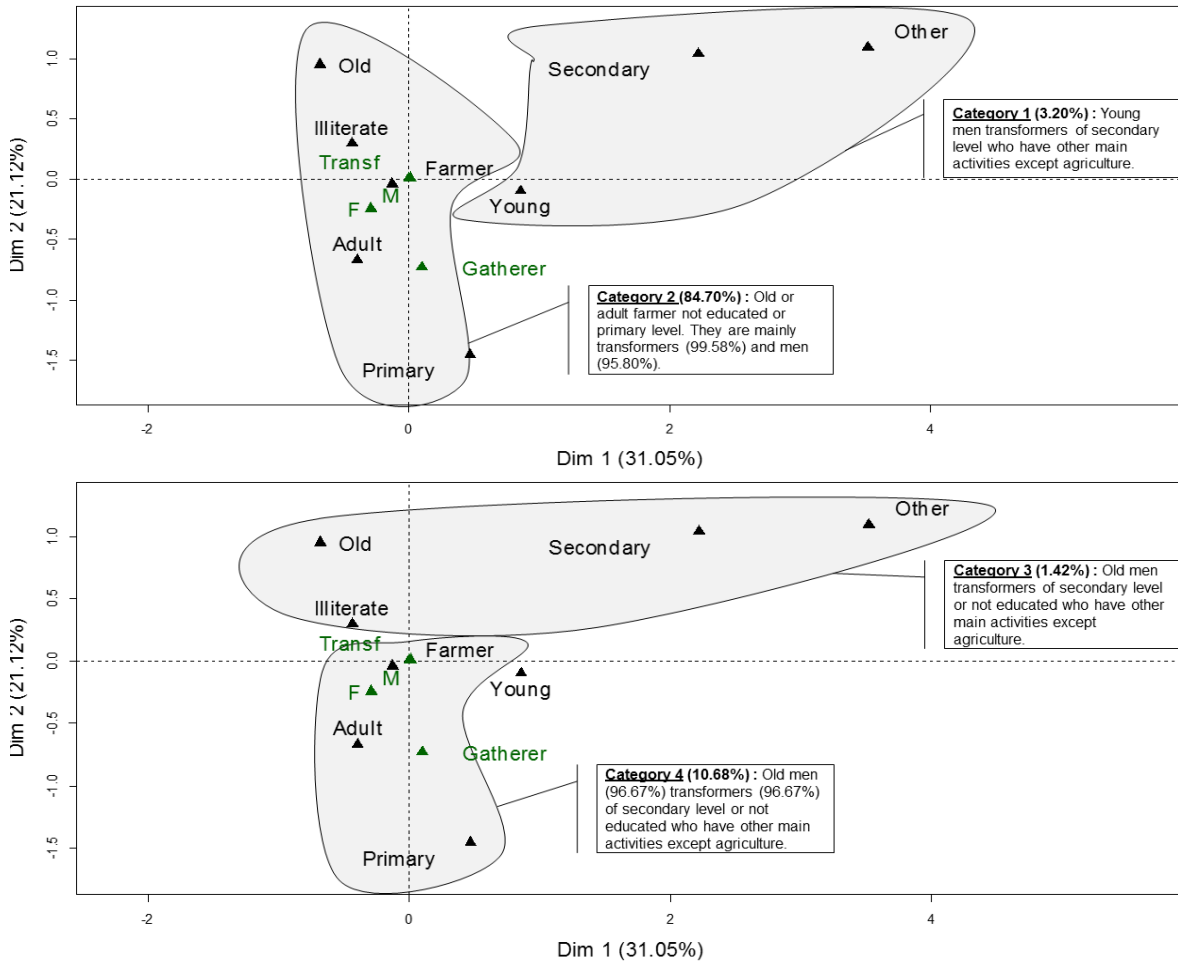
Variables	Modalities	Dimension 1		Dimension 2	
		Estimate	P-value	Estimate	P-value
Age	Young	0.67	1.65E-60		
	Adult	-0.23	6.21E-10	-0.43	1.45E-27
	Old	-0.44	3.02E-21	0.53	3.23E-44
Education	Illiterate	-0.85	2.24E-58	0.20	6.13E-24
	Primary	-0.20	2.35E-07	-0.84	1.15E-81
	Secondary	1.06	1.23E-70	0.64	3.97E-13
Main activities	Farmer	-1.31	3.91E-61	-0.34	7.38E-06
	Other	1.31	3.91E-61	0.34	7.38E-06





**Fig. 2.** Multiple Correspondence Analysis (MCA) plot of *R. hookeri*

Legend: Gath = Gatherer of rafflesia's organs; Transf = Transformers of rafflesia's organs; Second = Secondary level; Illit = Illiterate or not educated; Exp = Exploitation of rafflesia as main activity; other = others main activities except agriculture and exploitation of rafflesia's species.



**Fig. 3.** Multiple Correspondence Analysis (MCA) plot of *R. sudanica*

Legend: Gath = Gatherer of raffias' organs; Transf = Transformers of raffias' organs; F = Female; M = male.

The table 5 showed that, on the first dimension, the young were often from secondary school and did others activities except agriculture contrary to Adults and Olds who were not educated (illiterate) or from primary school and did agriculture as their main activity. At last, on the second dimension, adults' persons were often farmers and from primary school in contrary to old people who were from secondary school or not educated and did others activities except agriculture.

*Repartition of informant categories per phytodistricts area (Fig. 4)*

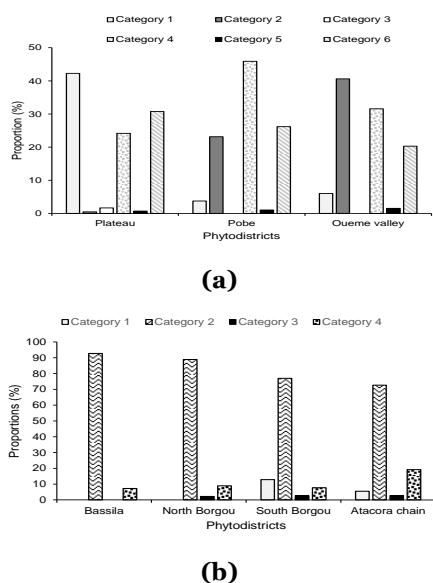
*Raphia hookeri*

As the p-value (X-squared = 66.08, df = 5, p-value = 6.67e-13) is less than the 0.05 significance level, the proportions of users is different following categories.

The most important category was category 4 follow by categories 6, 1, 5 and 3. The proportions of these categories were also different following phytodistricts (X-squared = 303.09, df = 10, p-value < 2.2e-16). Then the most represented categories were category 1, 2 and 4 respectively in Plateau, Oueme valley and Pobe phytodistricts. It noticed that the category 3 was only in phytodistrict Plateau (Fig. 4a).

*Raphia sudanica*

As the p-value (X-squared = 3.2971, df = 3, p-value = 0.348) is greater than the 0.05 significance level, the proportions of informants didn't differ following categories. But, the most important category was category 2 follow by categories 4, 1 and 3. The proportions of these categories were different following phytodistricts (X-squared = 30.408, df = 9, p-value = 0.0004). Then the most represented categories were 2 in all of the phytodistricts (Fig. 4b).



**Fig. 4.** Repartition of informant categories in different phytodistricts areas

Legend: (a) *R. hookeri* and (b) *R. sudanica*.

#### *Ethnobotanics values per categories of informants*

Cultural importance index computed following informant categories and use categories of *R. hookeri* showed that categories 1, 3, 4 and 6 were specialized in handcraft (Table 6) by madding bed except informants of category 3 who transform raffias' organs in cage-bird. The informant diversity value showed that *R. hookeri* is very important for the category 4 (IDV = 101.03) and used by more people than others categories. The category, for which *R. hookeri* is the least important, is category 3 (IDV = 2.58). The category 2 and 5 were specialized in extraction of raffias' wine. As regards *R. sudanica*, all of the informants' categories were specialized in mat processing. But it was important for category 2 (IDV = 167.20) than category 3 for who *R. sudanica* was least important (Table 7).

**Table 6.** Ethnobotanics values per categories of informants of *R. hookeri*

Use categories	Uses	Number of citation	Cultural Importance Index (CII) per classes					
			C1	C2	C3	C4	C5	C6
Construction		127	0.21	0.45	0.67	0.36	0.02	1.36
	Ceiling	29	0.11	0.00	0.67	0.06	0.01	0.32
	Hut	4	0.02	0.00	0.00	0.00	0.00	0.08
	Roof	94	0.08	0.45	0.00	0.30	0.01	0.96
Handicraft		448	1.33	0.93	0.67	1.13	0.02	5.16
	Armchair	3	0.01	0.00	0.00	0.01	0.00	0.04
	Bag	1	0.01	0.00	0.00	0.00	0.00	0.00
	Basket	32	0.04	0.06	0.00	0.14	0.00	0.28
	Bed	98	0.46	0.02	0.00	0.19	0.00	1.20
	Cage-Bird	9	0.02	0.04	0.67	0.01	0.01	0.04
	Broom	10	0.00	0.08	0.00	0.02	0.00	0.12
	Chair	37	0.14	0.00	0.00	0.04	0.00	0.76
	Curtain	2	0.01	0.00	0.00	0.00	0.00	0.04
	Fish-trap	5	0.01	0.00	0.00	0.01	0.00	0.12
	Horse-box	9	0.00	0.06	0.00	0.04	0.00	0.04
	Key-ring	3	0.02	0.00	0.00	0.00	0.00	0.04
	Lounge	52	0.24	0.04	0.00	0.11	0.00	0.56
	Mat	69	0.21	0.14	0.00	0.21	0.00	0.64
	Necklace	2	0.00	0.00	0.00	0.00	0.00	0.08
	Placing-TV	4	0.01	0.00	0.00	0.00	0.00	0.12
	Rope	27	0.10	0.04	0.00	0.06	0.00	0.32
	Shelf	1	0.00	0.00	0.00	0.00	0.00	0.04
Sideboard	1	0.01	0.00	0.00	0.00	0.00	0.00	
Sodabi	73	0.04	0.45	0.00	0.25	0.01	0.52	
Stool	8	0.00	0.00	0.00	0.04	0.00	0.12	
Table	1	0.00	0.00	0.00	0.00	0.00	0.04	
Top	1	0.00	0.00	0.00	0.00	0.00	0.04	
Raw Material		115	0.38	0.14	0.33	0.33	0.00	1.20
	Rachis	115	0.38	0.14	0.33	0.33	0.00	1.20

Use categories	Uses	Number of citation	Cultural Importance Index (CII) per classes					
			C1	C2	C3	C4	C5	C6
Tools		26	0.14	0.00	0.00	0.06	0.00	0.24
	Fishing-rod	22	0.12	0.00	0.00	0.05	0.00	0.20
	Paddle	4	0.02	0.00	0.00	0.01	0.00	0.04
Food		100	0.08	0.84	0.00	0.19	0.03	0.92
	Wine	100	0.08	0.84	0.00	0.19	0.03	0.92
Worship		17	0.02	0.06	0.67	0.04	0.01	0.16
	Batchè	6	0.02	0.00	0.67	0.01	0.01	0.00
	Bough	8	0.00	0.04	0.00	0.02	0.00	0.16
	Ghost Clothes	3	0.00	0.02	0.00	0.02	0.00	0.00
Firewood		20	0.00	0.02	0.00	0.08	0.00	0.36
	Bundle	20	0.00	0.02	0.00	0.08	0.00	0.36
Global		853	2.16	2.43	2.33	2.17	0.08	9.40
	Informant Diversity Value (IDV)		68.16	51.25	2.58	101.03	3.56	75.75

**Table 7.** Ethnobotanics values per categories of informants of *R. sudanica*

Use categories	Uses	Number of citations	Cultural Importance Index (CI)			
			C1	C2	C3	C4
Handicraft		467	1.56	1.65	1.25	1.83
	Armchair	7	0.00	0.03	0.00	0.03
	Broom	14	0.00	0.06	0.00	0.00
	Basket	6	0.00	0.02	0.00	0.03
	Bed	66	0.56	0.21	0.25	0.33
	Bench	5	0.00	0.01	0.00	0.07
	Bird-Cage	6	0.33	0.00	0.25	0.03
	Bracelet	1	0.00	0.00	0.00	0.00
	Chairs	17	0.00	0.06	0.00	0.07
	Cord	130	0.00	0.50	0.25	0.37
	Curtain	2	0.00	0.01	0.00	0.00
	Door	6	0.00	0.02	0.00	0.03
	Fan	3	0.00	0.01	0.00	0.03
	Fish-trap	8	0.00	0.03	0.00	0.03
	Hat	5	0.00	0.01	0.00	0.07
	Mat	154	0.56	0.55	0.50	0.50
	Sodabi	1	0.00	0.00	0.00	0.00
Stool	22	0.11	0.08	0.00	0.10	
Table	14	0.00	0.04	0.00	0.13	
Construction		16	0.11	0.06	0.00	0.00
	Ceiling	6	0.00	0.03	0.00	0.00
	Enclosure	6	0.11	0.02	0.00	0.00
	Frame	4	0.00	0.02	0.00	0.00
Food		17	0.00	0.07	0.00	0.03
	Wine	17	0.00	0.07	0.00	0.03
Medicine		1	0.00	0.00	0.00	0.00
	Pulp	1	0.00	0.00	0.00	0.00
Raw-material		13	0.00	0.05	0.00	0.07
	Rachis	13	0.00	0.05	0.00	0.07
Tools		16	0.00	0.05	0.00	0.17
	Ladder	2	0.00	0.01	0.00	0.00
	Palette	11	0.00	0.03	0.00	0.17
	Yoke	3	0.00	0.01	0.00	0.00
	Global	530	1.67	1.88	1.25	2.10
Informant Diversity Values (IDV)			6.08	167.20	1.92	22.17

*Impact of raffias' uses on socioeconomics variables for informants*

The users of *R. hookeri* found more income than *R. sudanica* users ( $W = 192960$ ,  $p\text{-value} < 2.2e-16$ ) and these incomes were significantly correlate with use value and relative use value of raffias' species. But the correlation between cultural importance index and the average annual income was not significantly ( $r = 0.088$ ,  $P\text{-Value} = 0.601$ ). The evaluation of the impact of *R. hookeri* use on socioeconomics factors showed that median annual income from *R. hookeri* exploitation vary significantly following education level ( $P\text{-value} = 0.018$ ) and main activity ( $P\text{-value} = 8.861e-14$ ) of informant (Table 8). It showed that the income of not educated (3939.24\$US) was higher than income of those from primary (3385.87\$US) and

secondary (2191.26\$US) school. In same time, the farmer took more income (3912.26\$US) from exploitation of *R. hookeri* than other activities except exploitation of *R. hookeri* (Table 8). The exploitation of *R. hookeri* was the best activity of not educated persons who haven't more opportunities to get job and the best alternative to farmer to get more money to her family. But this exploitation hasn't effect on age classes of informants and type of actors. As regards *R. sudanica*, type of actors ( $P\text{-value} = 0.002$ ) and gender ( $P\text{-value} = 0.020$ ) of informants had a significant effect on median annual income from it use. The transformers took more income (1110.70\$US) from raffias' exploitation than gatherers (7.47\$US). It is same thing for men who took 1136.38\$US from raffias' exploitation, whereas, woman took 66.38\$US.

**Table 8.** Average annual income of use of *R. hookeri* per socioeconomics variables

Variable	Age	Mean (\$US)	Minimum (\$US)	Maximum (\$US)	P-value
Age	Old	6348.21±1569.41	5.11	91927.92	0.109
	Young	3091.81±404.15	4.60	56178.17	
	Adult	2909.09±231.83	20.43	19817.56	
Main activity	Exploitation of raffias	4297.78±880.49	20.43	81713.71	8.861e-14
	Farmer	3912.26±437.96	4.60	91927.92	
	Other	739.10±191.13	10.22	8512.70	
Actor	Transformers	3932.90±433.51	4.60	91927.92	0.683
	Gatherer	2393.94±313.49	10.22	23664.70	
Education	Illiterate	3939.24±484.93	5.45	91927.92	0.018
	Primary	3385.87±608.74	5.11	56178.17	
	Secondary	2191.26±416.78	4.60	14709.94	

**Table 9.** Average annual income of use of *R. sudanica* per socioeconomics variables

Variables	Modalities	Mean (\$ US)	Minimum (\$ US)	Median (\$ US)	Maximum (\$ US)	P-value
Actors	Gatherer	7.47±4.77	0.09	3.06	25.54	0.002
	Transformer	1110.70±532.47	1.70	85.10	221307.96	
Sex	Female	66.38±26.89	3.06	17.00	425.59	0.020
	Male	1136.38±545.86	0.09	86.00	221307.96	
Age	Adult	1651.99±1436.29	0.17	85.10	221307.96	0.501
	Old	1256.25±646.78	2.55	89.40	68405.47	
	Young	487.37±203.66	0.09	85.10	34047.38	
Education	Illiterate	1350.27±742.94	1.70	85.10	221307.96	0.065
	Primary	640.54±364.46	0.09	89.40	34047.38	
	Secondary	201.86±56.08	3.41	85.10	1940.89	
Main activities	Farmer	1121.50±538.48	0.09	85.10	221307.96	0.107
	Other	82.05±35.88	3.41	25.50	297.94	

Because the interactions between socioeconomics variables were not possible with Kruskal-Wallis test, to take in to account them, the average annual income of categories of informants were compared and it showed that median annual income from *R. hookeri*

varied significantly ( $P\text{-value} = 0.0001$ ). Then, the young and old farmers who exploit raffias species like secondary activity (category 4) took more annual income (6205.73\$US) than others categories. It followed by category of adults and old gatherers not

educated (category 2) which took 4828.64\$US as annual income from exploitation of *R. hookeri*. The category which took a least income from exploitation of *R. hookeri* is adult educated (secondary) that have other activities except agriculture and exploitation of raffias species (category 3).

As regards *R. sudanica*, the category 2 composed of olds or adults' persons not educated (illiterates) or from primary level took more income (1678.85\$US) from exploitation of *R. sudanica* than category 4 (366.41\$US), category 3 (268.15\$US) and category 1 (66.48\$US) (Table 11).

**Table 10.** Average annual income of use of *R. hookeri* per users' categories

Categories	Mean	Minimum	Median	Maximum
Category 1	2391.79±349.60	4.60	1242.85	14709.94
Category 2	4828.64±1283.45	24.52	2043.05	81713.71
Category 3	218.49±83.71	51.08	302.20	302.20
Category 4	6205.73±1209.27	5.11	2877.29	95166.24
Category 5	3182.68±1157.15	302.20	3234.82	5958.89
Category 6	3982.46±402.31	51.08	2715.55	19817.56

**Table 11.** Average annual income of use of *R. sudanica* per users' categories

Categories	Mean (\$ US)	Minimum (\$ US)	Median (\$ US)	Maximum (\$ US)
Category 1	66.48±35.18	3.41	25.50	297.94
Category 2	1678.85±988.47	1.70	85.10	221307.96
Category 3	268.15±178.77	89.38	268.00	446.92
Category 4	366.41±173.85	0.17	85.10	5162.44

## Discussion

### *Use and ethnobotanics values of raffias*

The use value of each specie showed that the number of uses known for *R. hookeri* was larger than those known for *R. sudanica*. Indeed *R. hookeri* range is Guinean zone which is more developed than soudano-guinean or soudanian zones because is opened on the world and received more strangers due to the roads, airport and port that are developed there. This situation permits cultural brazing between populations and strangers, then the knowledge on use of forest resources was improved. This comparison of number of use of both species permit to conclude that *R. hookeri* is more important for people in Guinean zone than *R. sudanica* in soudano-guinean or soudanian zones. Another reason, generally, the different measures of palm use and importance differed greatly between species, indicating that species-specific characteristics determine the degree to which a palm is used and esteemed (Byg and Balslev, 2001). It means that species with high use values had also high number of uses known by

informants. Then it notices that for species with a high number of uses the contribution of the different uses to the total utility of that species varied greatly.

The principal use category of raffias' species was handcraft and the plant part frequently used by informant was rachis. In Zahamena, eastern Madagascar the most frequently mentioned application was that of palm hearts as food source (Byg and Balslev, 2001). The conclusion is the principal use category and most frequently plant part used depend on socioeconomic context in which the resource is used. As regards raffias' species, except sap whose excessive consumption is harmful to human health because it contains alcohol, other plant parts were used in handcraft because they can't be sold without an added value. Tardio and Pardo-de-Santayana (2008) found in Southern Cantabria (Northern Spain) that the first use category of useful wild plants is craft followed by its use for animal food, for firewood and for symbolic uses.

The rachis was the plant part which was more available during certain period of the year and renewable sometime, then it was the plant part easy to harvest and its transformation was mastered with the time by people. It had the high value of use value. It can be concluded that higher is the use value, most the plant part is frequently used.

#### *Categories of raffias' users*

The required socioeconomic variables to categorize the raffias' users were age, gender, type of user, classes, education level and main activities (Donou Hounsodé *et al.*, 2016). The type of user (gatherers and transformers) and the gender were used as supplementary data because more and more users are men and transformers. Because the exploitation of raffias' species need more force to access their habitat (presence of water or slippery soil) and to harvest the raffias' organs and the presence of thorns on the plants, only the men exploited them. But there are women who sold the raffias' products and are going to study in value chain analysis. In this study, the numbers of users' categories vary greatly following the raffias' species because the socioeconomic variables which influence the exploitation of raffias' species depend on the raffias' species (Donou Hounsodé *et al.*, 2016). It means that the ethnobotanics studies of palms must take in to account the socioeconomic context of users because a change in socioeconomic context of user, changes will be made in uses of the palm, in harvesting practices and in the price of everything (Anderson, 2004). For example, in this study, according to users' categories, if they become old or farmers, they will regard raffias' species as useful than others. But, more they have high education level, least they consider exploitation of raffias' species as main activity.

#### *Impact of socioeconomic characteristics of informants on income from raffias' species*

The income from exploitation of raffias' species was correlated with use value and means that more the use value is high more the income increase. Then, the users of *R. hookeri* brought more income than users of *R. sudanica*. Indeed, the distribution area of

*R. hookeri* is Guinean zone which is developed part of Benin where there are many infrastructures like airports and ports and which are visited by strangers (Europeans and Americans) who claim the quality of products which become more expensive. More the product is expensive more it brought back a lot of income. For example, about the social context for harvesting *Iriarteia deltoidea*, it said that new roads have opened access to new areas and the potential for new jobs, especially for men (Anderson, 2004). This means that the new road creates favorable environment to develop our business and consequently to get more money. This change occurs changes in uses of the palm and changes in the price of everything like raffias' products. The informants said that, traditional uses of palms have found entry into the market for tourist souvenirs. Bag, key ring and bird cage are sold in hotels and shops in towns through which eco-tourists often pass. Due to the cultural signification of products, they were sold very expensive to the tourists.

There linear correlation between cultural importance index and the income from product wasn't significant. It means that, cultural importance index is not able to use in determining of average annual income from non-timber forest products (NTFP). In addition, the cultural importance index didn't take in to account only the use value. Then we can conclude that, for better determine the income from raffias' products, it will be interesting to take into account the consumers by studying the value chain of raffias' products. But, the average income from raffias' exploitation was affected by education level, the main activity, actor type (gatherer or transformer) and sex contrary to Aiyeloja *et al.* (2014) who said that demographic characteristics such as age, sex, marital status and educational qualification had no influence on the profitability of the raffia wine. However, the location of the marketers (Community) was significant. The same author said in his previous article that, most NTFPs are gathered and processed by women and children while men are involved in the collection from difficult terrains and those requiring physical strength (Aiyeloja *et al.*, 2012).

Considering raffias' habitats (swampy area) and their morphology (thorns), their exploitation requires physical strength and exclude some part of women and certain age classes. Besides, there are about 50% Muslim in Nigeria who didn't drink alcohol, it would be necessary to take into account the religion and others demographic characteristics. If palms use and use value depend on socioeconomic characteristics of users (Anderson, 2004; Araújo and Lopes, 2012; Balslev *et al.*, 2010; Bennett and Hicklin, 1998; Bernal *et al.*, 2011; Byg and Balslev, 2001; Byg and Balslev, 2006; Byg *et al.*, 2006; Poché *et al.*, 2012; Sampaio *et al.*, 2012; Schroth *et al.*, 2004), we think that the income from the exploitation of palm would be influenced by one of the socioeconomic characteristics of users. For example, highly educated people are often not interested in agricultural activities, therefore they use less NTFPs and derive less income. Like that, the impact of socioeconomics variables on this income from raffias showed that more the informants are educated less he get a lot of income from raffias' exploitation. But, the main activity which is compatible with the exploitation of raffias' species is agriculture. Indeed, the raffias species are in field or near the field then it is easy for farmers to use them. The exploitation of raffias' species need more time and after rural activities the farmers have a lot of time to transform the organs harvested. It is an activity which diversifies their sources of income. Like Kar and Jacobson (2012) and Paumgarten (2005) NTFPs are considered a safety net to fill in the gaps should there be an agricultural shortfall or another kind of emergency state that NTFPs supplement household diets and income as well as serving as an "economic buffer in hard times". As regards *R. sudanica*, the transformer took more income than gatherer because the handicraft items have added value. In addition to this, in Benin, the organs from raffias' species never sold as gross product because more you add value, more you get a lot of money. As regards the interaction between the socioeconomics variables, we can learn that the median of annual income from raffias' uses vary significantly under the following socioeconomics conditions of users and the type of raffias' species.

Considering the informant categories, the income from exploitation of both species decreases from the first above socioeconomics terms at the last:

#### *R. hookeri*

- Young and old farmers who exploit raffias' species like secondary activity.
- Adults and old gatherers not educated.
- Adult transformer illiterate/primary level who have agriculture as main activities.
- Young and old educated (secondary) who have exploitation of raffias species and others (except agriculture) as main activities.
- Young transformers educated (primary and secondary) who have agriculture like main activity.
- Adult educated (secondary) who have other activities except agriculture and exploitation of raffias species.

#### *R. sudanica*

- Old or adult farmers not educated or primary level. They are mainly transformers and men.
- Old men transformers of secondary level or not educated who have other main activities except agriculture.
- Old men transformers of secondary level or not educated who have other main activities except agriculture.
- Young men transformers of secondary level who have other main activities except agriculture.

### **Conclusion**

The number of uses is greater for *R. hookeri* than *R. sudanica* but the principal plant part used for both species is rachis which is used to make bed, mat, basket, etc. These raffias' species are used principally in handicraft. The income from exploitation varied significantly following age and main activities for *R. hookeri* and type of informant (Gatherer and Transformers) and sex for *R. sudanica*. The old persons and farmers took more income than others age classes and main activities. The transformers and men took more income from exploitation of *R. sudanica* than others gatherer and women.



The income of both species is correlated with number of use and relative use value. The user categories will be considered in all programs concerning management of raffias' species populations are six (06) for *R. hookeri* and four (04) for *R. sudanica*. But it is necessary to take in accounts the old transformers who have agriculture as main activity. The sustainable management of raffias' species populations must contribute to improve the life level of old people, the illiterate in rural areas and farmer.

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