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Floristic Diversity of Edible Non-Timber Forest Products (NTFPs) Sold on the Markets of Brazzaville

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Abstract **Original Research Article**

The Congolese flora abounds in an important reserve of edible non-timber forest products (NTFPs). The present study was conducted to assess the floristic diversity of edible non-timber forest products sold in the markets of Brazzaville. An ethnobotanical survey was carried out using an open questionnaire in the markets of Brazzaville. Data on the floristic diversity of edible NTFPs was collected according to a standardised framework inspired by the resulting NTFP survey database. The identification of the plants mentioned was carried out in the field and at the Brazzaville Herbarium. This study recorded 65 species offering edible non-timber forest products divided into 28 families and 45 genera. The most represented family is the Gnetaceae (24.30%). The most consumed species was Gnetum africanum Welw (15.09%). The most consumed organs were fruits (61.24%). The NTFPs inventoried were much more consumed processed (44.79%). The most dominant phytogeographic type was the Guinean-Congolese type (66.54%). Trees (40.69%) were the dominant morphological type. The majority of NTFPs inventoried orinated from forests (90.24%). This work could constitutes a basic study for further scientific investigation.
Keywords: NTFP, plant consumption, Food, trade, Congo.

INTRODUCTION

Food insecurity is one of the scourges that plague many countries in the world today. It is currently estimated that nearly 690 million people worldwide are hungry, or 8.9 percent of the world's population, or 10 million more people in one year and nearly 60 million more in five years (FAO 2020. Nearly 5 million children in developing countries are malnourished and lack essential vitamins. The consequences of this malnutrition are felt in the health of young and adult populations around the world (Loubelo E, 2012).

Non-timber forest products (NTFPs) are part of the natural resources that the Congolese population use to diversify its productive activities and improve its income. These products are an essential part of the various menus; they guarantee the diversity, quality and accessibility of food for a large majority of the population (FAO, 2012). The availability of food in the household requires that it is accessible in local markets. Sustainable production mechanisms, stocks and marketing mechanisms at both local and external market levels are essential. Dysfunction in each of these links contributes to food insecurity (FAO, 2004). Stable production and prices, market infrastructure, storage capacity and conservation are also essential to ensure food for the population.

According to FAO (2003), there are all kinds of non-timber forest products in Africa, such as gums and resins, honey and beeswax, medicinal and aromatic plants, dyes and tanning materials, bamboo and rattan, bushmeat and fodder. Despite their important role in the rural economy, information on their overall contribution is patchy and incomplete at best, except for a few commercially important species and products (FAO, 2012).

Knowledge in edible NTFPs of plant origin traded on the Brazzaville markets provides indications that can guide the population of Brazzaville to improve knowledge of the use of these products and then allow the scientific community to have a database on these products in order to develop some avenues of domestication of edible NTFPs of plant origin in relation to the demand on the Brazzaville markets. The survey aimed to identify: (1) the species of edible NTFPs of plant origin traded in Brazzaville markets; (2) the organs and different parts of these organs of edible NTFPs of plant origin used or consumed by the population of Brazzaville; (3) the different modes of consumption of these products.

MATERIALS AND METHODS

Study area

The study was conducted mainly in urban areas, particularly in Brazzaville.which accounts for almost a third of the country's total population. On the basis of certain criteria such as NTFP entry routes and the various uses of NTFPs on the markets or by the population, Brazzaville was divided into four zones (Zone A : arrondissement 9; Zone B: arrondissement 6; Zone C: arrondissements 3, 4 and 5; Zone D: arrondissements 1, 2, 7 and 8) and seven to eight markets were selected per zone out of a total of thirty (30) markets.

1.1. Méthodes

Over the period from September 2019 to August 2020, i.e. twelve (12) months, an ethnobotanical inventory was carried out using the so-called qualitative multi-resource inventory method accompanied by individual observations, employed by several authors (Lejoly J *et al.*, 1993, Mbété R.A *et al.*, 2011). During this survey phase the local and scientific names of edible NTFPs of plant origin, families and genera were determined.

A herbarium was set up for the undetermined species in the field, with a view to their botanical identification at the Brazzaville Herbarium. Descriptive statistics, analysis of variance, student's test and the use of the following ecological indices were used to assess the floristic diversity of the four marketing zones distinguished:

- Richness indices (Bruhier V.S. *et al*. 1998).
- Overall richness : total number of species present in a given area ;
- Original richness : the number of species present only in one area and not in all four ;
- Local richness : the average of the specific richness (number of species) per market calculated on all markets in the same area :
- Common species background : the total number of species present simultaneously in the four selected areas :

- Family diversity index (Di (%))

$$Di\ (\%) = \frac{nomber\ of\ species/\ family}{Total\ number\ of\ species\ /\ family}\ x\ 100$$

- Shannon index

$$H' = -\sum Pi * \log_2 Pi$$

Pi is the specific frequency of species i and varies from 0 to 1, while H' is generally between 0 and 5 bit (Barbault R, 1997). The Shannon index has high values for species with the same amount of cover or floristic diversity and takes low values when some species have high cover or different floristic diversity.

- Index of maximum floristic diversity

$H_{max} = \log_2 S$
S: species richness

H_{max} provides information on the maximum diversity that can be achieved by a phytocenosis ;

- Pielou Equitability Index

$$Eq = \frac{H'}{Hmax}$$

H': Shannon index ; H_{max} : Index of maximum floristic diversity

Pielou's equitability index varies from 0 to 1 and makes it possible to assess intra-community variations. It tends towards 1 when all species have the same abundance and tends towards 0 when one species is dominant (Legendre L and Legendre P, 1984, Pielou E.C, 1984, BockoY.E *et a*l 2016).

Species rarefaction index or Géhu and Géhu rarefaction index (Géhu J.M. and Géhu J., 1980).

- [14].

Ri = [1 – (ni / N)] x 100
With:

- Ri : rarefaction index of a species i;
- ni : number of plots where it is found;
- N : total number of plots surveyed.

Species with a rarefaction index of less than 80% are considered preferential, very frequent and abundant in the areas studied. Species with a rarefaction index greater than 80% are considered rare and therefore vulnerable to extinction in the locality (Géhu J.M. and Géhu J., 1980).

- Relative dominance

$$Dr\ (\%) = \frac{Number\ of\ individuals/\ species}{Total\ number\ of\ individuals/\ species}\ x\ 100$$

- Relative frequency

$$Fr\ (\%) = \frac{Number\ of\ records\ with\ species\ present}{Total\ number\ of\ records\ of\ species}\ x\ 100$$

- Raw spectrum of consumed elements

Raw spectrum =
$$\frac{\Sigma\ of\ element\ used\ or\ consumed\ by\ species}{Total\ number\ of\ species}\ x\ 100$$

The raw spectrum of phytogeographic types, morphological types and habitat types. The parameters noted for each species are habitat type, morphological or biological type, and phytogeographical type.

The phytogeographical distribution is based on African chorol (White F., 1979; White F., 1986). According to this classification, the recognised elements are: (i) broadly distributed element [Cosmopolitan (Cosm), Pantropical (Pant), Paleo-tropical (Paleo), Afro-malagasy (Afma), Afro-American (Afam)]; (ii) linkage element [Afro-montane (Afm), Afro-tropical (Aftr), Afro-montane-Afro-tropical (AfmAftr), Afro-montane-Guineo-Congolese (Afm-GC)]; (iii) endemic element [Guineo-Congolese (GC)], Guineo-Congolese-Zambezian (GC-Z), Bas-Guinea-Congolese (BGC), Zambezian (Z), Congolese (C), Guineo-Congolese-Sudanese (GC-S), Bas Guinéens (BG) (Kimpouni V *et al.* 2018).

The raw spectrum was evaluated according to this formula:

$$\text{Raw spectrum (S)} = \frac{\text{Number of representations of a species}}{\text{Total number of species}} \times 100$$

2. RESULTS

2.1. Floristic richness

- **Global, original, local richness and the common fund**

In thirtytarget markets in the study area, 9757 NTFP stalls were inventoried, 65 species of edible non-timber forest products of plant origin divided into 28 families, and 45 genera were identified. Figure1, presents the ecological indices of richness obtained during this study.

The survey showed that the local richness obtained after quantifying the species richness (number of species per market) varyedies very little : Zone A (26), Zone B (27), Zone C (26) and Zone D (33), with an average of about 28±4 species per market. The overall richness varied from one zone to another, ranging from 38 to 57 species, with an average of 47±8 species for all the markets. Zone D had the highest overall richness (57 species), followed by Zone B (51 species), Zone A (43 species) and Zone C (38 species). The original richness was also high in Zone D with 8 species compared to Zone A and B with 1 and 2 species respectively ; Zone C has no original richness. The common background of the four edible NTFP plant marketing zones was 26 species.

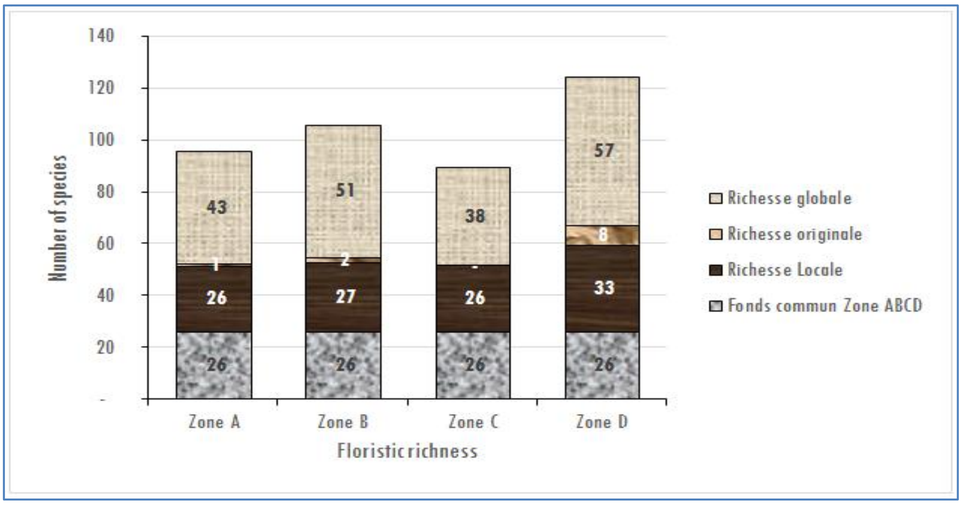

Fig-1: Distribution of richness indices by marketing area

Family diversity

The family diversity of species was determined by taking into account the number of species per family. On the Brazzaville markets, the five most diverse families (traded), in descending order, are: Gnetaceae (24.30%), Zingiberaceae (13.04%), Apocynaceae (11.39%), Arecaceae (9.01%) and Sapindaceae (7.97%) and the five least traded families, in ascending order are: Rubiaceae (0.03%), Lamiaceae (0.06%), Oxalidaceae (0.08%), Bombacaceae (0.14%) and Irvingiaceae (0.18%). The difference between the families was highly significant (P < 0.05).

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- **Genus diversity**

The diversity of genera was determined by taking into account the number of species per genus. The five most traded genera on the Brazzaville markets, in descending order, are : Gnetum (24.30%), Aframomum (12.98%), Landolphia (8.27%), Cola (6.65%) and Laccosperma (6.24%). The five least traded genera, in ascending order, are: Sarcocephalus (0.03%), Anacardium (0.03%), Tamarindus (0.04%), Treculia (0.05%) and Costus (0.06%). The difference between the genera is highly significant (P < 0.05).

- **Class diversity**

Class diversity was determined by taking into account the number of species per class. In the Brazzaville markets, the Magnoliopsida (47.16%) werethe most dominant class, followed by the Liliopsida (27.26%), the Gnetopsida (24.30%) and the Polypodiopsida (1.28%). The difference between the classes was highly significant (P < 0.05).

- **Order diversity**

The diversity of orders was determined by considering the number of species per order. In Brazzaville, the trade in edible NTFPs of plant origin was dominated by Gnetales (24.30%), followed by Zingiberales (13.04%), Gentianales (11.42%), Malvales (10.23%) and Sapindales (9.93%). The least traded in ascending order were Lamiales (0.06%) and Oxalidales (0.10%). The difference between the orders is highly significant (P < 0.05).

- **Relative dominance (Density) and relative frequency (Fr)**

The results of the relative dominance (density) and relative frequency (Fr) indices for the four surveyed areas, are presented in Table 1, showed that the five (5) most dominant species in the study area, were associated in decreasing order as follows : Gnetum africanum Welw (15.09%) ; Gnetum buchholzianum Engl (9.21%) ; Aframomum giganteum (Oliv. & D. Hanb) K. Schum. (6.89%) ; Laccosperma secundiflorum (P. Beauv.) Kuntze (6.24%) and Chrysophyllum lacourtianum De Wild (5.17%). Thus the five (5) less abundant species in the study area, associated in ascending order as follows : Anacardium occidentale L (0.03%), Sarcocephalus latifolius (Sm.) E. A. Bruce (0.03%), Tamarindus indica L. (0.04%) ; Dacryodes pubescens (Vermoesen) H. J. Lam (0.04%) and Treculia africana Decne. ex Trécul (0.04%). The difference within species was highly significant, (P < 0.05).

The relative frequency index in the Study Area was higher for the following species : Gnetum africanum Welw, Gnetum buchholzianum Engl, Chrysophyllum lacourtianum De Wild, Cola acuminata (P. Beauv.) Schott & Endl, Cola nitida (Vent.) Schott & Endl, and Cola rostrata K. Schum, with 100% each of them. This means that these species have been identified over all markets in Brazzaville.

Table-1: Indices of relative dominance (density) (Dr) and relative frequency (Fr) of the four surveyed areas

PFNL-COV	Relative frequency (Fr)					Relative dominance (Dr)				
	Area A	Area B	Area C	Area D	Study area	Area A	Area B	Area C	Area D	Study area
Gnetum africanum Welw.	100	100	100	100	100	13.36	15.83	17.51	13.65	15.09
Gnetum buchholzianum Engl.	100	100	100	100	100	9.25	9.64	10.68	7.28	9.21
Aframomum giganteum (Oliv. & D. Hanb) K. Schum.	100	88	100	100	97	7.66	7.15	6.74	6.01	6.89
Laccosperma secundiflorum (P. Beauv.) Kuntze	100	100	100	13	78	8.88	8.48	7.17	0.44	6.24
Chrysophyllum lacourtianum De Wild.	100	100	100	100	100	6.19	5.40	5.22	3.88	5.17
Dioscorea liebrechtsiana De Wild	14	75	100	100	72	0.92	4.11	7.17	7.50	4.93
Aframomum alboviolaceum (Ridl.) K. Schum.	100	88	100	100	97	4.23	4.57	4.18	5.46	4.61
Litchi sinensis Sonn.	100	88	100	100	97	3.06	3.95	5.60	4.35	4.24
Nephelium lappaceum L.	100	88	100	100	97	2.45	3.53	5.13	3.79	3.73
Grewia coriacea Mast.	100	88	100	100	97	5.45	2.20	2.80	3.27	3.43
Piper guineense Schum. & Thonn.	100	88	100	100	97	2.08	2.62	3.99	3.74	3.11
Landolphia owariensis P. Beauv.	100	88	100	100	97	2.27	1.95	2.52	3.57	2.58

Landolphia lanceolata (K. Schum.) Pichon	100	88	100	100	97	2.51	2.29	1.95	3.52	2.57
Landolphia jumellei (Pierre ex Jum.) Pichon	86	88	86	100	90	2.27	2.66	1.76	2.77	2.36
Cola acuminata (P. Beauverd) Schott & Endl.	100	100	100	100	100	2.27	2.24	2.23	2.27	2.25
Cola nitida (Vent.) Schott & Endl.	100	100	100	100	100	2.08	2.20	2.14	2.49	2.23
Saba Comorensis (Bojer) Pichon	86	100	71	100	89	2.51	2.08	1.57	2.63	2.20
Cola rostrata K. Schum.	100	100	100	100	100	1.90	2.20	2.09	2.49	2.17
Garcinia mangostana L.	100	100	86	100	96	2.21	1.62	1.47	1.99	1.82
Pteridium aquilinum subsp. centrali africanum Hieron.	86	63	57	38	61	2.21	1.12	0.90	0.89	1.28
Aframomum melegueta (Roscoe) K. Schum.	57	50	71	100	70	1.04	1.12	1.42	1.14	1.18
Raphia hookeri G. Mann & H. Wendl.	57	75	29	25	46	1.78	1.45	0.38	0.25	0.96
Raphia sese De Wild.	86	88	29	-	50	1.84	1.54	0.38	-	0.94
Anisophyllea quangensis Engl. ex Henriques	43	13	14	100	42	1.29	0.17	0.47	1.58	0.88
Trichoscypha acuminata Engl.	29	25	57	88	50	0.49	0.33	0.90	1.41	0.78
Mammea africana Sabine	29	13	-	38	20	1.29	0.96	-	0.86	0.78
Mondia whitei (Hook.fil.) Skeels	57	25	43	75	50	1.04	0.33	0.71	0.80	0.72
Garcinia kola Heckel	57	13	43	88	50	0.98	0.21	0.57	0.91	0.67
Raphia laurentii De Wild.	57	63	14	-	33	1.10	1.29	0.24	-	0.66
Antrocaryon klaineanum Pierre	14	25	-	25	16	0.49	0.75	-	0.64	0.47
Canarium schweinfurthii Engl.	14	25	-	25	16	0.37	0.66	-	0.50	0.38
Monodora myristica (Gaertn.) Dunal	14	13	-	38	16	0.49	0.25	-	0.75	0.37
Aframomum citratum (J. Pereira) K. Schum	14	13	-	13	10	0.61	0.33	-	0.28	0.31
Trilepisium madagascariensis DC.	-	-	-	63	16	-	-	-	1.19	0.30
Xylopia aethiopica (Dunal) A. Rich.	14	25	-	-	10	0.43	0.75	-	-	0.29
Baillonella toxisperma Pierre	14	13	-	38	16	0.31	0.33	-	0.53	0.29
Lasimorpha senegalensis Schott	29	38	-	-	17	0.55	0.54	-	-	0.27
Dacryodes heterotricha (Pellegr.) H. J. Lam	14	-	-	38	13	0.37	-	-	0.66	0.26
Coula edulis Baill.	14	-	-	63	19	0.31	-	-	0.72	0.26
Tetracarpidium conophorum (Müll. Arg.) Hutch. & Dalziel	-	25	14	25	16	-	0.33	0.24	0.39	0.24
Myrianthus arboreus P. Beauv.	-	-	14	63	19	-	-	0.19	0.72	0.23
Eremospatha wendlandiana ammer ex Becc.	-	13	14	38	16	-	0.29	0.33	0.22	0.21
Clitandra cymulosa Benth.	14	13	-	13	10	0.43	0.25	-	0.14	0.20

Chrysophyllum africanum A. DC.	14	13	-	38	16	0.25	0.21	-	0.36	0.20
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	-	-	-	50	13	-	-	-	0.72	0.18
Olax latifolia Engl.	-	25	-	13	9	-	0.50	-	0.19	0.17
Dialium englerianum Henriq.	-	-	14	50	16	-	-	0.19	0.47	0.17
Adansonia digitata L.	-	13	29	25	17	-	0.08	0.24	0.25	0.14
Landolphia dulcis (Sabine ex G. Don) Pichon	-	50	57	63	42	-	0.17	0.19	0.19	0.14
Landolphia Kirkii Dyer	-	50	57	63	42	-	0.17	0.19	0.19	0.14
Annona senegalensis Pers.	14	-	-	25	10	0.25	-	-	0.25	0.12
Landolphia Parvifolia K. Schum.	-	38	57	50	36	-	0.12	0.19	0.17	0.12
Landolphia myrtifolia (Poir.) Markgr.	-	38	57	50	36	-	0.12	0.19	0.17	0.12
Landolphia buchananii (Hallier fil.) Stapf	-	25	57	63	36	-	0.08	0.19	0.19	0.12
Scorodophloeus zenkeri Harms	14	13	-	-	7	0.25	0.21	-	-	0.11
Averrhoa carambola L.	14	-	-	-	4	0.31	-	-	-	0.08
Landolphia ligustrifolia (Stapf) Pichon	-	13	-	13	6	-	0.17	-	0.11	0.07
Landolphia foretiana (Pierre ex Jum.) Pichon	-	13	-	-	3	-	0.25	-	-	0.06
Costus ligularis Baker	-	-	-	25	6	-	-	-	0.25	0.06
Vitex doniana Sweet	-	-	-	25	6	-	-	-	0.25	0.06
Treculia africana Decne. ex Trécul	-	13	-	-	3	-	0.21	-	-	0.05
Dacryodes pubescens (Vermoesen) H. J. Lam	-	-	-	13	3	-	-	-	0.17	0.04
Tamarindus indica L.	-	-	-	13	3	-	-	-	0.17	0.04
Sarcocephalus latifolius (Sm.) E. A. Bruce	-	-	-	13	3	-	-	-	0.11	0.03
Anacardium occidentale L.	-	-	-	13	3	-	-	-	0.11	0.03

Floristic diversity

- **Species diversity and equitability**

The results concerning the biodiversity index of the four edible plant NTFP in marketing areas are presented in Table 2. It can be seen that the Shannon-Weaver index of specific diversity has high values in overall (4.3 to 4.8), sugesting that the edible plant NTFPs are diverstly identified. In contrast, the regularity index (Pielou Equitability) has low values (i.e. 0.4 in all zones), indicating that the distribution of these NTFPs is not equitable. The difference within the Shannon indices was not significant (P > 0.05).

Table-2: Specific diversity and equitability of the study areas.

Index	Area A	Area B	Area C	Area D
Numer of species	43	51	38	57
Maximum diversity	11	11	11	12
Shannon index	4.7	4.6	4.3	4.8
Equitability index	0.4	0.4	0.4	0.4

- **Rarefaction index of species or Géhu and Géhu rarefaction index**

Table 3 indicates the rarefaction index of species traded on the Brazzaville markets for consumption. The rarefaction index of the species evaluated in this study was ranged between 0 and 88 (0 < R ≤ 88). In Brazzaville, the majority of species, i.e. 77.10% of the taxa inventoried, have a rarefaction index of less than 80% ; these species are known to be more abundant, while those with a rarefaction index of between 80 and 88% in all areas, i.e. 22.90% of the total species in Brazzaville, are scare.

Table-3: Rarefaction index of species inventoried in the study area

Rarefaction index	Area A	Area B	Area C	Area D	Study area
Ri ≥ 80%	32.56	27.45	15.79	15.79	22.90
Ri < 80%	67.44	72.55	84.21	84.21	77.10

- **Raw spectrum of NTFP organs used**

The plant organs used as edible NTFPs identified were fruits, leaves, stems and roots. Fruits were the organs the most used or consumed as edible NTFPs in all areas, followed by leaves, stems and roots. However, in Brazzaville, 61.24% of fruits are sold, followed by leaves (24.96%), stems (13.08%) and roots (0.72%). The difference between the different organs of the species used or consumed was significant (P < 0.05).

- **The raw spectrum of fruit types traded**

The types of fruit sold as edible NTFPs of plant origin identified were drupes, berries, follicles, false fruits and pods. Berries are the most traded type of fruit in all areas, followed by drupes. Mean while, in Brazzaville, 59.46% of berries are sold, followed by drupes (28.36%), follicles (11.38%), false fruits (0.48%) and pods (0.32%). The difference between the types of fruit sold or consumed is highly significant (P < 0.05).

- **Raw spectrum of consumtion patterns**

Edible NTFPs of plant origin traded in Brazzaville markets are consumed either raw or processed (boiled, grilled, prepared, etc.). In areas A, B and C, the most common mode of consumption is processed, with 43.50%, 48.61% and 48.98% respectively. On the other hand, in area D, these products are consumed much more raw with a percentage of 45.56%. In Brazzaville, edible non-timber forest products of plant origin are consumed both processed (44.79%) and raw (39.14%), or both raw and processed at the same time (16.08%). The difference between the modes of consumption of edible NTFPs of plant origin is highly significant (P < 0.05).

- **Raw spectrum of phytogeographic types**

The phytogeographic types of the identified species were: Guineo-Congolese, Pantropical, Cosmopolitan, Guineo-Congolese-Zambezian, Lower Guineo-Congolese, Zambezian, Paleo-tropical, Afro-tropical, Guineo-Congolese-Sudanese, Lower Guinean and Afro-Malagasy. The most represented phytogeographic type is Guineo-Congolese (66.54%), Low Guineo-Congolese (10.09%), Pantropical (9.95%), Zambezi (5.62%), Guineo-Congolese-Zambezi (3, 97%), Cosmopolitan (1.28%), Paleo-tropical (1.18%), Afro-tropical (0.65%), Guinean-Congolese-Sudanese (0.30%), Lower Guinean (0.30%), Afro-Malagasy (0.12%). The difference between the phytogeographic types is highly significant (P < 0.05).

- **Raw spectrum of morphological types**

The morphological types of the identified species were: Trees, lianas, herbaceous, shrubs and bushes. The morphological type that produces the most edible NTFPs of plant origin traded in Brazzaville markets is Trees (40.69%), followed by lianas (34.70%), herbaceous (23.61%), shrubs (0.88%) and bushes (0.12%). The difference between morphological types is highly significant (P < 0.05).

- **Raw spectrum of habitat types**

The edible NTFPs of plant origin identified in the Brazzaville markets were dominated by products from forests (90.24%), followed by those from the savannah (9.76%). The difference between habitat types is highly significant (P < 0.05).

DISCUSSION

The importance of NTFPs from natural tropical forests is well documented. It is already widely known that food and fodder provided by natural forests are particularly important in agricultural systems subject to the variation of the seasons, both as nutritional supplements and as food in times of drought and other contingencies. They are often the most obvious manifestation of the value of the forest to people.

The floristic richness of Brazzaville indicated a diversity of 65 species of edible NTFPs of plant origin, belonging to 45 genera and 28 families. These results are similar to those obtained by many authors (Ouattara N.D *et al.*, 2016 ; Maléla K.E, *et al.*, 2016 ; Houmenou V *et al.*, 2017), but lower than those obtained by Profizi J.P *et al*., (1993), who reporte 166 species belonging to 56 families are used for food. This can be explained by the fact that several NTFPs inventoried at that time have lost their title of wild species, i.e. have been converted from wild to fully domesticated species. It can also be explained by the fact that the work of Profizi *et al*. (1993) was conducted nationwide. These results were also lower than those obtained by Koakou K.A, *et al.* (2018), because they worked on all NTFPs of plant origin and in a wider forest area than our study area. However, these results were higher to those obtained by Kimpouni V *et* *al.* (2018) who also worked on NTFPs, more specifically on pteridophytes.

The family of edible NTFPs of plant origin most valued by the people of Brazzaville were the Gnetaceae, followed by the Zingiberaceae and Apocynaceae. And the most valued or consumed species of all edible NTFPs of plant origin was *Gnetum africanum* Welw. These results are in line with those obtained by Mialoundama F (1996), who states that among the edible foliage of the Central African rainforests and the DRC in particular, that of the small understorey liana of the genus Gnetum is particularly appreciated by consumers who collect it. Furthermore, Chevalier A (1951) notes that in 1950 his attention was drawn to a plant product sold all year round in the markets of Bangui and known to the peoples of the Central African sub-region as "koko". The two African species (*Gnetum africanum* and *Gnetum buchholzianum*) are small undergrowth vines with edible leaves. They are a valuable source of protein and minerals, which are traded by women throughout the year in Central African markets. Of all these NTFP foods, one of the most consumed is *Gnetum africanum* (Anonymous, 2001 ; Mialoundama F (1996), According to Sunderland T.C.H *et al.*, (2000) Gnetum is the most valuable NTFP for both domestic consumption and marketing.

Although the Gnetaceae family and the species gnetum africanum Welw were the most valued by the population of Brazzaville, the most consumed organs of these edible NTFPs of plant origin were fruits. These results confirm those of Toirambe Bamoninga B (2007), who showed that the organs of NTFPs commonly sought and consumed by the Congolese population are fruits (45%), followed by leaves (38%), tubers or rhizomes (11%), bark (2%) and small pieces of wood (1%).

The type of fruit sold as edible NTFPs in the Brazzaville markets were berries, followed by drupes, follicles, false fruits and pods. The most consumed part of these fruits is the pulp. These results confirm those obtained by Malela K.E *et al.* (2016). The most consumed part of the stems is the terminal bud ; of the leaves is the leaf blade and of the roots is the bark. These edible NTFPs of plant origin are consumed processed (roasted, boiled, prepared and many others). These results differ from those obtained by Mosango M and Szafranski F (1985), who worked only on fruits and showed that in this area fruits are consumed more raw than processed. Also, these results confirm those obtained by Monizi Mawunu *et al.* (2016) and Ouattara N.D *et al.* (2016).

This study also shows that the majority of edible NTFPs of plant origin traded on the Brazzaville markets are of the Guinean-Congolese phytogeographic type, followed by Bas-Guineo-Congolese and Pantropical species. These results are in line with those obtained by Malela K.E *et al*. (2016) who state that the phytogeographic types of the species inventoried show a high representation of endemic species (EE), i.e. Guineo-Congolese, which cover 86%. This chorological category is followed by African species with a wide distribution (EALD : 9.47%). Very widely distributed species (VWS) and linkage species (LS) were poorly represented. But these results contrast from those obtained by Kimpouni V, *et al.* (2018), who working only on pteridophytes that constitute part of the NTFPs of plant origin, state that the data on the phytogeographical types of pteridophytes reveal that the Guinean-Congolese low element (12.5%) is clearly dominated by the broadly distributed element (54.2%) on the one hand, and the linkage element (33.3%) on the other.

The present study also showed that the morphological types that provide more edible NTFPs of plant origin in the Brazzaville markets are trees, followed by lianas, herbs, shrubs and bushes. These results are similar to those obtained by other authors (Mosango M and Szafranski F, 1985; Maléla K.E, 2016; Monizi Mawunu *et al.* (2016).

CONCLUSION

The objectives of the study were to identify: the species of edible NTFPs of plant origin traded in Brazzaville markets; and the organs and different parts of these organs of edible NTFPs of plant origin used or consumed by the population of Brazzaville. Also to describe the different modes of consumption of these products.

The survey has identified 65 species of edible NTFPs of plant origin, divided into 28 families and 45 genera. Gnetum africanum Welw of the Gnetaceae family is the species most consumed by the population of Brazzaville. The most prized organs of edible NTFPs of plant origin were fruits, followed by leaves, stems and roots. The most represented phytogeographic type in terms of marketed species was the Guinean-Congolese type, and the morphological type that supplies more NTFPs to the Brazzaville markets is trees. These NTFPs were consumed much more transformed (boiled, grilled, prepared). This study showed that the presence or sale of edible NTFPs of plant origin in Brazzaville markets was more or less important, and these products contribute to food security to some extent. It has also enabled the population of Brazzaville to improve their knowledge of the use of edible NTFPs of plant origin, and the scientific community to have a database on the edible NTFPs of plant origin that circulate on the markets of Brazzaville in order to develop some avenues of domestication with a view to strengthening food security.

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