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Research Paper

ETHNOBOTANICAL STUDY OF SPONTANEOUS WILD PLANTS USED FOR FOOD BY KROBOU PEOPLE, IN THE SOUTH OF CÔTE D'IVOIRE

N'GUESSAN Koffi[1], KOUAMÉ N'Dri Marie-Thérèse[2], ASSI-KAUDJHIS Chimène[1] and AKÉ Claude Bernard[1]

[1]Université Félix Houphouët-Boigny (Côte d'Ivoire),
U.F.R. Biosciences, Laboratoire de Botanique
[2]Centre de Recherche en Ecologie de l'Université Nangui Abrogoa (Côte d'Ivoire).

Abstract

Despite the technical and technological progress made in the field of agriculture, our world is still facing hunger and malnutrition because of poverty. There is an urgent need to develop strategies of survival, by exploiting easily accessible and cheap spontaneous food resources, to face nutritious insecurity in most of the developing countries. An ethnobotanical survey realized in Krobou villages (Agboville, Côte d'Ivoire) made it possible to collect informations related to 67 species of spontaneous plants and 03 species of comestible mushrooms, used as dietary supplements near 90 farmers (men, women and children). Most of the time, the listed plants are trees (42.85%); we also have shrubs, herbs, lianas and Mushrooms. Most of these plants come from anthropological circles (58.58%). Various parts of mushrooms (carpohores) and plants (leaves, flowers, fruits, seeds, root, stem and its barks and tubers) are eaten; the leaves (32.80%) are mainly used. The organs are eaten raw, as such, fully ripe. They are also cooked in sauce, in the ash, stewed, boiled in water. They are used as additives, condiments of sauce, refreshing drinks and potassium hydroxide, in herbal teas, in the form of powders, oil and spices. The barking, the removal of branches and the cutting down are sampling procedures that are harmful to the plant. Because of the systematic collection of the seeds from *Ricinodendron heudelotii* and *Xylopia aethiopica*, which are sold on markets, young plants are not found any more under the feet of some existing specimens, explaining the rarity of these two species in the locality.

Key words: Agboville, Côte d'Ivoire, Dietary supplement, Ethnobotany, food Plants, nutritious Insecurity.

INTRODUCTION

Food plays a vital role in human's life [1]. On the historical level, the archaeological discoveries and ancient stories show that human activity was practically steered towards gathering and hunting [2]. If historically, for almost the entire life of man on earth, it has lived as a hunter-gatherer, it is because the use of spontaneous wild plants for food seems to provide him high-quality nutrition. Unfortunately, these products are currently endangered. Deforestation has contributed to an imbalance in nature, extinction of forests, which in turn implies an increasing scarcity of wild food plants [3]. Moreover, in spite of the technical and technological progress made in the field of agriculture, there is still hunger and malnutrition in our world. There are

still food shortages, because many people do not have enough money to buy quantity and quality food. In developing countries, more than a billion people are obliged to live with one euro or less per day. Every day, in the world, 40000 children die from malnutrition and from diseases associated with this plague [4]. Thus, there is unprecedented food insecurity in the whole earth. It is in this context that a genuine research activity on wild food plants grew through Africa and especially in Côte d'Ivoire. Irvine [5], Falconer [6] and Malaisse [7] have contributed to the study of wild food plants in different African countries. In Côte d'Ivoire, we note the work of Aké-Assi [8], who listed 3662 species of vascular plants and dedicated a part of his research findings to the presentation of 50 species of wild food plants used by various peoples of the country. N'Dri [9] has published a list of wild food plants used by Dida in the region of Divo. Gautier-Beguin [10], N'Guessan [3], Tra-Bi [11], Kouamé [12, 13] and Ambé [14], have conducted similar studies, respectively, in Baoulé, Krobou, Niaboua, Gagou, Bété and Malinké regions. It is obvious that a better knowledge of these wild food resources will contribute to improving the nutrition of the populations which are unable to get basic food, that are more and more expensive. Therefore, concerning the Krobou people, for the sake of cultural preservation, we conducted this study through which we want to show that the flora of this locality still overflows with vegetable resources we can protect and use to face food insecurity.

MATERIAL AND METHOD

SITE OF THE STUDY

Our investigations took place in Krobou District, with its three villages: Aboudé-Kouassikro, Aboudé-Mandéké and Oress-Krobou**.** Located at about 100 km from Abidjan, this District is part of the Southern forest of Côte-d'Ivoire (West Africa), in the guinea field of the mesophilic sector, characterized by dense moist semi-deciduous forest [15]. Currently, the original vegetation has been degraded by human activities [16]. Annual average pluviometry is about 1400 mm of water. Its climate, warm and humid, is characterized by two seasons: a dry season from December to February and a long rainy season from March to November, with two peaks; one is the largest recorded in June, the rainy month and the other in October; between the two peaks, there is a period of less rainfall during August. Krobou District had 18000 inhabitants [17]. The Krobou, native people, constitute an ethnic entity of the Akan group, in the great group Kwa [18]. Nearby the Krobou, there is a community of non-natives coming from all the other areas of Côte-d'Ivoire and also a community of foreigners for the most part coming from the West African sub-region.

VEGETABLE MATERIAL AND TECHNIQUE

The vegetable material is represented by all the plants and mushrooms that are subject of this study. As technical equipment, we used a classic material that allowed us to have access to the plants and take some samples to build up a collection of dried plants. A Nikon digital camera allowed shots during our field investigations.

ETHNOBOTANICAL SURVEY

The investigation on the spontaneous wild food plants was conducted among natives of three villages (Aboudé-Kouassikro, Aboudé-Mandéké and Oress-Krobou), in the Department of Agboville (Côte d'Ivoire). As approach, we met the farmers (men, women and children) and organized semi-structured interviews. Each of them was met twice, at different moments, to answer the same questions. This helped us check the informations we had already collected. During this ethnobotanical investigation, we collected informations relating to spontaneous wild food plants, the different organs used, their methods of preparation and consumption and the impact of these sampling on flora and the local vegetation. From the collected samples and specimens of the herbarium of National Floristic Center, we identified the plants by their scientific name and we determined their botanical characteristics. We used APG III [19] nomenclatural classification to name the taxa.

RESULTS AND DISCUSSION

BOTANICAL CHARACTERISTICS OF THE STUDIED PLANTS AND MUSHROOMS

The ethnobotanical investigations we conducted in Krobou District (Department of Agboville, Côte d'Ivoire), made it possible to identify 67 species of non-cultivated plants and 03 species of mushrooms that the farmers use to face food insecurity. These species (table 1) belong to 61 genera and 36 families divided into fungal and plantae kingdoms. The 03 species of mushrooms belong to the division of Basidiomycota. Among the plantae, we note 03 clades: Paleodicots (03 species: *Monodora myristica*, *Piper guineense* and *Xylopia aethiopica*), Monocots (11 species) and Eudicots (53 species), 01 subphylum (Tracheophytinae) and 01 phylum (Embryophyta). The Dicots, 56 of them, representing 80% of the identified species, have the highest number of plants. The ligneous species of taxonomic groups as Ferns and gymnosperms have not been listed. These wild food plants are found in diverse ecological environments. Depending on colonized environments, we divided them into two major groups: the plants of dense forest, including those of the undergrowth and the plants of the anthropological circles consisting of ruderal plants, plants around the village, plants of fallow and plants of secondary forest. There are 29 species or 41.42% of plants from dense forests, against a majority of species (41 or 58.58%) from anthropogenic environments. There are few plants in dense forests; this reflects the state of deterioration caused by man.

The Dicots have the highest number of plants. This representation has also been observed, to some differences near, during ethnobotanical investigations conducted in Côte d'Ivoire. In classified forests of Haut-Sassandra and SCIO, in Côte-d'Ivoire, Tra-Bi [11] mentions that 65 species of Angiosperms constitute the main element of the arsenal of tax used as food in rural populations. Kouamé [13] reported that the Bété people from Department of Gagnoa (Central-West region of Côte d'Ivoire) use 80 species of wild food plants. Among these species, there are 72 Dicots which represent 90%. We note, therefore, the overall consistency of results, which would be caused by identical approaches of ethnobotanical surveys or the similarity of tastes of the populations in the choice of taxa.

ETHNOBOTANICAL CHARACTERISTICS

PEASANTS MET

The ethnobotanical investigations we conducted made it possible to meet 50 peasants who agreed to collaborate with us, by providing informations on wild food plants and mushrooms. Age of informers varies from 15 to 70 years old. There were more female respondents (70%) than men (20%) and children (10%).

ORGANS OR PARTS OF THE PLANT USED FOR FOOD

Some parts of the plant are harvested to develop receipts. The whole plant is never collected, as regards the superior vegetables. From the point of view of the parts of the plant used for the consumption, the results that we have got appear as follows: carpophores (4.28%), leaves (32.80%), flowers (2.85%), fruits (24.28%), seeds (21.42%), root (1.42%), stem and its barks (11.42%) and tubers (1.42%). We additionally use carpophores, collected on Basidiomycetes Mushrooms. The most used organs are leaves, fruits and seeds; the leaves are the best represented and, especially, come from herbs (11 species or 15.71%). As for fruits, they are collected, in a large part, on trees (8 or 11.42%) and shrubs (7 or 10%). Most of the time, the seeds are produced by trees (9 or 12.85%).

There are 03 Basidiomycetes Mushrooms, 01 herbaceous liana (*Passiflora foetida*) and 14 herbs; the non ligneous species are in minority and represent 25.71%. The ligneous plants: trees, shrubs, ligneous liana (74.28%), essentially provide the biggest part of the edible organs.

Our results show that the leaves (32.80 %) are the best represented. From the point of view of the most sought organs, these results are comparable to those of Kouamé [12]; in his study related to the spontaneous wild food plants in the Department of Oumé (Central-West region of Côte d'Ivoire), the author shows that the Gagou people uses mainly the leaves which represent

33.85% of the eaten organs. In Zougoussi, in the Baoulé community, the leaves (37%) are the most used [10]. In Bété community of Gagnoa (Central-West region of Côte d'Ivoire), the leaves represent 34% of the eaten organs [13]. The leaves are used for their flavor, especially when they are dried and added in sauce, as spices; we can quote, in that case the example of *Aframomum exscapum*. The leaves are generally used when they are still young and tender. Their widespread use would be the fact that they are available practically at any time of the year; we could possibly attribute this intense consumption of the leaves to their nutritional value. Busson [20] shows that the leaves of *Solanum americanum* contain 40% of carbohydrates, 32% of proteins, 15% of minerals; we also notice the presence of 22 trace elements and diverse amino-acids. The leaves of *Ceiba pentandra, Triplochiton scleroxylon*, are rich in ascorbic acid, in carotene, in minerals and in vitamins B1 and B2 [21]. The content of the leaves of *Amaranthus lividus* appears as follows: carbohydrates (34.2%), proteins (31.6%) and minerals (10%); some trace elements and amino-acids were put in evidence [7]. The same author points out that the leaves of *Talinum triangulare* contain carbohydrates (36.6%), proteins (24.1%), minerals (11%), amino-acids (24%) and various trace elements. As a whole, the lipid content of edible leaves is low-protein; the content of proteins varies considerably, with a 15% average; the carbohydrate content is high and reaches 30-40%. The leaves are a good source of vitamins.

RECEIPTS AND MODES OF CONSUMPTION

PLANTS WHO'S ORGANS ARE EATEN RAW, FULLY RIPE

As organs used, raw or ripe for consumption, we find the fruits and seeds. The fruit pulp is consumed as such, fully ripe, for its pleasant taste, sometimes sweet or bittersweet. For example*, Dacryodes klaineana* is used for its fragrant ripe fruit, that's reminiscent of the flavor of mangoes. *Chrysophyllum delevoyi* is used for its sweet pulp, stretching slightly as chewing gum. *Myrianthus arboreus* is consumed for its bittersweet fruit. The fibrous pulp of fruits of *Irvingia gabonensis* and *Irvingia robur* (Fig. 1) are used, for their aroma. The mesocarp of *Spondias mombin* is used for its taste of vinegar and its aroma. In addition to their sweet taste, the fruits of *Carpolobia lutea* are used because of their aphrodisiac effect. Some fruits such as *Uapaca esculenta* are suitable for fermentation and their juice can be consumed as lemonade. The seeds are also eaten raw; the seeds of the following species are used for that purpose: *Buchholzia coriacea*, *Cola lateritia*, *Coula edulis* and *Garcinia kola*. The seed of *Garcinia kola*, commonly called "little cola", gives, after chewing, a bitter extract with aphrodisiac effects. For *Thaumatococcus daniellii*, the aril of the seed is used as a sweetener. The aril of seed of *Paullinia pinnata*, is used raw, in salads and that's also the case of the aril of the seed of *Blighia sapida* (Fig. 2). A warning is made about the consumption of the aril of *Blighia sapida* seed. The fruit of the plant, before bursting, thus being unripe, contains a hypoglycin (amino-acid) that affects production of blood glucose and causes fatty-acid degradation, resulting in the formation of short chain of fatty acids in blood, causing a coma. To prevent poisonings, it is advisable not to eat the aril of the seed of a fruit that's still green (unripe fruit or before bursting).

Plants are eaten and prepared in different ways because of their nutritional value, appearance, flavor and smell. It transpires from some studies, the finding of overlapping interest, related to plants which use is recognized by other ethnic groups. According to Tra-Bi [11], people from classified forests of Haut-Sassandra and SCIO use, like the Krobou people, the pulp or mesocarp of fruits from the following species: *Dacryodes klaineana, Drypetes chevalieri, Landolphia hirsute*, *Parkia bicolor, Passiflora foetida* and *Pouteria aningeri*. In the Department of Gagnoa, Central-West region of Côte d'Ivoire, Kouamé [13] shows that people also use the pulp of the ripe fruit of these different species.

PLANTS WHO'S ORGANS ARE EATEN COOKED

Various parts of the plant are eaten, boiled or steamed. These are leaves, fruits, seeds, terminal buds of palm trees, carpophores of Basidiomycetes Mushrooms and tubers. The fresh leaves of *Amaranthus lividus, Amaranthus viridis, Bombax buonopozense* (Fig. 3), *Solanum americanum* (Fig. 4) and *Talinum triangulare* (Fig. 5) boiled in water and kneaded, are eaten as spinach. The young leaves are eaten cooked in sauces, as condiments as it is the case of *Asystasia buettneri,*

Ceiba pentandra, Corchorus olitorius, Ficus sur (Fig. 6), *Myrianthus arboreus* (Fig. 7), for examples. The leaves of *Vernonia colorata* are also eaten cooked in sauce; given their bitter taste, it is recommended to make them pleasant to consumption by boiling them several times. The dried leaves of *Aframomum exscapum* are prepared in a sauce as an aromatic condiment. The seeds dried, roasted and crushed, give a smooth paste that are used to make a sauce very popular, having the taste of peanut sauce. The following species are used: *Ricinodendron heudelotii* (Fig. 8), and *Pterocarpus santalinoides*. The terminal bud or heart or saw palmetto of *Laccosperma secundiflorum* is eaten in sauce or braised in the leaves of *Thaumatococcus daniellii*. The tubers of *Dioscorea smilacifolia* are boiled and consumed. The stem bark of the following species: *Landolfia hirsuta*, *Potomorphe guineense* and *Treculia africana*, are cooked in sauce as condiments. The fruits of *Psathyrella tuberculata* (Fig. 9), *Termitomyces letestui*, *Volvariella volvacaea* (Fig. 10), are eaten cooked in sauce or steamed in the leaves of *Thaumatococcus daniellii*. The fruits of *Glyphaea brevis* are eaten cooked in sauce, as substitute for the gumbo.

The exploitation of vegetable resources as food is widespread in the world. Dealing with the use of wild plant resources as food supplement in the Sahelian region of Burkina Faso, Ganaba *et al*. [22] pointed out that the leaves of *Adansonia digitata* are largely consumed by the ethnic groups Mossi of Yatenga and by the Fulani in the northern part of the country; that's also the case of leaves of *Cleome gynandra* also eaten cooked; thus confirming our results. The assessment of the gastronomic quality of 3 species of listed mushrooms (*Psathyrella* sp., *Termitomyces* sp. and *Volvariella volvacaea*), is their consistency, their fragrance and taste. From an energy point of view, Mushrooms do not play an essential role in food and their important protein gives them a secondary role; however their relatively important minerals bring them an important role [7].

PLANTS THAT PRODUCE SAP USED FOR DRINKING

A clear refreshing liquid flows from the excision of the stem of *Adenia lobata, Gouania longipetala* and *Landolphia hirsuta*. This liquid is drunk in cases of water shortage. From portions of buttress roots of *Musanga cecropioides*, it flows a clear, clean, but bland flavored liquid, which is used during water shortages for cooking and washing dishes. The delicious capitulums of *Costus afer*, by expression, gives a clear liquid, appreciated for drinking and cooking, in case of water shortage. A wine called "raffia wine" is extracted from the incision of the terminal bud of *Raphia hookeri*. This bittersweet wine is especially appreciated by old people. The production of this wine has considerably fell because of the rarity of the plant that is overused for handicrafts purposes; the fibers extracted from young leaves are used in plaiting, in the manufacture of hats, knitted for the manufacture and repairing of clothes, and are also used to manufacture hammocks, shoes, tablecloths, fabrics and many other elements of home-made nature.

The importance of the plants collecting activity varies with ethnic groups, season, geographic area, ecological environment and the degree of food shortage. Despite this variation, the use of a plant can be recognized in other populations. We notice identical methods concerning the use of some saps of plants as water or beverage. Through the slit made to their organs, *Adenia lobata, Gouania longipetala and Musanga cecropioides* exude sap that people, living in classified forests of Haut-Sassandra and SCIO in Côte d'Ivoire, use as drinking water [11]. The author also indicates that these populations make a more or less alcoholic drink, the raffia wine, from the incision of the terminal bud of *Raphia hookeri.*

PLANTS WHO'S ORGANS ARE USED TO MAKE POWDERS

The dried and pulverized calyx of *Bombax buonopozense* gives a powder that can be used to make a sticky sauce. The dried and powdered leaves of *Adansonia digitata* give a powder which is used in sauces. This result tallies with that of Baumer [23] who indicates that in Senegal, the powder of *Adansonia digitata* leaves is used to prepare couscous.

OIL CROPS OR PLANTS THAT PRODUCE FAT

From the dried seeds of *Irvingia gabonensis*, *Irvingia robur, Parinari excelsa, Pentaclethra macrophylla, Pterocarpus santalinoides, Ricinodendron heudelotii, Strombosia pustulata* (Fig. 11) and *Tieghemella heckelii*, we extract oil that enters in various receipts. The use of fats in the preparation of many dishes, from seeds of *Irvingia gabonensis*, *Ricinodendron heudelotii* and *Strombosia pustulata*, was also reported in Gagnoa by Kouamé [13].

PLANTS USED AS HERB INFUSION AND POTASSIUM

As substitute for coffee or tea, herb infusions are prepared by using infused dried leaves of *Alchornea cordifolia* and *Paullinia pinnata*. The ashes of the stem bark of *Carapa procera* are used as potassium in the preparation of sauces. The use of *Carapa procera* as potassium has also been reported by Aké-Assi [8].

PLANTS USED AS SPICES

The word spice usually refers to parts of plants (root, stem, leaf, flower, fruit and seed) that produce flavorings. Very appreciated for their culinary value, we can get different flavors with the same spice by frying it, crushing it, by putting the entire part in the sauce or oil or by mixing it with other ingredients. Used to flavor foods, spices are natural substances that are found in various parts of the world: Africa, America and India [24]. Given their perfume, the dried leaves of *Aframomum exscapum* is an aromatic condiment, confirming the dietary use of the plant, by the people of Haut-Sassandra and SCIO in Côte d'Ivoire [11]. The dried seeds of *Aframomum melegueta* got by crushing, give a spicy flavored powder used as additive to flavor dishes of "foufou". The scent of the seeds is due to an essential oil, the Paradol [24]. The pepper vine: *Potomorphe guineense* (Fig. 12) is an eupeptic condiment that owes its irritant properties to piperine [25]. According to Asekun & Adeniyi [26], the aroma of Negro pepper (*Xylopia aethiopica*) is due to the Cuminal that's a colorless essential oil.

SAMPLINGS TECHNIQUE AND THEIR IMPACT ON THE FLORA

There are different methods of sampling. For the underground system (tubers of *Dioscorea smilacifolia,* for example), the sampling is made with a hoe. Easily accessible specimens (leaves) are usually picked by hand. The flowers and the inflorescences are pulled by hand or harvested with special tools. Fruits and seeds are harvested when they are completely ripe, by using hands or with a billhook. Concerning the stems and roots of ligneous specimens, the barking is done with machetes. For rather high specimens, people loop the branches off, thanks to special tools (billhooks); the ax is used for the cutting down of large, high and inaccessible specimens (case of *Xylopia aethiopica*). For high and inaccessible specimens, one proceeds, certain times in the collection of fruits and seeds, under the foot (case of fruits of *Ricinodendron heudelotii*).

The intensive sampling of leaves is not harmful to the plant [27]. According to these authors, the removal of 50% of the leaves of a plant does not significantly affect the survival of this plant. The barking on the periphery of the trunk of the trees makes them vulnerable to pests and causes problems in water supply. The barking is stressful and it prevents the plant from reaching bloom and it induces infections. The uprooting, the looping off of branches, the cutting down, the barking, are harvesting methods reported by Ouattara [28]. In its ethnobotanical approach of plants in the region of Divo (South forest of Côte-d'Ivoire), the author stated that, most of the times, the barking leaves huge scars through which these plants are, later on, attacked by fungi, birds and caterpillar's infestation. The removal of roots deprives the plant of nutrients supply; this affects its vegetative appearance and its physiology and is the source of the threat of extinction [29]. The massive or excessive harvest of fruit of *Ricinodendron heudelotii* and *Xylopia aethiopica*, by slaughter of trees seeds, causes their scarcity in the locality. These two species are very important but their excessive use raises serious concerns today because of the threat that's hang over it. Under the feet of some existing specimens, there are no more young plants, because people systematically pick the seeds and sell them in the markets.

Table I: Morphological and ethnobotanical charasteristics of listed spontaneous wild food plants and mushrooms in Krobou region

Plants species	Morphological Type	Type of plant according to place of harvest	Receipts
Adansonia digitata L. (Malvaceae)	Tree	Outside the village	Dried leaves, crushed: powder in sauce
Adenia lobata (Jacq.) Engl. (Passifloraceae)	Liana	Ruderal	Stem: its cut gives a limpid liquid
Aframomum exscapum (Sm.) Hepper (Zingiberaceae)	Herb	Forest undergrowth	Dried leaves: aromatic spice for sauce
Aframomum melegueta K. Schum. (Zingiberaceae)	Herb	Forest undergrowth	Crushed seeds: spice for foufou dishes
Alchornea cordifolia (Schum. et Thonn.) Müll. Arg.(Euphorbiaceae)	Liana	Fallow	Dried leaves : herb infusion
Amaranthus lividus L. (Amaranthaceae)	Herb	Ruderal	Kneaded fresh leaves, cooked as spinach
Amaranthus viridis L. (Amaranthaceae)	Herb	Ruderal	Kneaded fresh leaves: spinach
Antidesma laciniatum Müll. Arg. (Euphorbiaceae)	Shrub	Forest undergrowth	Fruit (pulp) eaten raw, ripe
Asystasia buettneri Lindau (Acanthaceae)	Herb	Pluvial	Kneaded fresh leaves: spice for sauce
Bidens pilosa L. (Asteraceae)	Herb	Pluvial	Kneaded fresh leaves: spice for sauce
Blighia sapida Konig (Sapindaceae)	Tree	Fallow	Seed (aril) eaten raw in salad
Bombax buonopozense P. Beauv. (Malvaceae)	Tree	Secondary Forest	Dried calyx, crushed: powder in soup
Borassus aethiopum Mart. (Arecaceae)	Tree	Village outskirts	Young plants eaten braised
Buchholzia coriacea Engl. (Capparidaceae)	Shrub	Forest undergrowth	Seeds, eaten raw when fully ripe
Carapa procera DC. (Meliaceae)	Shrub	Dense forest	Stem Bark ash: potash sauces
Carpolobia lutea G. Don (Polygalaceae)	Shrub	Forest undergrowth	Fruit (pulp) eaten raw when fully ripe
Ceiba pentandra (L.) Gaertn. (Malvaceae)	Tree	Dense forest	Fresh leaves, cooked: condiment for sauce
Chrysophyllum delevoyi De Wild. (Sapotaceae)	Shrub	Dense forest	Fruit (pulp): eaten raw when fully ripe
Cleome gynandra (L.) Briq. (Capparidaceae)	Herb	Ruderal	Fresh leaves, cooked: condiment for sauce
Cleome rutidosperma DC. (Capparidaceae)	Herb	Ruderal	Fresh leaves, cooked: condiment for sauce
Cola lateritia var. *maclaudi* (A. Chev.) Brenan et Keay (Malvaceae)	Tree	Fallow	Seed eaten raw when ripe
Corchorus olitorius L. (Malvaceae)	Herb	Pluvial	Fresh leaves, cooked: condiment for sauce
Costus afer Ker-Gawl. (Zingiberaceae)	Herb	Secondary Forest	Inflorescences (flower head): clear liquid
Coula edulis Baill. (Coulaceae)	Tree	Dense forest	Seed (kernel): raw or cooked in the ashes
Dacryodes klaineana (Pierre) Lam. (Burseraceae)	Tree	Dense forest	Fruit (pulp): eaten raw when ripe
Dioscorea smilacifolia De Wild. (Dioscoreaceae)	Liana	Fallow	Tuber: eaten boiled
Drypetes chevalieri Beille (Euphorbiaceae)	Shrub	Forest undergrowth	Fruit (pulp): eaten raw when ripe
Ficus exasperata Vahl (Moraceae)	Shrub	Fallow	Molded leaves (young): condiment for sauce
Ficus sur Forssk. (Moraceae)	Shrub	Pluvial	Fresh leaves, cooked: condiment for sauce
Garcinia kola Heckel (Clusiaceae)	Tree	Dense forest	Seed eaten raw when ripe
Glyphaea brevis (Spreng.) Monachino (Malvaceae)	Shrub	Seconday Forest	Fruit cooked in sauce: substitute for gombo
Gouania longipetala Hemsl. (Rhamnaceae)	Liana	Seconday Forest	Stem (excision): clear quenching liquid
Irvingia gabonensis (Aubry-Lecomte) Baill. (Irvingiaceae)	Tree	Plantation	Fruit (pulp): raw; Seed: oil for meals
Irvingia robur Mildbr. (Irvingiaceae)	Tree	Plantation	Fruit (pulp): raw; Seed: oil for meals
Laccosperma secundiflorum (P. Beauv.) Wendl. (Arecaceae)	Liana	Hélophile des forêts	Stem (saw palmetto): steamed
Landolphia hirsuta (Hua) Pichon (Apocynaceae)	Liana	Dense forest	Stem: liquid; bark of steam, cooked in sauce
Monodora myristica (Gaertn.) Dunal (Annonaceae)	Tree (small)	Forest undergrowth	Crushed seeds: spices for foufou meals
Musanga cecropioides R. Br. (Urticaceae)	Tree	Fallow	Aerial root: exudes a refreshing liquid
Myrianthus arboreus P. Beauv. (Urticaceae)	Tree (small)	Forest undergrowth	Leaves (young), cooked in sauce; ripe raw fruit
Myrianthus libericus Rendle (Urticaceae)	Tree (small)	Forest undergrowth	Molded leaves (young): condiment for sauce
Parinari excelsa Sabine (Chrysobalanaceae)	Tree	Dense forest	Seed (kernel): oil for various meals
Parkia bicolor A. Chev. (Fabaceae)	Tree	Dense forest	Fruit (pulp): eaten raw, when ripe
Passiflora foetida L. (Passifloraceae)	Liana	Ruderal	Fruit (pulp): eaten raw, when ripe
Paullinia pinnata L. (Sapindaceae)	Liana	Pluvial	Seed (aril): raw in salad; leaves: herb tea

Pentaclethra macrophylla Benth. (Fabaceae)	Tree	Dense forest	Seed (kernel): oil for various meals
Potomorphe guineense Schum. et Thonn. (Piperaceae)	Liana	Dense forest	Dried fruit:spice; st of bark: condiment of sauce
Pouteria aningeri Baehni (Sapotaceae)	Tree	Dense forest	Fruit (pulp): eaten raw, when ripe
Psathyrella tuberculata (Pat.) Smith (Psathyrellaceae)	Undefined	Saprophyte	Carpophore cooked in sauce or steamed
Pterocarpus santalinoides DC. (Fabaceae)	Tree	Dense forest	Seed (dried): sauce, oil for various meals
Raphia hookeri Mann et Wendl. (Arecaceae)	Shrub	Dense forest	Stem (terminal bud): raphia wine
Ricinodendron heudelotii (Baill.) Pierre ex Pax (Euphorbiaceae)	Tree	Secondary Forest	Seed (dried) : sauce ; oil for various meals
Sesamum radiatum Schum. et Thonn. (Pedaliaceae)	Herb	Pluvial	Fresh leaves, cooked: condiment for sauce
Solanum americanum Mill. (Solanaceae)	Herb	Pluvial	Fresh leaves, cooked as spinach
Solanum distichum Thonn. (Solanaceae)	Shrub	Pluvial	Fresh fruit, cooked: condiment for sauce
Solanum torvum Sw. (Solanaceae)	Shrub	Pluvial	Fresh fruit, cooked: condiment for sauce
Spondias mombin L. (Anacardiaceae)	Tree	Fallow	Fruit (pulp): eaten raw, when ripe
Sterculia tragacantha Lindl. (Malvaceae)	Tree	Fallow	Molded leaves (young): condiment for sauce
Strombosia pustulata Oliv. var. *lucida* (Léonard) Villiers (Olacaceae)	Tree	Dense forest	Seed (dried) : sauce ; oil for meals
Talinum triangulare (Jacq.) Willd. (Portulacaceae)	Herb	Pluvial	Fresh leaves, cooked: as spinard
Termitomyces letestui (Pat.) R. Heim (Lyophyllaceae)	Undefined	Saprophyte	Carpophore cooked in sauce or steamed
Thaumatococcus daniellii (Benn.) Benth. (Marantaceae)	Herb	Seconday Forest	Seed (aril): raw when fully ripe
Tieghemella heckelii Pierre ex A. Chev. (Sapotaceae)	Tree	Dense forest	Seed (kernel): oil for various meals
Treculia africana DC. var. *africana* (Moraceae)	Tree	Dense forest	Bark of stem : condiment for sauce
Triplochiton scleroxylon K. Schum. (Malvaceae)	Tree	Dense forest	Molded leaves (young): condiment for sauce
Uapaca esculenta A. Chev. ex Aubrév. et Léandri (Euphorbiaceae)	Tree	Dense forest	Fruit (pulp) : eaten raw, when fully ripe
Vernonia amygdalina Del. (Asteraceae)	Shrub	Pluvial	Molded leaves (young): condiment for sauce
Vernonia colorata (Willd.) Drake (Asteraceae)	Shrub	Pluvial	Molded leaves (young): condiment for sauce
Volvariella volvacaea (Fr.) Singer (Pluteaceae)	Undefined	Fallow	Carpophore cooked in sauce or steamed
Xylopia aethiopica (Dunal) A. Rich. (Annonaceae)	Tree	Dense forest	Dried fruit: spice
Zanthoxylum gilletii (De Wild.) Wattermann (Rutaceae)	Tree	Fallow	Molded leaves (young): condiment for sauce

Fig. 1: *Irvingia robur* (Irvingiaceae). Ripe fruits (stone fruit). Photo Kouamé (2009)

Fig. 2: *Blighia sapida* (Sapindaceae). Fruits (capsules); the ripe fruits show black seeds with yellow aril. Photo N'Guessan (2008)

Fig. 3: *Bombax buonopozense* (Malvaceae). Leafy small branch. Photo N'Guessan (2008)

Fig. 4: *Solanum americanum* (Solanaceae). End of fruit-bearing stem. Photo N'Guessan (2008)

Fig. 5: *Talinum triangulare* (Portulacaceae). End of stem with blossom. Photo N'Guessan (2008)

Fig. 6: *Ficus sur* (Moraceae). Leafy small branch. Photo N'Guessan (2008)

Fig. 7: *Myrianthus arboreus* (Urticaceae): Leafy small branch. Photo Kouamé (2009)

Fig. 8: *Ricinodendron heudelotii* (Euphorbiaceae) Seeds. Photo N'Guessan, Aboudé-Mandéké, 2010

Fig. 9: *Psathyrella tuberculata* (Psathyrellaceae) Carpophores (hats and feet). Photo N'Guessan (2008)

Fig. 10: *Volvariella volvacaea* (Pluteaceae) Carpophores. Photo N'Guessan (2008)

Fig. 11: *Strombosia pustulata* (Olacaceae). Seeds in soup tureens. Photo Kouamé (2009)

Fig. 12: *Potomorphe guineense* (Piperaceae). Fruits (berries) in clusters. Photo N'Guessan (2008)

CONCLUSION

This ethnobotanical study shows that various parts of plant (basidiocarps, leaves, flowers, fruits, seeds, root, stem bark, stem tubers), from 70 species, are used as supplements to face the food insecurity. The selection of the plants takes into account specific criteria (taste, flavor, appearance, texture, nutritional value, ecological environment). The trees are the most requested. The leaves are involved in the preparation of various dishes and are most used. The organs are eaten raw, ripe, cooked in sauce, with ash or stewed, boiled in water. They are used as additives, condiments for sauce, refreshing drinks, potassium, herbal teas, in the form of powders, oils and spices form. The slaughter of some specimens (*Ricinodendron heudelotii, Xylopia aethiopica*) to get seeds, partly sold in the markets, causes the rarity of these two species in the locality.

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