# Ethnobotanical and phytochemical studies of ichtyotoxic plants used by populations in the South of Gabon.

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## 1 ABSTRACT

**Local people have used plants and animals as food and medicine for generations. Local people have used plants to feed and as medical treatment. Meanwhile, artisanal fishing is a traditional practice among many local populations in central Africa. These people have used various methods to capture fish from rivers, lakes, and streams for their own consumption. Among these, the poisoning of rivers with tree barks, fruits, and leaves is a frequently used technique. However, the current state of knowledge on plants used as fishing poison in Gabon remains fragmentary. Thus, an ethnobotanical study was conducted aiming at determining plants and their use as fishing poison from artisanal fishermen in several Gabonese localities. To determine the chemical composition of plant organs likely to be used as fishing poison, phytochemical tests were carried out on 15 of the most used plants by local populations in three Gabonese regions: Haut-Ogooué, Nyanga and Ogooué-Lolo provinces. Out of a total of 87 collected specimens in these three regions, 31 species and 16 families were identified. Plant families frequently used were Papilionnaceae (32.18%), Acanthaceae (19, 54%) and Mimosoïdeae (10, 34%), while the most represented species was *Tephrosia vogelii* (23 %). In addition, leaves were the most exploited parts of the plant (60.91%). The Papilionaceaes, Ancanthaceae and Mimosaceae are well known for their ichthyoidal properties in other regions of the world and the large number of these plants (87 in total) unveils not only of the high richness throughout sampled provinces, but also the expert botanical knowledge of local ethnic groups. Furthermore, several molecules of secondary metabolism were highlighted regardless of the plant organ they were extracted from. These were alkaloids, flavonoids, tannins, free anthraquinones, total polyphenols, sterols/terpenes, reducing sugars, cyanogenic heterosides and flavones.**

## 2 INTRODUCTION

Ichtyotoxic plants (fish poison) have been known for several decades (Gruvel, 1928; Heizer, 1953; Bishop *et al.*, 1982), and their uses in fishing have been reported worldwide (Kerharo *et al.*, 1960). The only regions of the world where the literature does not mention any use of these plants are New Zealand and Tasmania (Kerharo *et al.*, 1960). This practice however had been common in Africa (Kerharo *et al.*, 1960; Stauch, 1960). In tropical Africa, populations still use these plants today as fishing tools (Kerharo and Bouquet, 1948; Anoh, 2007; Kimpouni *et al*., 2011; Dougnon *et al*., 2015; Uno *et al*., 2018) and in traditional medicine (Nyakabwa and Dibaluka, 1990; Adomou *et al.,* 2012). However, this method of fishing is prohibited for various reasons, including their ecological impact. Ichtyotoxic plants probably facilitate fish capture, especially given the economic and social crises that people are going through currently in the Sub-Saharan Africa. This empirical artisanal fishing technic involves women and men using various plant organs (seeds, leaves, roots, fruits, and sap) to intoxicate fishes and easily capture them out of water bodies (Kerharo *et al*., 1960; Stauch, 1960; Kimpouni *et al*., 2011). In Ivory Coast for instance, the most used ichthyotoxic plants are *Tephrosia sp*. and *Raffia sp*. (Anoh, 2007). Indeed, *Tephrosia vogelii* Hook (Caesalpiniaceae), a shrub grown in gardens near village dwellings, is known in several parts of the world (Howes, 1930; Belmain *et al*., 2012). The presence of this plant has also been reported from Grande Comore, one of the islands of the Comoros archipelago (Bourgois, 1989). In addition of being used as an ichthyotoxic plants, it serves as an insecticide (Farida and Vander, 1997) and as a rodent repellent (Ogendo *et al*., 2004; Koona and Dorn, 2005). Recently, Lépengué *et al.* (2020) indicated that it could be used against *Phoma sabdariffae* Sacc, a deuteromycete fungus of the Phomaceae family that destroys roselle in Gabon. Apart from the species *Tephrosia sp*. and *Raffia sp*, the leaves of *Calotropis procera* (Sodom apple) have been shown to be toxic to *Oreochromis niloticus* (the Nile tilapia) (Kabré, 2013), as has the leaf dust of *Nicotiana tabaccum* for *Clarias gariepinus* (the African sharptooth catfish) (Muniyan, 2009). Ichtyotoxic plants include several families (Kerharo *et al*., 1960). Dounias (2011) reported that some ichthyotoxic plants belonging to the Acanthaceae family are aquatic herbaceous like *Justicia extensa*. This study also pointed out the existence of several other families such as Rubiaceae (i.e., the small bushy shrub *Bertiera elabensis*) and Apocynaceae (i.e., the woody lianas *Strophantus gratus*). Other works indicated families such as Loganiaceae, Lecythidaceae, Euphorbiaceae, Papilionaceae and Sapindaceae (Moretti and Grenand, 1982; Rasoanaivo *et al*., 1991). As with all fish poisons, the "intoxicated" behaviour of the fish is attributed to the direct toxicity of the chemicals contained in these plants (Jenness, 1967). The presence of rotenone and saponides in ichtyotoxic plant extracts from and other toxic substances (i.e., alkaloids and tannins) for aquatic organisms have been documented (Kerharo *et al.,* 1960; Walker and Sillans, 1961; Mabberley, 1993; Ibrahim *et al*., 2000; Agbon *et al*., 2004). Only a few studies have been conducted on Central African ichthyotoxic plants. There is not enough studies on central African ichtyotoxic plants. When the biological diversity and active principles of ichtyotoxic plants are referenced, hardly anything is mentioned about Gabon. Existing data on the properties of Gabonese plants were ethnobotanical (Walker and Sillans, 1961; Bourobou *et al*., 1996) and traditional medicine surveys (Aboughe Angone *et al*., 2009). The only review publication revealing the ichthyocidal properties of plants used as fishing poison in Gabon is from Ibrahim *et al.* (2000). Thus, ethnobotanical investigations should be carried out with indigenous people and local communities who hold endogenous knowledge of plants to establish an overall assessment of knowledge in the use of these ichtyotoxic plants. The purpose of this study was then to carry out an inventory of these plants in three provinces (Ogooué -Lolo and Nyanga) of Gabon, to gather as much information as possible on their mode of use in fishing practices, and to phytochemically characterize them.

## 3 MATERIAL AND METHODS

**3.1 Study site:** The study was carried out in three provinces of Gabon: Haut-Ogooué, Ogooué -Lolo and Nyanga. The Haut-Ogooué and Ogooué-Lolo provinces are in south-eastern Gabon, overing an area of 36,547 km$^2$ and 25,380 km$^2$, respectively (Meyo-Bibang and Nzamba, 1992). The vegetation in this part of the country is characterized by a mosaic of forest and savanna. The vegetation in this part of the country is distinguished by savana and forest. According to the work of Boupassia (1998), dense forest is the most dominant vegetation. According to the work of Boupassia (1998), dense forest have been the most representative vegetation. Plant families such as Euphorbiaceae, Passifloraceae, Mimosaceae, Caesalpiniaceae and several others with an ichtyocidal nature are present there. In the Haut-Ogooué province specifically, there is also the presence of shrub savannah, which is encountered far east throughout the Plateau Batéké region. The Nyanga province is in southwestern Gabon, covering an area of 21,285 km$^2$. This region is characterized by vast areas of plains and dense forests (Descoings, 1961). All three provinces have an extensive hydrographic network, including numerous water bodies (lakes and small rivers) connected to either the Ogooué or the Nyanga rivers (Figure 1). The ichtyfaune in these rivers and lake is rich, new taxa being regularly described (Cutler *et al.*, 2019; Cutler *et al.,* 2020; Ibanez *et al.*, 2007; Mipounga *et al.*, 2020).

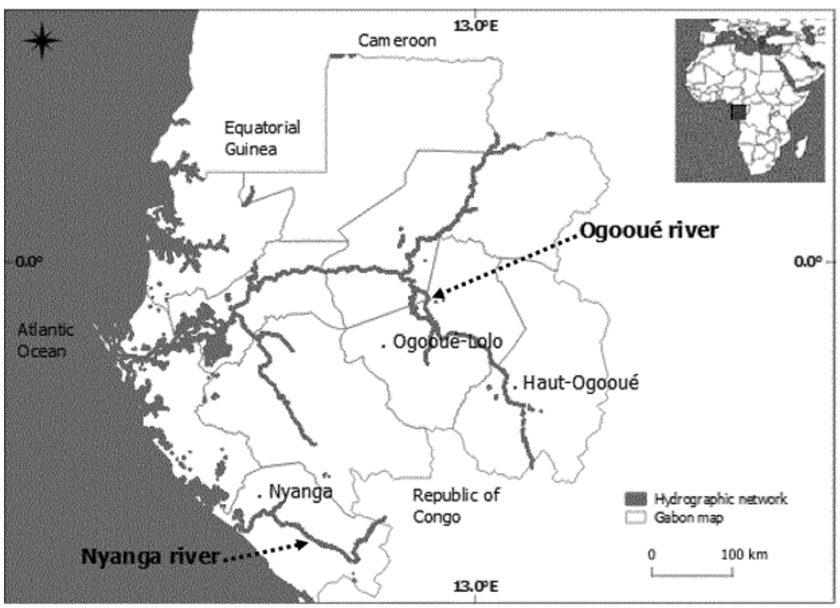


**Figure 1.** Location of the three provinces (Haut-Ogooué, Ogooué -Lolo and Nyanga) and the two main rivers (Ogooué and Nyanga) where the study took place.

**3.2 Ethnobotanical survey:** The ethnobotanical survey was carried out according to the literature (Adjanohoun *et al.,* 1988; Kimpouni *et al.*, 2011). The surveys took place from February to July 2019 in 16 localities total: six (6) in the Haut-Ogooué (Benguia, Okondja, Ekala, Souba, Sucaf, M'Vengué and Léconi), four (4) in the Ogooué-Lolo (Lastourville, Maléndé, Mandji - Puvi and Mikouma), and six (6) in the Nyanga (Douki, Doumanga, Malunga, Bibora, Pegnoundou and Rinanzala). These surveys focused on interviewing adults and elderly people who have knowledge about the use of medicinal and ichtyotoxic plants. Along with the interviewees, plants were sampled and placed in between newspaper sheets for herbarium collection and later identification verification. The vernacular name of each plant, the organs used and how to use it were noted during the interview. The scientific names were confirmed by two botanists (Mr Yves Azizet Issembè and Dr Davy Ulrich Ikabanga) of the Department of Biology of the Université des Sciences et Technique de Masuku (USTM) in Gabon.

**3.3 Phytochemical analysis of ichtyotoxic plants:** Phytochemical tests were carried out at the Laboratory of Electrophysiology and Pharmacology of the Agrobiology Research Unit of USTM. The amounts of saponins, tannins, polyphenols, flavonoids, terpenoids, sterols and alkaloids were characterized by referring to the colorimetry techniques described in the work of Paris and Moyses (1969) and Sofowora (1982). The presence or absence of these chemical components in the aqueous extract was quantified as: very abundant (+++); moderately abundant (++); slightly abundant (+); absent (-).

## 4 RESULTS

Overall, 62 individuals (17 men and 45 women) from ten (10) ethnic groups whose age ranged from 33 to 76 years were interviewed.

**4.1 Ichtyotoxic plant diversity:** A total of 87 plants were collected: 39 in the Haut-Ogooué, 16 in the Ogooué-Lolo, and 32 in the Nyanga. Overall, the four plant types in the three provinces were: trees (50.57 %), shrubs (23 %), grasses (12.64 %), and lianas (13.79 %) (Figure 2). Of these, 31 species (see Table 1) and 16 families were identified. The most represented family in the three surveyed provinces were: Papilionnaceae (32.18%), Acanthaceae (19, 54%) and Mimosoïdeae (10, 34%). Although some families were identified in all surveyed provinces (Acanthaceae, Loganiaceae, Rutaceae, Rubiaceae, Euphorbiaceae, Cariaceae, Mimosoïdeae, Papilionnaceae), others were province specific. Plants belonging to the families Araceae, Commelinaceae, Ebénaceae, Palmeae and Cesalpiniaceae were recorded in the Nyanga, while Passifloraceae and Asteraceae were only recorded in Ogooué-Lolo and Haut-Ogooué respectively. At the species level, it appeared that *Chromolaena odorata* and *Vernonia colorata* were only found in the Haut-Ogooué, while *Adenia lobata* was found in the Ogooué-Lolo.

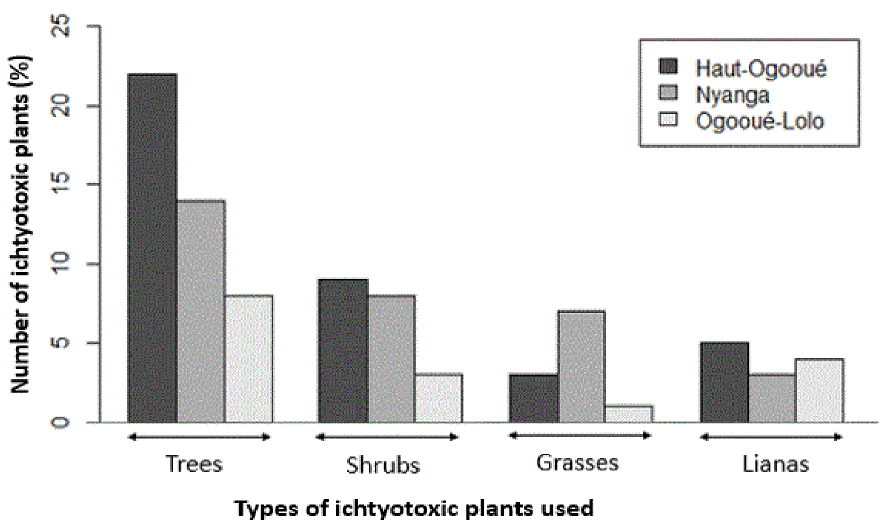


**Figure 2.** Percentages of ichtyotoxic plants according to plant types.

However, *Tephrosia vogelii*, *Asystasia vogeliana* and *Zanthoxylum hertzii* were found in all three provinces.

**Table 1**: List of 31 ichtyotoxic plant species, the parts used, and their usage percentages in the three surveyed provinces of Gabon.

| Plant type | | Scientific names | Vernacular names | Organs used | % Haut-Ogooué | % Ogooué-Lolo | % Nyanga |
|---|---|---|---|---|---|---|---|
| **Tree** | Fabaceae-Mimosoideae | *Pentaclethra macrophylla* | Mupandji (Eshira) | Bark | 7.7% | - | - |
| **Shrub** | Legumine-Papilionnaceae | *Tephrosia Vogelii* | Woula (Kaningui) | Leaf | 25.64% | 25% | 31.25% |
| **Grass** | Acanthaceae | *Asystasia vogeliana* | Mbagha (Nzebi) | Leaf | 20.51% | 18.75% | 15.62% |
| **Tree** | Fabaceae-Mimosoideae | *Tetrapleura tetraptera* | Moumbala (Kaningui) | Bark | 10.25% | - | - |
| **Tree** | Asteraceae | *Vernonia colorata* | Moposa (Punu) | Leaf | 2.6% | - | - |
| **Tree** | Fabaceae-Mimosoideae | *Pentaclethra eetveldeana* | Musamu (Bawumbu) | Bark | 5.12% | - | - |
| **Shrub** | Euphorbiaceae | *Manihot esculenta.* | Meyaka (Téké) | Leaf | 5.12% | - | - |
| **Shrub** | Loganiaceae | *Anthocleista vogelii* | Ngoya bambu (Nzebi) | Fruit | 5.12% | - | - |
| **Tree** | Cariaceae | *Carica papaya* L | Mulôlu (Punu) | Leaf | 5.12% | - | 3.12% |
| **Grass** | Asteraceae | *Chromolaena odorata* | Moanda (Téké) | Leaf | 2.6% | - | - |
| **Tree** | Fabaceae-Mimosoideae | *Fillaeopsis discophora* | Moussamou (Adouma) | Bark | - | 12.5% | - |
| **Tree** | Rubiaceae | *Brenania brieyi* | Mbara (Adouma) | Bark | - | 12.5% | 3.12% |
| **Liana** | Passifloraceae | *Adenia lobata* | Moutoto (Puvui) | Sap | - | 6.25% | - |
| **Tree** | Rutaceae | *Zanthoxylum heitzii* | Ndunghu (Punu) | Bark | 5.12% | 12.5% | - |
| **Tree** | Rubiaceae | *Pausinystalia johimbe* | Gibutu (Vili) | Bark | - | 6.25% | - |
| **Shrub** | Acanthaceae | *Duvernoia dewevrei* | Mbaga-Pangu (Vili) | Leaf | - | - | 3.12% |
| **Grass** | Araceae | *Colocasia esculentum* | Tsanga-Ndjiami (Vili) | Leaf | - | - | 3.12% |
| **Grass** | Araceae | *Xanthosoma sagittæfolium* | Dikabu (Punu) | Leaf | - | - | 3.12% |
| **Grass** | Commélinaceae | *Palisota hirsute* | Diyôyôra (Eshira) | Sap | - | - | 3.12% |
| **Tree** | Ebenaceae | *Diospyros piscatorial* | Mufintsi (Punu) | Fruit | - | - | 3.12% |
| **Liana** | Legumine-Papilionnaceae | *Leptoderris fasciculate* | Mbale (Vili) | Sap | - | - | 3.12% |
| **Tree** | Légumine-Mimosoïdeae | *Cylicodiscus gabunensis* | Moudouma (Eshira) | Bark | - | 6.25% | 3.12% |
| **Liana** | Loganiaceae | *Strychnos aculeate* | Digyèmbè (Lumbu) | Fruit | - | - | 3.12% |
| **Tree** | Euphorbiaceae | *Croton tchibangensis* | Bimbi-di-musagala (Punu) | Bark | - | - | 3.12% |
| **Tree** | Rutaceae | *Zanthoxylum gilletii* | Ndongo (Vili) | Bark | - | - | 3.12% |
| **Tree** | Fabaceae-Césalpiniaceae | *Erythrophleum ivorense* | Mokasa (Vili) | Bark | - | - | 3.12% |
| **Shrub** | Euphorbiaceae | *Elaeophorbia drupifera* | Onaye (Téké) | Leaf | 5.12% | - | - |
| **Liana** | Légumine-Papilionnaceae | *Leptoderris congolensis* | Mbahaamba (Eshira) | Leaf | - | - | 3.12% |
| **Tree** | Fabaceae-Césalpiniaceae | *Pachyelasma tessmannii* | Mundumbula (Vili) | Bark | - | - | 3.12% |
| **Tree** | Fabaceae-Césalpiniaceae | *Erythrophleum guineense* | Mbaga (Lumbu) | Bark | - | - | 3.12% |
| **Tree** | Palmeae | *Raphia sp.* | Mindumu (Punu) | Fruit | - | - | 3.12% |

**4.2 Ichtyotoxic plant utilization:** The ethnobotanical survey revealed that traditional fish poisoning is more practiced in the dry than in the rainy season. The diversity of plant organs used to intoxicate fish include leaves (60.91%), barks (23%), fruits (9.2%), and sap (6.89%) (Figure 3). Sampled plants were also used by local populations in traditional medicine (i.e., infection treatment), women abortion, biological control of crop pests, hunting arrow poisoning, and protection against evil spirits and the dead.

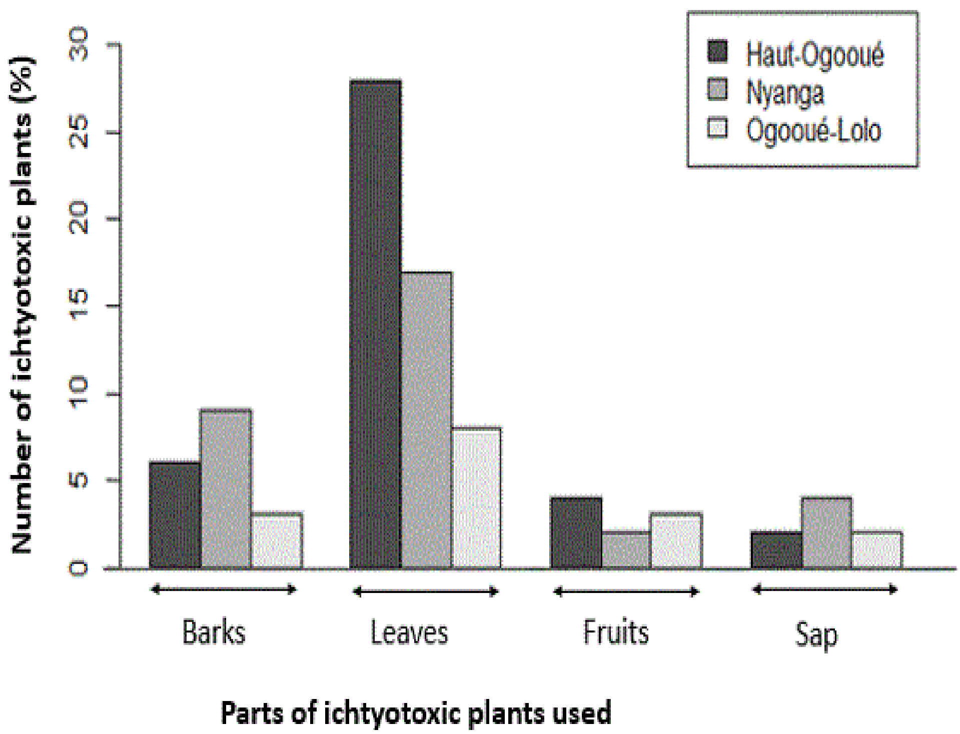


**Figure 3.** Percentages of ichtyotoxic plants according to plant organs

Over all three provinces, *Tephrosia vogelii* (23%) and *Asystasia vogeliana* (14.47%) were the most widely used ichtyotoxic plants. In general, local populations prepared the final fishing poison according to the following steps: (1) grinding of the fresh plant material, (2) pouring into the water of the shredded material, (3) ripening of the obtained mixture in water for two days (observed only among Bakaningui, Nzébi and Adouma ethnic groups). In addition, it has been observed that certain plant species are often associated with *Tephrosia vogelii* to increase toxicity and make it much easier to catch fish. This was the case with plants such as *Chromolaena odorata, Vernonia colorata, Adenia lobata, Manihot esculenta* and *Tetrapleura tetraptera*.

**4.3 Phytochemical characterization of extracts:** All fifteen (15) of them were rich in secondary metabolites (see Table 2). Indeed, Tannins were found in all plants, except *Brenania brieyi, Pentaclethra eetveldeana* and *Adenia lobata*. Species such as *Vernonia colorata, Chromolaena odorata, Anthocleista vogelii, Zanthoxylum heitzii, Brenania brieyi, Fillaeopsis discophora* and *Cylodiscus gabonensis* contain sterols and terpenes, unlike *Pentaclethra macrophylla* and *Tephrosia vogelii*. The saponosides were revealed in *Zanthoxylum heitzii, Vernonia colorata, Brenania brieyi, Fillaeopsis discophora* and *Cylodiscus gabonensis*. Some saponoside traces were also found in *Pentaclethra macrophylla* and *Manihot esculenta*. Alkaloids were found in *Elaephorbia drupifera, Anthocleista vogelii, Brenania brieyi, Asystasia vogeliana* and *Cylodiscus gabonensis*. Polyphenols were present in *Vernonia colorata, Elaephorbia drupifera, Pentaclethra macrophylla, Chromolaena odorata, Zanthoxylum heitzii, Fillaeopsis discophora* and *Tephrosia vogelii*. The flavonoids were found in all plant species, except *Pentaclethra eetveldeana*. Reducing sugars were found in *Chromolaena odorata, Brenania brieyi, Asystasia vogeliana* and *Manihot esculenta*. Traces of cardiotonic heterosides were found in the chemical composition of all species, except in *Pentaclethra eetveldeana* and *Pentaclethra macrophylla*. Anthracene compounds were found in all species, except in *Pentaclethra eetveldeana* and *Vernonia colorata*. However, it should be noted that some species contained all the compounds; these were *Chromolaena odorata and Fillaeopsis discophora*. Others, such as *Elaephorbia drupifera, Asystasia vogeliana, Zanthoxylum heitzii, Anthocleista vogelii* and *Cylicodiscus gabonensis*, contained almost all these compounds.

**Table 2:** Secondary metabolites extracted from studied plant organs

| **Vegetal** | | | **Secondary metabolism** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Especies | Organs | Tan | Ste/Ter | Sap | Alc | Pol | Flav | Red Sug | Het | Ant |
| Fabaceae-mimosoïdeae | *Pentaclethra macrophylla* | Bark | + + | - | + + | + | + + + | + + | + | - | + |
| Euphorbiaceae | *Elaephorbia drupifera* | Leaf | + + | + + | - | + + + | + + + | + + + | + | + | + |
| Astéraceae- compositeae | *Vernonia colorata* | Leaf | + + + | + + + | +++ | + + | + + + | + + + | - | + + + | - |
| Acanthaceae | *Asystasia vogeliana* | Leaf | + + + | + + | - | + + + | + + | + + + | + + + | + + | + + |
| Fabaceae-papilionnaceae | *Tephrosia Vogelii* | Leaf | + + + | - | - | + + | + + + | + + + | - | + | + |
| Euphorbiaceae | *Manihot esculenta* | Leaf | + + | + | + + | - | - | + + + | + + + | + + | + + |
| Astéraceae | *Chromolaena odorata* | Leaf | + + + | + + + | + | + + | + + + | + + + | + + + | + | + + + |
| Fabaceae-mimosoïdeae | *Tetrapleura tetraptera* | Fruit | + + | + + | - | + | + + | + + + | + + | + + + | + + + |
| Rutaceae | *Zanthoxylum heitzii* | Bark | + | + + + | + + + | - | + + + | + + + | + | + + | + + + |
| Rubiaceae | *Brenania brieyi* | Bark | - | + + + | + + + | + + + | - | + + + | + + + | + + + | + |
| Loganiaeae | *Anthocleista vogelii* | Sap | + + + | + + + | - | + + + | + | + + + | + + | + + + | + + + |
| Fabaceae-mimosoïdeae | *Fillaeopsis discophora* | Bark | + | + + + | + + + | + + | + + + | + + + | + | + + + | + + + |
| Fabaceae-mimosoïdeae | *Cylodiscus gabunensis* | Bark | + + + | + + + | + + + | + + + | - | + + | + + | + + + | + + + |
| Fabaceae-mimosoïdeae | *Pentaclethra eetveldeana* | Bark | - | + + | - | + | + + | - | - | - | - |
| Passifloraceae | *Adenia lobata* | Leaf | - | + + | - | - | + | + + + | - | + + | + + |

Very abundant (+++); moderately abundant (++); slightly abundant (+); absent (-)

## 5 DISCUSSION

Ethnobotanical surveys undertaken herein with endogenous populations in the southern provinces of Gabon have made it possible to identify 31 species belonging to 16 families of ichtyotoxic plants. Although the literature provides numerous examples of plant families toxic to fish in Africa (Stauch, 1960; Rasoanaivo *et al*., 1991; Dounias, 2011), our study is the first to describe their use in these three provinces of Gabon. Indeed, families such as Papilionnaceae, Acanthaceae and Mimosoïdeae are well known for their ichtyocidal properties in other regions of the world (Chevalier, 1937; Kerharo *et al*., 1960). Among the 31 plant species recorded during this ethnobotanical survey, it appears that only *Tephrosia vogelii* and *Asystasia vogeliana* are frequently used for artisanal fishing practices in south-eastern Gabon, as previously found (Stauch, 1960; Dougnon *et al.,* 2015; Walker and Sillans, 1961, Bourobou *et al*., 1996; Ibrahim *et al*., 2000; Ekanem et al., 2004; Uno et al., 2018). The other twenty-nine (29) ichtyotoxic plants have also been reported previously. In the Democratic Republic of Congo, the use of Passifloraceae *Adenia lobata* by local populations has been reported (Koto-te-Nyiwa Ngbolua *et al*., 2018). Walker and Sillans (1961) already indicated its use in traditional fishing practices in Africa. Also, *Carica papaya, Tetrapleura tetraptera, Raphia sp., Croton tchibangensis, Brenania brieyi, Pentaclethra macrophylla* are well documented in the work of Walker and Sillans (1961) and Kimpouni *et al*. (2011). However, the large number of plants collected (87 in total herein) testifies not only of the high diversity of the flora of the surveyed provinces, but also the great knowledge of the flora by visited ethnic groups. In addition, this study results revealed several morphological types of ichtyotoxic plant species used by the populations surveyed. Trees (50.57%) and shrubs (22.98%) were the most exploited plant types. The use of herbaceous plants is nonetheless more important in the Nyanga province (63.63%), and lianas are generally less used in the three studied provinces (13.79%). The probable reasons for these observed differences would be ecological and socio-cultural. It has been reported that certain environments, due to their ecological conditions (soil type, precipitation and the availability of nutrients), are favourable to a type of vegetation (Campbell *et al*., 2006). Likewise, the largest number of villages surveyed in the town of Tchibanga were located within the plains. Thus, herbaceous species and lianas were the most predominant vegetation type around these villages (Descoings, 1961). Alternatively, it seems like village communities of all surveyed provinces use the same types of ichthyotoxic plants. This could be attributed to socio-cultural similarities between local and indigenous communities. Grenand and Prévost (1994) reported that local and indigenous communities exploit plant diversity by using their natural assets or the endogenous knowledge that sustain their traditional societies. Naturally, the virtues of plants are ancestral knowledge that is passed on from generation to generation (Klotoé *et al*., 2013). In addition, this work revealed a diversity of plant organs used by populations of these regions. The leaves are the most used. Previous works reported that leaves were the most used parts in fishing practices (Kimpouni *et al.,* 2011), and even for some treatments in traditional medicine (Dongock *et al.,* 2018). Even though the ease and speed of leaf harvesting justify the high rate of leaves used by populations (Bitsindou, 1986), the great demand on leaves in traditional fishing seems to be due to their richness in secondary metabolites (Bigendako-polygenis and Lejoly, 1990). Secondary metabolites, distributed throughout the plant or preferably in one or more of its parts, are responsible for antioxidative and antifungal properties as which would explain the plant toxicity (Kerharo *et al*., 1960; Uno *et al*., 2018). Phytochemical results revealed the existence of secondary metabolites in extracts from ichtyotoxic plants (Table 2). These are chemicals such as: saponins, alkaloids, polyphenols, flavonoids, reducing sugars, cardiotonic heterosides, anthracene compounds, tannins, sterols and terpenes. In fact, the existence of these chemicals in ichthyotoxic plants had been reported for several decades (Kerharo *et al.*, 1960, Nikièma 2005, Doughari *et al.* 2007, Guissou *et al.* 2008). Overall, the action of ichthyotoxic plants on cold-blooded animals (insects, fish, snakes) is attributed to these chemicals; the main ones being rotenone and saponosides. Indeed, the presence of rotenone derivatives in plants toxic to fish has been shown before (Lefournier, 1980; Agbon *et al.,* 2004). Rotenone derivatives affect the respiration of fish by blocking oxygen transfer from water to blood through the gills (Roark, 1932; Erikson, 2006). In addition, saponosides were also documented for their toxic effects (Bishop *et al.*, 1982); due to their solubility, they very quickly paralyze fishes once in contact with their gills (Kabemba, 2015). Alkaloids and tannins have also been involved in the poisoning of aquatic species (Mabberley, 1993). Although studies on these practices mentioned no danger to consumers health (Kerharo *et al.*, 1960; Anoh, 2007), the practice is non-selective and may affect the ecosystem structure and functioning. In fact, the poisoning of water bodies (lakes and rivers) with ichtyotoxic plants may constitute a threat leading to aquatic animal biodiversity loss. Disturbingly enough, around 80% of our informants had no knowledge about biodiversity conservation and management. Therefore, it is important to initiate projects to raise awareness among these indigenous and local populations in the rational use and benefits of biodiversity (ecosystem services).

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