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Impact of Ichthyotoxic Plants on Biodiversity in the Freshwater of Businga Territory, Nord Ubangi Province in the Democratic Republic of the Congo

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Abstract

In the Democratic Republic of the Congo, the traditional fishing by poisoning of the freshwater ecosystems is one of the sources of animal proteins for the population of the forest regions. The aim of the present survey was to value the environmental impact of the ichtyotoxic plants-based fishing on the freshwater biodiversity. Surveys were carried out in Businga sector (Nord Ubangi) according to the probabilistic sampling technique based on a poll to several degrees. The findings indicated that this traditional technique of fishing is practiced more by female than male (54 vs 45%) and it is practiced by people belonging to the age group of 44 to 51 years. Blighia welwetschii is the most used plant species (35%) followed by Tephrosia vogelii (25%). It was observed that this traditional fishing is more practiced in dry season (88%) than in rainy season (12%). 81% of the practitioners do not have any knowledge on the conservation and the protection of biodiversity. Since the chemical pollution of the rivers by natural products of plant origin already entailed the disappearance of some fish species in this ecosystem, it is therefore necessary that to conduct awareness campaign to the populations for a participative approach to the conservation of aquatic biodiversity in Nord Ubangi Province in general and precisely in Businga Sector through the usual aquaculture system for a sustainable development.

Keywords

Ichthyotoxic Plants, Traditional Fishing, Blighia Welwetchii, Biodiversity Conservation

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1. Introduction

In general, African rivers and precisely rivers of the Democratic Republic of the Congo (DRC) constitute an invaluable reservoir of goods and services. Indeed, the resources they contain play an important role in meeting the energy, medical and cultural food needs of different communities and it should be noted that these resources contribute significantly to local and national economies [1-2]. Given the fish richness of these rivers, fishing in rural areas

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is a very important economic income and a significant source of food. In DRC, fishing is the second most important activity after agriculture, generating income for many families and is also an important source of self-sustaining products in rural areas [3-5]. In addition, fishing is one of the solutions to solve the problem of malnutrition, especially that related to the protein-caloric deficit in rural areas [6].

In fishing, the use of ichthyotoxic plants is a very old practice in Africa, although the law on the establishment of a merchant marine framework formally prohibits their use. The high demand for fishery products due to the rapidly growing population in rural areas in recent years and the increasing level of unemployment among the young population explain the frequent use of ichthyotoxic plants in fishing. The aim of this practice is to increase the volume of capture in order to meet the demand [3, 7-8].

To this end, the principle of sustainable development stipulates that environmental resources must be exploited in such a way that they can always be found in quantity and quality [9-10]. Fishing with the use of ichthyotoxic plants, although it favors the capture of a large number of fish, this practice constitutes a real danger for the human if ingested or in contact with these plant extracts. Another risk is the consumption of poisoned fish, which can cause diarrheal diseases [11-12]. From an environmental point of view, fishing with the use of ichthyotoxic plants reduces the biodiversity due to its non-selectivity because this technique helps not only to capture fish but it also destroys other aquatic animal taxa [13].

The main goal of this survey was to assess the environmental impact of plant-based ichthyocides on freshwater biodiversity among some ethnic groups in the Nord Ubangi forest region in DRC. Specific aims were to identify: (1) the fishing techniques used, ichthyotoxic plants, their mode and period of use and; (2) fish species which are endangered in this ecoregion. At the end of this survey, an assessment was performed on the respondents' perception about the concept of conservation and protection of biodiversity in the forest environment.

2. Materials and Methods

2.1. Study Area

This survey carried out between January 2015 and March 2017 in the Businga district with the following geographical coordinates: 4° 22' latitude North; 22° 2' longitude East; Altitude: 2000 m above sea level, Businga district in the Nord Ubangi Province in DRC. This area has an Af-type climate according to Köppen's classification [14-15].

2.2. Method

The methodology used is the probability sampling technique based on a multistage survey. It consists of grouping the population by ethnic group (five) within which we interviewed 80 fishermen. The selection was performed only on groups living along the banks of DUA River and its tributaries. This survey focused on personal interviews and focus group discussion including both genders. It was semi-directive and open-ended, with no influence on the respondent's expected response [13].

In fact, poison fishing using poisonous plants is simple and the same in all areas. The parts of these plants are scraped into small pieces and thrown into the water while its poison dissolves rapidly. The bark of these plants was buried in the sand under water while dried bark or fruits was roughly pulverized and the powder obtained was sprinkled on the surface of the pond. Other used a concentrated plant suspension (plant material) was macerated or decocted [16].

After collecting the part of the plant to be used, these parts were dried under the sun for two to three days until their red color turn to the black one in order to facilitate the grinding process. In addition, other barks or fruits were already collected black, so there was no need of keeping them for days but instead they were for two or three hours before being crushed (use of a piece of wood or a stone) in order to obtain the powder.

First, it is question of the fishing location choice (e. g. pond or stagnant water having a weak current or try to delimit the chosen area as it is the case for scooping technique). For safety reasons, the fisherman wore gloves or plastic bags and the participant try to avoid any eye or mouth contact while crushing the used parts of the ichthyotoxic plants. Having obtained the powder from different parts used, this powder was put inside a porous basket having small mesh and this basket was submerged in water where the fishing was carried out. The content of the basket was shaken at the delimited place chosen for fishing till foams appeared i. e. the pollutant was dissolved in this aquatic environment. After five to ten minutes the toxicity effects were shown not only on fish but also to other aquatic organisms like insects, snakes, molluscs and then the capture began.

3. Results and Discussion

3.1. Socio-Demographic Characteristics of Respondents

The distribution of respondents following the ethnic groups, riparian grouping, gender and age is presented from figures 1 to 4 below.

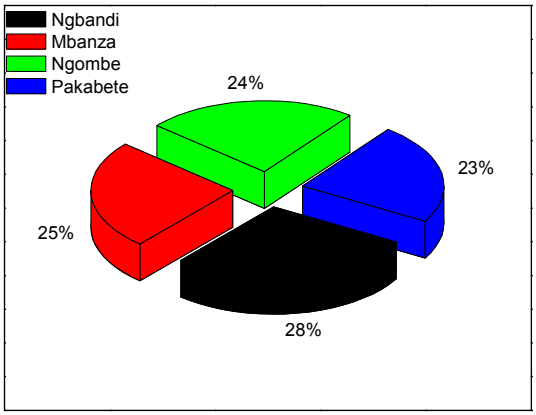


Figure 1. Distribution of respondents following the ethnic group.

Out of the 80 respondents interviewed, the figure showed that 28% of respondents belong to the Ngbandi ethnic group, followed by the Mbanza (25%), Ngombe (24%) and Pakabete (23%).

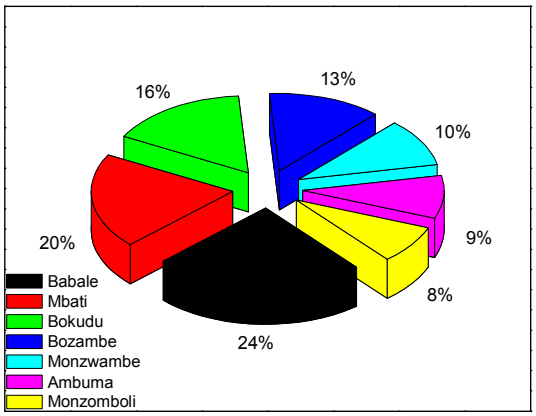


Figure 2. Distribution of respondents according to the riparian groupings.

The majority of respondents living along the banks of DUA river belong to Babale grouping (24%), followed by the Mbati grouping (20%), then the Bokudu and Bozame grouping with 16% and 13% respectively. Meanwhile, the following proportion was found for Monzwambe and Ambuma (10%) followed by Monzomboli (8%).

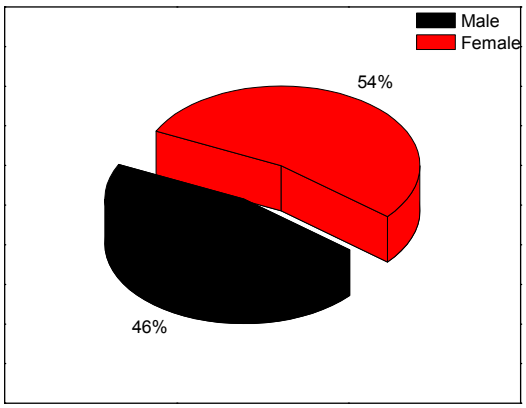


Figure 3. Distribution of respondents according to gender.

As shown above, most of the respondents were female (54%) while the remaining was male (46%). This means that this technique was more practiced by females who participated in this study.

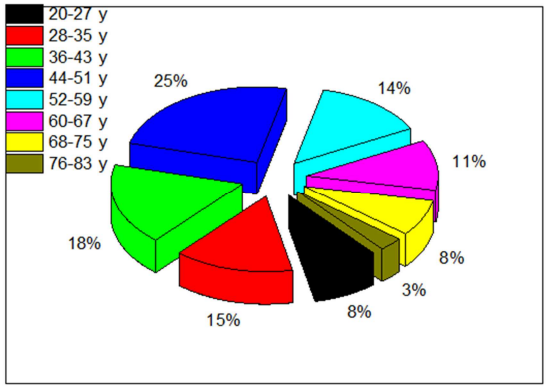


Figure 4. Distribution of respondents according to age.

Most of the respondents who participated in this study were in the range age of 44-51 years (25%), followed by 36-43 years (18%), 28-35 years (15%), 52-59 years (14%) and 60-67 years (11%). Meanwhile, the range age of 20-27 years and 68-75 years showed 8% respectively, and the last group range age represented 3% (76-83 years). This last group represents most the old persons, a group who is not really active compared to the range age of 44-51 years.

Generally, in Africa it is established that the inland fishing is almost artisanal and uses rudimental instruments like nets with different mesh, hooks, traps, etc., as well as fishing techniques using these tools are almost exclusively the panacea of males in general. Meanwhile, most of the time females go for empirical techniques ranging from the scooping technique to the use of ichthyotoxic plants [13].

The distribution of respondents according to the fishing techniques is given in the figure below.

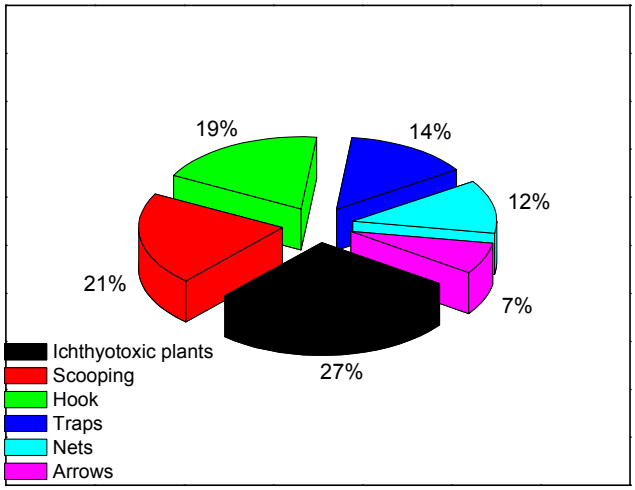


Figure 5. Distribution of respondents according to fishing techniques.

As shown above, a large number of respondents (27%) prefer using ichthyotoxic plants, followed by the scooping technique (21%), while 19% of respondents use hooks for their daily fishing activities. Moreover, other respondents prefer using traps (14%), nets (12%) and arrows (6%) respectively for the capture of fish. It should be noted that the use of arrows is less frequent and seems not be as effective as other techniques in this area. It should be noted that the ichthyotoxic plants are the most used due to the easy collection of different parts of the plant to be used.

The distribution of respondents following different species of ichthyotoxic plants used for fish capture in Nord-Ubangi is presented in figure 5 below.

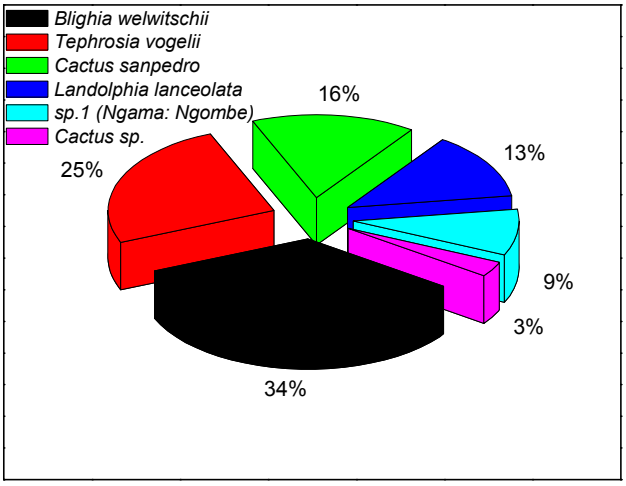


Figure 6. Distribution of respondents according to ichthyotoxic plant species used.

It is clearly shown that Blighia welwitschii (35%) is the most used ichthyotoxic plant species by these communities to capture fish compared to other plant species used for this purpose in the same area. Other plants used were: Tephrosia vogelii (25%); Cactus sanpedro (16%); Landolfia lanceolata (13%); sp. 1 (Ngama: Ngombe) 8% and Cactus sp. (3%). The fruits and inflorescence of Blighia welwitschii are given in the figure below.

(a) Fruits

(b) Inflorescence

Figure 7. Blighia welwetschii (Hiern) Radlk. (Sapindaceae).

Neuwinger [16], reported a list of ichthyotoxic plants which are widely used as fishing poisons as examples, he stated Tephrosia, Mundulea, Euphorbia spp., Strychnos aculeata, Adenia lobata, A. cissampeloides, Blighia sapida, B. welwitschii, Balanites aegyptiaca, Gnidia kraussiana, Swartzia madagascariensis, Neorautanenia mitis and Tetrapleura tetraptera. Therefore, it is necessary to continue searching for other ichthyotoxic plants in order to create a database that would help for future studies.

As secondary metabolites, the toxic constituents of fishing poisons are structurally very different and belong to such highly different structural types for instance triterpene saponins, diterpene esters, rotenoids, sesquiterpenes, lignans, proanthocyanidin polymeres, polyacetylenic compounds [16]. The plants described need to be studied chemically, pharmacologically and toxicologically for their contents, efficacy and mechanism of action.

The temporal aspect of the use of ichthyotoxic plants in fishing is presented in the figure below.

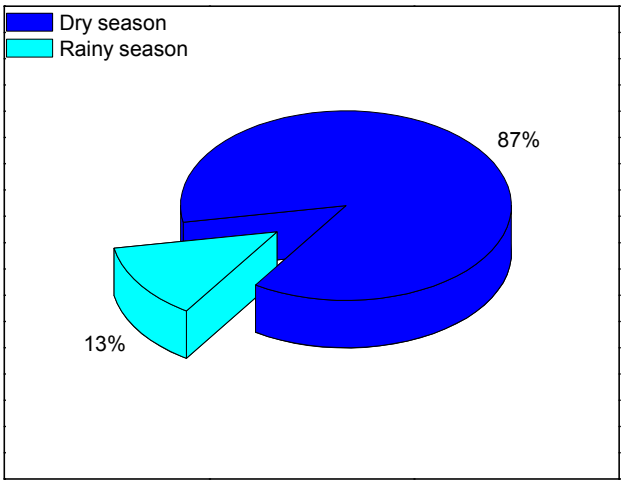


Figure 8. The use of ichthyotoxic plants according to the season.

It is important to underline that the temporal aspect is vital for the practice of poisoning fishing. The findings of the current survey indicated that 87% of respondents practiced this fishing technique during the dry season while 13% prefer performing it during the rainy season as shown in the figure above. This finding is similar with Neuwinger [16], who reported that this fishing technique is more practiced during the dry season.

The level of knowledge of respondents on the conservation of biodiversity was as well assessed as shown in the figure below.

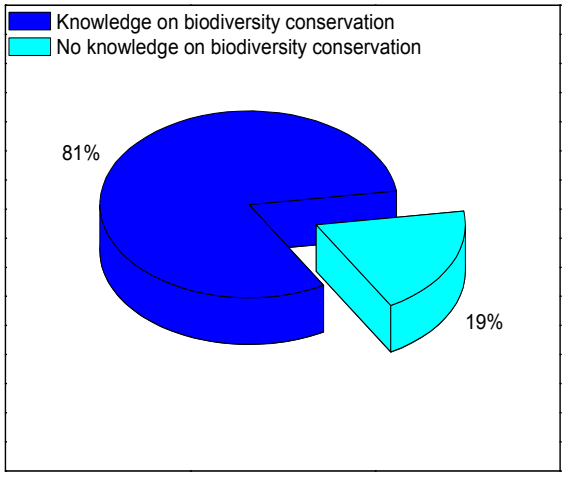


Figure 9. Level of knowledge of respondents on the biodiversity conservation.

Most of the respondents (81%) did not know anything about biodiversity conservation while 19% of respondents have already heard about biodiversity conservation and protection. This implies an awareness campaign by researchers along with the politics so that fishermen or fisherwomen may know how to practice this poisoning technique safely in order to avoid the destruction of this biodiversity.

3.2. Endangered Species at Businga District

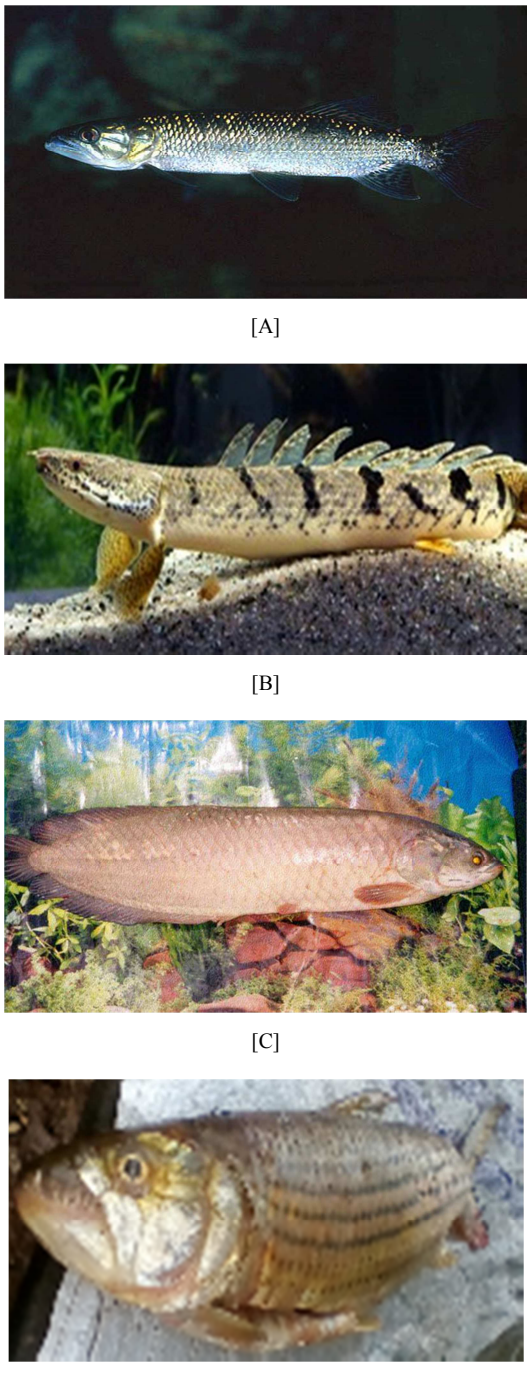
Table 1 lists the fish which are threatened as a result of fishing poisoning in Businga, these are species which live and reproduce in the first layer of water.

Table 1. List of fish that have totally disappeared as a result of fishing by poisoning in Businga district.

Scientific names	Families	Common name
Hemichromis bimaculatus.	Cichlidae	Mokenge (Ngombe)
Hemichromis guttatus	Cichlidae	Ekaba (Ngombe)
Hemichromis faciatus	Cichlidae	Ekoke (Ngombe)
Hemichromis sp. 1	Cichlidae	Mokoyo (Ngombe)
Hemichromis lifalili	Cichlidae	Ikutu (Ngombe)
Alestes sp.	Characidae	Mokobe (Lingala)
Sacordace sp.	Polypetridae	Moloti
Polypterus ornatipinnis	Polypteridae	Mokonga
Heterotucus niloticus	Osteoglocidae	La Mer (Lingala)
Hydrocinus vitatus	Characidae	Mbenga

From the above table, it is shown that Hemichromis genus is the most threatened genus due to the higher number of species which are threatened to extinction. Henceforth, this fishing technique contributes to the destruction of the aquatic ecosystem (figure 10).

Figure 10 gives the pictures of endangered species in Businga district due to this fishing technique.



[A]

[B]

[C]

[D]

Figure 10. Photos of threatened fish in Businga are. [A] Sacordace sp. Family: Characidae; Local Name: Moloti; [B] Polypterus ornatipinnis; Family: Polypteridae; Local name Mokonga; [C] Heterotucus niloticus; Family: Osteoglocidae; Local name: la Mer; [D] Hydrocinus vitatus; Family: Characidae; Local name: Mbenga.

3.3. Traditional Fishing by Poisoning

Traditional fishing by poisoning rivers is a common practice in Africa. Because of its effectiveness, this fishing technique allows the population to obtain an essential food supplement during the season when the forest is not very favorable to hunting [6, 18, 19]. However, despite its traditional nature and effectiveness, this fishing technique is not very selective with respect to all the organisms that constitute the freshwater ecosystem [20].

The ichthyocidal effect is believed to be related to the chemical nature of secondary metabolites contained in ichthyotoxic plants. Rotenone plants (Tephrosia vogelii) have the property of asphyxiating fish. It has been reported that rotenones act on all animals by blocking the respiratory chain at the mitochondria, but warm-blooded animals are protected from the harmful action of these compounds by their skin coating which prevents the resorption of poison while cold-blooded animals (arthropods, fish, snakes) are on the contrary extremely sensitive to them, even at very low doses [16]. On the other hand, saponin plants (Blighia welwitschii) would act by modifying the surface tension of the water (surfactant/detergent properties) and by blocking respiratory exchanges in the fish gills. This would lead to the death of fish by asphyxiation [17]. The results of this study show that chemical pollution of rivers by natural substances of plant origin has already caused the extinction of six fish species in the Businga ecoregion.

4. Conclusion and Suggestions

The aim of this study was to assess the environmental impact of ichthyotoxic plants on freshwater biodiversity in Businga (Nord Ubangi Province) in DRC. The findings of this survey showed that traditional fishing by poisoning rivers is more practiced by female than male and the age group of 44-51 years was the most predominant in the practice of fishing using ichthyotoxic plants. Blighia welwetschii was the most used plant than the others. This fishing technique is more practiced during the dry season and the majority of respondents do not have knowledge on the biodiversity conservation.

Since the chemical pollution of rivers by natural substances of plant origin (secondary metabolites) has already led to the disappearance of some fish species in this area, it is therefore desirable to initiate projects to raise public awareness for a participatory approach to the conservation of aquatic biodiversity in the Nord Ubangi Province in general and the Businga district in particular through family fish farming for a sustainable development.

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