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(RESEARCH ARTICLE)

Wild plants with edible fruits commercialized in markets in the city of Daloa, Central-West of the Côte d'Ivoire: Specific diversity, origin and economic fallout

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Abstract

The diversity of wild species and their edible fruits commercialized in the markets is unrecognized. In the Côte d'Ivoire, in the markets of many cities, in particular in Daloa, in the Central-West of the country, the edible fruits of some wild species are commercialized. The aim of the study is to know these spontaneous plant species and their edible fruits commercialized in the markets in Daloa. By the ethnobotanical survey method, semi-structured interviews with 24 people from the wild edible fruit commercialization sector aged 25 to 65, distributed into 21 women (87.5%) and 3 men (12.5%) in 7 markets s were made. The geographical coordinates of the survey sites were maked out using a GPS. In total, 17 wild species with edible fruits divided into 17 genera and 14 families have been identified. The most represented families are the Annonaceae, the Fabaceae and the Malvaceae with 11.76% of the species each. The results showed that the commercialization of the fruits of these wild species generates monthly financial income inconstant according to the production seasons and the actors identified: gatherers, wholesalers and retailers. They gave information on the diversity of wild species with edible fruits still commercialized in the markets. These results can guide scientific reflections and actions on the vulgarization and sustainable management of these plants threatened with extinction due to excessive deforestation.

Keywords: Wild species; Edible fruits; Financial income; Daloa; Côte d'Ivoire; West Africa

1. Introduction

In Sub-saharan Africa, the interest of wild plants with edible fruits for food is recognized and rests essentially on its important role in the socio-economic life of many indigenous and local populations which should be preserved [1, 2, 3, 4].

Unfortunately, the restriction of forests and especially cultivable areas in tropical Africa in recent decades has undermined the sustainability of these wild plants [2, 5, 6]. Indeed, in Côte d'Ivoire, these fruit species once well known to local populations are endangered due to excessive deforestation linked to the population growth.

Indeed, in Côte d'Ivoire, these fruit species once well known to local populations are endangered due to excessive deforestation linked to the population growth. Sided with the disappearance over the years of the diversity of wild species with edible fruits, formerly discernible on Ivorian markets, it is important to make an inventory of this plant biodiversity in order to evolve strategies for their popularization and management sustainable. In these circumstances,

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what are the wild species with edible fruits traditionally commercialized on the markets in Côte d'Ivoire and, in particular in the city of Daloa? What are their places of origin and their socio-economic fallout? To answer these questions, this study proposes to contribute to know the wild species with edible fruits commercialized in markets in Daloa, their origin and their economic fallout for the actors.

2. Material and methods

2.1. Study area

This study was carried out in the city of Daloa in Central-West of Côte d'Ivoire**.** Daloa is located at 6°27'00" North Latitude and 5°56'00' West Longitude. It has an equatorial climate comprising two rainy seasons and two dry seasons. The annual rainfall varies between 1300 and 2000 mm. The vegetation belongs to the mesophilic sector of the Guinean domain [7], today, consisting of forest fragments and savannas exploited for the benefit of agricultural plantations: cocoa trees, coffee trees, rubber trees, etc.

2.2. Material

The biological material consisted of wild species and their edible fruits. The technical material includes a geographic positioning device (GPS), a digital camera, survey sheets for interviews and a plastic bag for collecting samples of species and wild fruits.

2.3. Methods

2.3.1. Selection of markets

For the selection of sites surveyed, a week prospecting visit was carried out in the markets entire city of Daloa to list the market site. Then, seven markets were selected based on their purveyance in fruits of wild plants (Figure 1). These are: abattoir market (6°52'11.74936"N and 6°26'29.7636"W), Kennedy market 1 (6°53'17.29"N and 6°27'45, 05"W), Kennedy Market 2 (6°53'23.70"N and 6°28'15.008"W), Lobia 2 Market (6°53'53.32"N and 6°27'11.01"W), big market (6°52'52.77"N and 6°27'27.55"W), Orly market (6°52'13.10"N and 6°27'13.79"W) and Tazibouo market (6°53'35.56"N and 6°26'17.76"W).

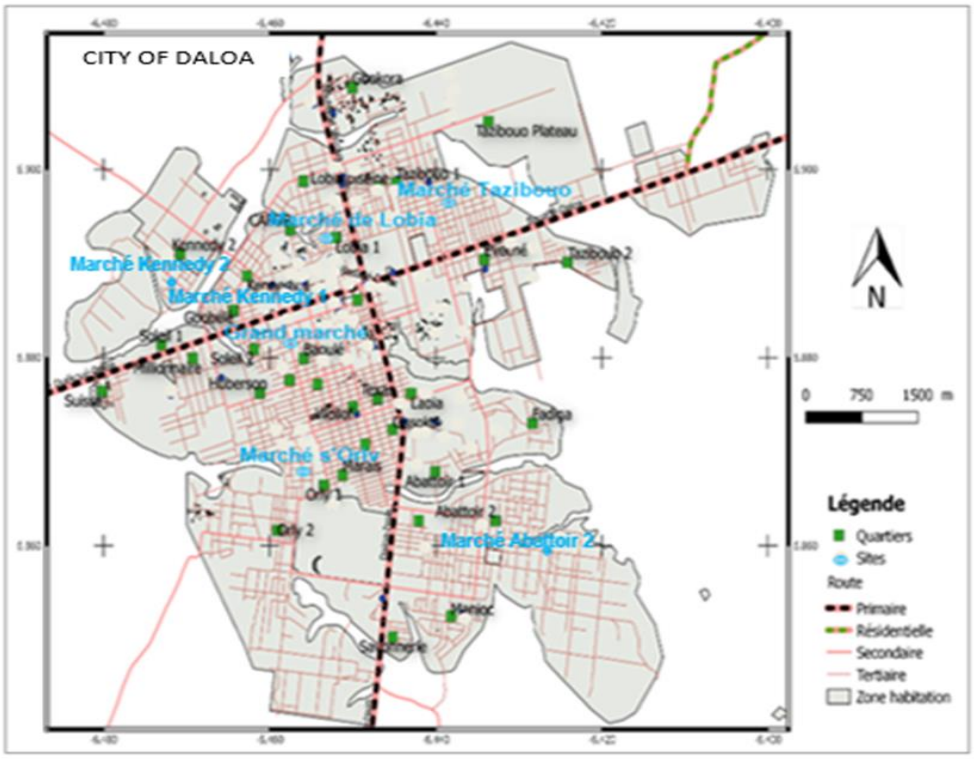

Figure 1 Location of markets surveyed or site in Daloa

2.3.2. Ethnobotanical surveys

The surveys were carried out during a semi-structured interview on each site with actors in the fruit marketing sector aged 25 to 65, divided into 21 women and 3 men using a questionnaire. The information collected concerned the socio-demographic characteristics of the respondents (age, sex, school level, ethnic origin, experience year in the activity), the fruits of wild species commercialized, the marketing methods and the economic fallout of the activity. Although familiar with the town of Daloa, the help of a local interpreter was sometimes needed to simplify communication with respondents who only speak the local language. To our knowledge, no specific ethnobotanical survey has yet been carried out in the markets of this city. In each market, the edible wild fruits commercialized and plant species were inventoried and recorded on floristic inventory cards. The identification was made using the works of Le brun and Stork [8] and documents consulted on the net.

2.3.3. Evaluation of expenditure and benefit of income

Two parameters were used to assess the expenses and income of the various players in the marketing of wild fruits. These are the gross margin and the net margin. The gross margin (GM) of an activity is the difference between the production value (PV) and the total variable costs (TVC). It has been used to assess the costs and benefits of selling wild fruits in markets. It is calculated according to the following formula:

GM = PV-TVC

As for the net margin (NM), it is the difference between the gross margin (GM) and the total fixed costs (TFC) its formula is:

NM = MB-CFT

3. Results

3.1. Socio-demographic characteristics of the surveyed

The survey was carried out among 24 people divided into 21 women (87.50%) and 3 men (12.50%) in the 7 markets. There is a clear gender dominance in the wild edible fruit commercialization sector in Daloa (Table 1). They are 25 to 65 years old. People aged 35 to 45 are in the majority with 10 people (41.67% of respondents). Young people (< 35 years) are in the minority with 1 person, either 4.17% are represented in the commercialization of edible wild fruits in Daloa (Table 1).

These interviewees mostly indicated a minimum experience of 5 years in the wild edible fruit commercialization sector with 15 people, either 62.50% of the respondents. The wild edible fruit marketing sector in markets in Daloa is strongly dominated by illiterates with a workforce of 11 out of the 24 interviewed, either 45.83% (Table 1). Only 7 interviewees, either 29.17% have a primary school level, 4 interviewees have a secondary level (either 16.67%) and 2 of the actors have high school (either 8.33%). Of the 24 interviewed, 17 (either 70.83% °) are Ivorians contra 16.67% Malian nationals and 12.50% Burkinabés (Table 1).

Table 1 Socio-demographic characteristics of surveyed

Parameters		**Interviewees (n = 24)**	**Frequencies (%)**
Gender	Female	21	87.50
	Man	3	12.50
Age	< 35	1	4.17
	35 - 45	10	41.67
	46 - 55	8	33.33
	> 55	5	20.83
School level	Illiterate	11	45.83
	Primary	7	29.17
	Secondary	4	16.67
	University	2	8.33
Experience year	1 - 5 years	9	37.50
	> 5 years	15	62.50
Survey sites (markets)	Abattoir	1	4.17
	Tazibouo	3	12.50
	Orly 1	5	20.83
	Orly 2	9	37.50
	Lobia	2	8.33
	Kennedy 1	1	4.17
	Kennedy2	3	12.50
Citizenship	Côte d'Ivoire	17	70.83
	Burkina Faso	3	12.50
	Mali	4	16.67

3.2. Diversity of wild edible fruit species commercialized

In total, 17 species of wild edible fruit plants commercialized were recorded and identified in 7 markets in the town of Daloa (Table 2). They belong to 17 genera and 14 botanical families. The most represented families in terms of species commercialized are the Annonaceae, the Fabaceae and the Malvaceae with respectively 2 species each, either 11.76%. Among these 17 species, eleven are the most requested and traded in the markets in Daloa (Table 2). These are *Adansonia digitata*, *Annona muricata*, *Borassus aethiopum*, *Cola nitida*, *Garcinia kola*, *Irvingia gabonensis*, *Parkia biglobosa*, *Ricinodendron heudelotii*, *Tamarindus indica*, *Viellera paradoxa* and *Xylopia aethiopica* (Figure 2). Among these 17 species, the fruits of two are in low demand and commercialized. We cite: *Balanites aegyptiaca* and *Saba senegalensis* (Table 2).

Figure 2 Some edible fruits of wild species commercialized: *Garcinia kola* (A), *Irvingia gabonensis* (B), *Dialium guineensis* (c), *Adansonia digitata* (D)

Table 2 Listed wild edible fruit species

Common names	Scientific names	Families	Production period	Interest
Baobab	*Adansonia digitata* L.	Malvaceae	January to february	***
Soursop	*Annona muricata* L.	Annonaceae	All seasons	***
Iboraghan	*Balanites aegyptiaca.* Delile	Zygophyllaceae	-	*
Rônier	*Borassus aethiopum* Mart.	Aricaceae	January to march	***
Wêssê	*Cola nitida* Schott et Endlicher	Malvaceae	October to march	***
-	*Dialium guineensis* Willd	Fabaceae	-	**
Small cola	*Garcinia kola* Heckel	clusiaceae	November to march	
Kplé	*Irvingia gabonensis* Aubry-lecomte	Irvingiaceae	January to April	***
Néré	*Parkia biglobosa* (Jacq) R. Br	Mimosaceae	December to march	***
Akai (baoulé)	*Ricinodendron heudelotii* (Bail) pierre ex pax	Euphorbiaceae	Janvier à mars	***
Kocota (amanie)	*Saba senegalensis* Pichon	Apocynaceae	Saison pluvieuse	*
Mirabelle	*Spondias mombim* L.	Anacardiaceae	September to october	**
Tamarind	*Tamarindus indica* L.	Fabaceae	All seasons	***
Cocoma	*Terminalia catappa* L.	Combretaceae	-	
Shea	*Viellera paradoxa* C.F.Gaertn	Sapotaceae	All seasons	***
African pepper	*Xylopia aethiopica* (Dunal) A. Rich	Annonaceae	November to january	***
Jujube	*Ziziphus jujuba*	Rhamnaceae	-	**

* - Low demand fruit species; ** - Medium demand fruit species; *** - Very popular fruit species, (-) – unknown

3.3. Origin of wild fruits commercialized

The origin of edible wild fruits inconstant from one year to another according to the encampments in the surrounding localities depending on the climatic conditions. Indeed, according to the surveyed (100% of respondents) on the sources of supply of edible wild fruits commercialized in various markets in the city of Daloa, affirm that the origin of these fruits comes mainly from the small encampments located on the Daloa axis: Issia, Daloa-Vaoua and Daloa-Douekué. Out of 19 persons of the 24 surveyed (79.17% of respondents) affirm that the presence of edible wild fruits in the various markets in Daloa is also conditioned by the rainy seasons which predate the fruit production of wild species.

3.4. Economic fallout of the activity of commercialization edible wild fruits

The commercialization of edible fruits of wild species is a profitable economic activity to varying degrees. Indeed, according to the respondents (100% of respondents), the sale of the various edible wild fruits generates daily and monthly benefits which change according to the actors and the production seasons of these fruits (short or long). Edible wild fruits are commercialized wholesale in the fields and surrounding camps to peasants or pickers by wholesale traders. These fruits are then commercialized to retail traders who sell them in detail in the markets of Daloa and not in kilograms. Out of 20 peoples of the 24 interviewed (either 83.33% of respondents) each actor identified can act different roles depending on the opportunities of supply and demand on the markets. The unit selling price of these wild fruits on the markets ranges from 25 to 100 XOF per heap. The income of actors in the edible fruit marketing sector change from 11 900 and 24 500 XOF per month and 71 400 to 147 000 XOF per annual (Table 3), either a profit of 109 200 XOF.

Table 3 Margin obtained by the actors of the sector of edible fruits on the markets (in XOF)

Parameters	**Actors**					
	Peasant		Wholesaler		Retailer	
	E	I	E	I	E	I
Transport	-	-	5 500	30 000	600	12 500
Mean of Net margin per Month	-	20 000	-	24 500	-	11 900
	20 000		24 500		11 900	
Mean of Annual Gross margin (GM)	120 000		147 000		71 400	

E - Expenditure, I – Inco

3.5. Constraints of the commercialization of edible wild fruits

In the commercialization of wild edible fruits, the production periods are in themselves a problem because of its variability due to the climate. Indeed, they are very often long or short depending on the year (100% of respondents). In addition, some of these wild fruit species are not very productive in their ordinary seasons because of the age of the plant species or and some diseases (parasitic attacks). Also, production areas, when they exist, are sometimes unattainable, making it problematic to commercialize this sort of fruit on the markets in Daloa (83.33% of respondents).

4. Discussion

The study on the edible fruits of wild plants commercialized on the markets of the city of Daloa, in the Central-West of the Côte d'Ivoire has identified 17 species belonging to 17 genera and 14 families. This number is lower than the 20 wild edible fruit species counted by Ouattara *et al*. [9] in Bondoukou, in the northeast of the Côte d'Ivoire and the 25 wild fruit species commercialized in the markets of the city of Douala [10]. But this number is much higher than the 10 wild fruit species commercialized identified by Djihounouck *et al*. [11] in Kasa in South Western Senegal. This difference noted could be explained by the extent of the area surveyed.

The results also show that the supply of edible wild fruits to markets is ensured by pickers, wholesale traders and retailers or small traders. These results confirm those of Djihounouck *et al*. [11].

Among the 24 people interviewed in this sector of activity, 70.83% are Ivorians. These results differ from those of Ouattara *et al*. [9] produced in the city of Bondoukou.

The commercialization of edible fruits of wild species and their financial incomes are recognized by all the people encountered during this study (100% of respondents). It appears that the estimated average financial incomes per month and per actor remain variable [4] and [11]. Indeed, the monthly income of the farmer is 20 000 XOF, the wholesaler (24 500 XOF) and the retailer (11 900 XOF) depending on the seasons of wild fruit production. Those involved in marketing edible fruits in markets can reduce poverty. The sale of these edible fruits requires the support of the authorities for their popularization and sustainable management.

5. Conclusion

This study was carried out to better understand the edible fruits of wild plants commercialized in the markets of the city of Daloa in order to promote their popularization. The surveys were carried out in 7 markets. The results of the surveys showed that the actors in the sector are mostly illiterate adults. They also identified 17 commercial edible fruit species included in 17 genera and 14 families. The results obtained indicate that these wild fruits of spontaneous plants commercialized come from the camps of the neighboring villages which are the supply zones. The most represented families are the Annonaceae, the Fabaceae and the Malvaceae with 2 species each, either 11.76%. This sector includes three actors: peasant, wholesaler and retailer. Their income varies according to the season and the plenty of edible fruit production from wild plants during the year. Ultimately, marketing is an important sector which provides significant seasonal income. These data could be used to set up an extension program through scientific reflections on their popularization and sustainable management.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The author declares no conflict of interest.

Author's contribution

In the present study, AADE and ONS ensured the development of the research protocol, the collection, the data processing and the wording of the manuscript. They were supported by SHEA, MAS, SF, DB and SD in proofreading the different versions to improve the scientific quality of the manuscript.

Statement of informed consent

Each actor interviewed gave their consent deliberately and was willing to answer the different questions.

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Author's short biography

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AMON Anoh Denis-Esdras holds a Ph.D. degree from the University Félix Houphouët-Boigny Specialty: Plant Ecology, Option: Agroforestry and works as a Lecturer-Researcher at the University Jean Lorougnon Guédé de Daloa. His fields of teaching are Botany (in its general concept), ethnobotany, plant ecology and agroforestry. Mr. AMON also works with Masters Students who are in the defense of crops and hemiparasitic plants, parasites of perennial crops and medicinal plants. He is the author of several articles including: The Loranthaceae (mistletoe) hemiparasites vascular trees and shrubs agroecosystems of the Sud-Comoé region, dense evergreen forest area of Côte d'Ivoire, Ethnobotany study of Loranthaceae, hemiparasitic plants used in traditional medicine by population, in the Sud-Comoé region (Côte d'Ivoire), Prevalence of Phragmanthera capitata (Spreng.) Ballé (Loranthaceae) on Rubber Trees of Farming Plantations at the Jean Lorougnon Guédé University Site in Central West of Côte d'Ivoire, Floristic and ethnobotanical studies of medicinal plants used in the treatment of childhood illnesses commercialized in the markets of Daloa (Côte d'Ivoire, Loranthaceae (mistletoe), a phytoparasitic dispersed by birds on annuity crops in periurban areas of the Daloa department, in Central West Côte d'Ivoire.