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Ethnobotanical investigations of insecticidal plants in Guinean flora: Case of the Boke region (Republic of Guinea)

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Abstract

The aim of this study is to identify the insecticidal plants used by the inhabitants of the Boke region to control insect pests that attack agricultural produce, in order to reduce the use of chemical products that are harmful to the environment and human health.

To this end, 100 questionnaire forms were drawn up and the ethnobotanical survey was carried out in the Boke region during 2022. The results identified 14 plant species belonging to 8 botanical families, of which the Solanaceae family is the most widely used for preserving agricultural produce. The results also show that leaves and fruits are the most widely used parts for preserving groundnuts and maize.

Then, the insect pests most targeted by the population of this Region are respectively *Sitophilus zeamaïs* maize and *Aphis craccivora* peanuts. These insect pests can cause enormous stock losses. The most common means of limiting the damage caused by these insects is the use of synthetic pesticides, whose undesirable effects are unfortunately very numerous, and human poisoning is a real danger to public health. Over the last two decades, a great deal of work has been carried out to find gentler food protection methods that respect human health and the environment.

Keywords: Insecticidal plants; Ethnobotanical study; Insect pests; Synthetic pesticides; Public health

1. Introduction

In Guinea, as elsewhere in Africa, traditional medicine is a very important component of cultural heritage, deeply rooted in the history, culture and beliefs of the people. It determines people's aptitudes and behavior in the face of personal, cultural, family and social events in their daily lives.

Until the middle of the 20th century, medicinal plants still held an important place in the therapeutic arsenal of these populations, and there was no resistance to their use for benign pathologies, serious illnesses or the protection of agricultural produce [1].

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With this in mind, and faced with the high cost of chemical products, players are turning to medicinal plants as a credible alternative worth exploring in depth. Plants with insecticidal properties play a key role in seed conservation. For this reason, Burkina Faso's Ministry of the Environment and the Living Environment [2] stresses that insecticide plants contribute to agricultural intensification by combating various crop pests, whose damage can sometimes affect 50% to 70% of agricultural produce. They also contribute significantly to improving health when used to combat the vectors of human and animal diseases [2].

Furthermore, in 2018, the preparation of the Guinea Integrated Agricultural Development Project (PDAIG) was born of the political will of Guinea and the World Bank to support the financing of the National Economic and Social Development Plan (PNDES). The design of the project was based on Guinea's growing need to transform its agricultural sector by increasing agricultural productivity and improving the resilience of producers and stakeholders in the target sectors. In the face of climate change, integrating value chains, developing markets, improving competitiveness and strengthening productive infrastructures, nutritional security and the fight against extreme poverty. Numerous aromatic plants such as Lamiaceae and Solanaceae have been used in place of synthetic chemical insecticides or pesticides to preserve agricultural produce.

The main dangers associated with the use of synthetic pesticides include the following:

- In most cases, many users of synthetic pesticides neglect or ignore the risks and dangers they represent. As a result, they tend to handle them without the slightest precaution, leading to risks of voluntary and involuntary poisoning.
- Pesticides also kill other non-target insects and birds that may be natural predators of pests. Similarly, water polluted by the use of pesticides becomes unsuitable and dangerous both for animals (wild and domestic) and aquatic animals, and also for humans through the phenomenon of bioaccumulation. This puts the entire food chain at risk.
- Waters are the main collectors of pesticide surpluses, and watercourses are environmental components liable to be polluted, with a negative effect on the water table and the food chain. In addition, the increased use of synthetic pesticides leads to soil pollution, which contributes to the elimination of harmful insects and microorganisms. On the other hand, these microorganisms help to overcome soil nutrient deficiencies and stimulate respiratory activity and mineralization.

On the other hand, the air pollution caused by these pesticides has repercussions on air quality, leading to the disappearance of certain insects (bees) and thus reducing beekeeping activities by causing respiratory problems [3]. Since insects and humans cohabit in the same environment, humans are sometimes obliged to eliminate certain insects, such as the pests of maize and peanuts, which are mainly beetles *Sitophilus zeamïs* and the *Aphis craccivora* which are frequently cited by farmers in the Boke region and can cause huge losses in food stocks. This is why the aim of the present study is to identify the different plant species with insecticidal properties used by the population of this region to preserve agricultural produce.

2. Materials and methods

2.1. Presentation of the study area

The Boke Region is an administrative subdivision of Guinea, with the town of Boke as its capital. Its surface area is 3.118.600 ha = 31.186 km2. It is located between 11°15' north and 14°15' west. Its density is estimated at 38 inhab. / km2 and its population at 1.190.724 according to the RGPH carried out in 2017.

The Boke Region has 5 Prefectures; 32 Sub-Prefectures; 394 Districts/Quartiers; 2.045 Sectors; 5 Urban Communes and 32 Rural Communes [4].

Figure 1 Map of the Boke Region [4]

2.2. Sampling and data collection

Qualitative, participatory surveys based on semi-structured interviews were conducted in the 5 Prefectures of the Boke region. Inhabitants use indigenous plants to combat insect pests of agricultural produce, notably groundnuts and maize. More specifically, the project will involve

- Identify all plants with insecticidal potential and their areas of use;
- List all traditional insect control methods and techniques.

The various prefectures were chosen on the basis of their lively cultural practices. Preliminary surveys revealed that people in these prefectures had long maintained their insect control and seed saving practices. In each prefecture visited, people of both sexes were subjected to a questionnaire. Customary authorities were targeted, as well as farm managers and their wives, and the heads of various agricultural services in the region during the period from February 1, 2023 to July 31, 2023. Then, trips were made to fields and markets to collect samples of the plants mentioned during the interview. The plants collected served as raw material for a herbarium.

The choice of prefectures was guided by customary authorities and other people of advanced years. However, some neighboring prefectures, not recommended by these authorities, were taken into account. This is in response to the concern to obtain representative and more reliable data, considering the possible risks of omission and ignorance on the part of the authorities [5]. The questionnaire covered the different uses of plant species with insecticidal potential, the types of insects on which these plants are used, and the methods used other than local plants to combat these insects. Agricultural practices for preserving foodstuffs were also noted in terms of their modality, timeliness and effectiveness. The aim was to observe and describe objectively what the farmer does, by analyzing the internal logic or rationalization of his practices. For this purpose, group interviews were preferred. It has been shown that a single person is not expected to have the knowledge on certain aspects, and this could lead to biased information. On the other hand, in these types of interviews, answers are progressively corrected and readjusted by certain people when inaccuracies or incorrectness are noted [5]. These interviews were conducted in local languages, with the help of interpreters. The names of plants, quoted in local languages, were identified by their scientific names in the field or, where appropriate, harvest samples were collected for determination in the laboratory.

2.3. Data processing

The survey forms were processed manually and using Microsoft EXCEL, the data were used to assess the percentage of quotations for plants with insecticidal properties, insects frequently targeted by farmers and farmers using the plants. This process made it possible to estimate the relative importance of each practice, and the analyzed data were used to construct illustrative histograms for the different areas of plant use. Next, analyses of variance on the numbers of respondents by prefecture were carried out on JMP8 at the 5% threshold: *Capsicum chinense, Capsicum frustescens, Capsicum annuum, Capsicum baccatum, Capsicum pubescens, Allium cepal* and *Zingiber officinal Rosc were very effective in preserving groundnuts and maize.*

These powders were mixed with agricultural produce and stored in sacks, granaries and metal barrels. This method involves mixing two (2) tablespoons of plant powder for every 50 kg of seed, and is effective against corn and peanut bruchids. The maximum shelf life is one year, and 90% of the population use this method of seed conservation. The leaves are sometimes scattered between stocks, serving as a repellent against insects. In some localities, the leaves are used as a fumigant to disinfect premises long before foodstuffs are stored, and they have a febrifuge property. Species such as : *Hyptis spicigera, Hyptis suaveolens, Ocimum americanum* and *Ocimum basilicium*; the leaves and inflorescences of *Cymbopogon schoenanthus*, *Azadirachta indica* and *Combretum micranthum* are mixed with peanut and maize pods in layers before being stored in bags in attics. These leaves are always dried and then ground by hand, before being mixed with the agricultural produce at a rate of two (2) tablespoons for every 50kg of seed to be preserved

Figure 2 Infected corn (Taken on 25/06/2023)

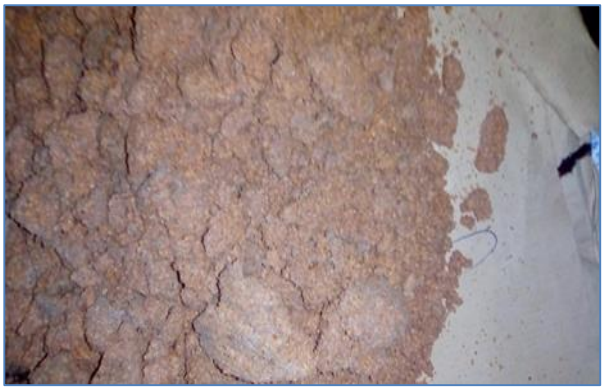

Figure 3 Capsicum chinense powder (Taken on 30/06/2023)

Figure 4 Mixing peanuts with powder (Taken on 30/06/2023)

Figure 5 Treated seed (taken on 30/07/2023)

3. Results and discussion

The ethnobotanical surveys enabled us to select 14 insecticidal plant species in the 5 Prefectures of the Boke Region, belonging to 8 botanical families.

These surveys showed that the plant species used in several fields, in particular the conservation of agricultural products: *Capsicum chinense* (98%), *Capsicum frustescens* (98%) and *Capsicum annuum* (97%) (Table 1). This result is in agreement with other previous studies carried out in Guinea by Diallo A. et al. [6]; in Burkina Faso by Savadogo S. et al. [7]. There were no significant differences between the number of respondents per prefecture (p = 0.45%).

These results enabled us to identify the different types of insects found on stored products such as maize: *Sitophilus zeamaïs* (98%), *Sitophilus oyzea* (97%), *Protephanus truncatus horn* (95%) (Table 2) and groundnuts: *Aphis craccivora* (98%), *Nematode* (80%), *Heteroceran Lepidoptera* (40%) (Table 3). These insects are capable of causing major losses by reducing the quality and quantity of stored produce. In addition, several studies carried out worldwide have reported the damage caused by these insects to agricultural produce, notably maize and groundnuts, such as Kechoute F. et al [8]; Ngamo T. S. L. et al [9].

This correspondence in the use of the plant species mentioned, in the search for maize and groundnut pests could be an indication of the definite effectiveness of these indigenous plants in the conservation of agricultural products, particularly maize and groundnuts.

A comparison of literature data based on biological activities showed that most of the plant species mentioned have been tested for their insecticidal activities [7].

All plant organs (leaves, bark, roots, flowers, fruit, wood and bulbs) were cited by respondents. Leaves were the most cited at 58%, followed by fruits at 54%, and other parts (roots, bark, flowers, etc.) accounted for only 5%. Our results

corroborate those of Diatta C. D. et al [10]; Dougnon et al [11]; Guèye M. T. et al [12] who reported in their studies that leaves were the most widely used parts of the plant.

The percentage of citations was determined according to the formula below:

Legend: P(c) = Percentage of citations; N(c) = Number of citations;

N(h)= Number of herbalistsAll plant organs (leaves, bark, roots, flowers, fruit, wood and bulbs) were cited by respondents. Leaves were the most cited at 58%, followed by fruits at 54%, and other parts (roots, bark, flowers etc.) accounted for only 5%. Our results corroborate those of Diatta C. D. et al [10]; Dougnon et al [11]; Guèye M. T. et al [12] who reported in their studies that leaves were the most widely used parts of the plant.

The percentage of citations was determined according to the formula below:

$$P(c) = [(N(c)/N(h)] * 100$$

Legend:
P(c) = Percentage of citations;
N(c) = Number of citations;
N(h) = Number of herbalists.

Table 1 Summary table of species and their areas of use

Species	**Parts used**	**Areas of use**	**Effects**	**Local name/Soussou**
Capsicum chinense	Fruit	Seed saving/Food	Insecticide/Insect repellent	Mamou Gbingbet
Capsicum frustescens	Fruit	Seed saving/Food	Insecticide/Insect repellent	Nènè Görö
Capsicum annuum	Fruit	Seed saving/Food	Insecticide/Insect repellent	Piciguirima
Capsicum baccatum	Fruit	Seed saving/Food	Insecticide/Insect repellent	Taïson
Capsicum pubescens	Fruit	Seed saving/Food	Insecticide/Insect repellent	Merkèta
Hyptis suaveolens	Leaves	Seed saving	Insecticide/Insect repellent	Yoguéhirignahi
Hyptis spicigera	Leaves	Seed saving	Insecticide/Insect repellent	Yoguéhirignahi
Ocimum basilicium	Leaves	Seed saving	Insecticide/Insect repellent	Hömygnon
ssssOcimum americanum	Leaves	Seed saving	Insecticide/Insect repellent	Hömygnon
Azadirachta indica	Leaves, seeds	Seed saving	Insecticide/Insect repellent	Barikéri
Cymbopogon schoenanthus	Leaves	Seed saving	Insecticide/Insect repellent	Tondonyogué
Allium cepal	Bark	Seed saving	Insecticide/Insect repellent	Yèbè
Combretum micranthum	Leaves	Seed saving	Insecticide/Insect repellent	Kenkéliba
Zingiber officinal Rosc	seeds	Seed saving	Insecticide/Insect repellent	Gnöhömi

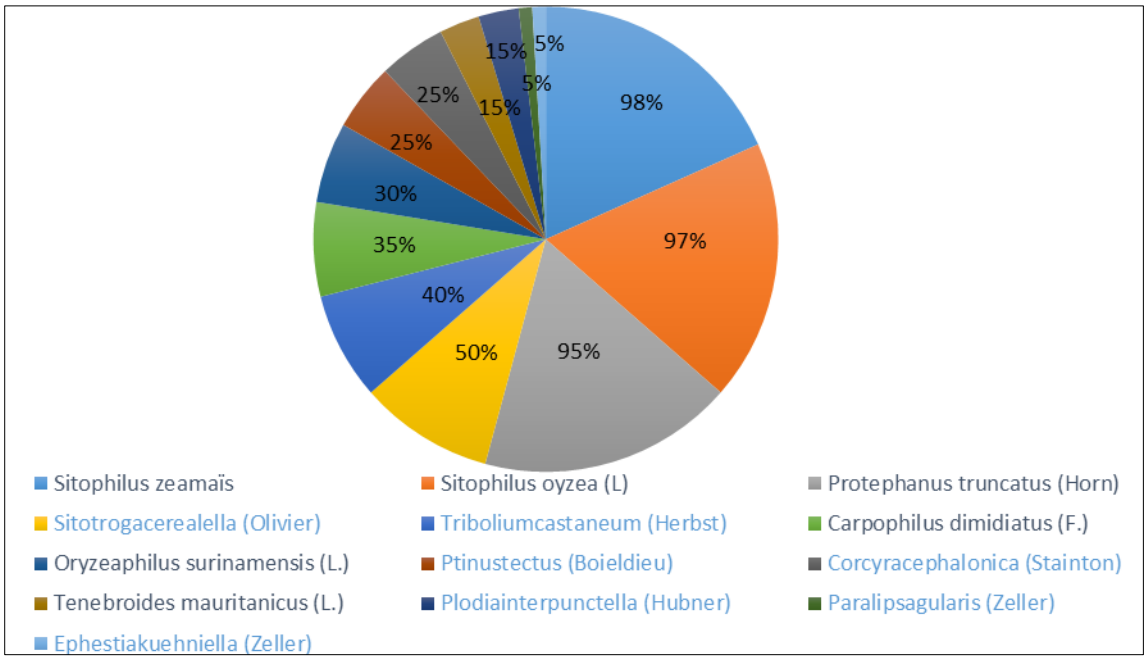

Figure 6 Percentage of corn pest citations

Table 2 List of main maize pests

Diet and nutrition	Order	Family	Scientific name	Local/ Soussou name
	Coleoptera	*Curculionidae*	*Sitophilus zeamaïs (Motchulsky)*	Kabet Könet
Cletrophage			*S. oryzea (L.)*	Kabet Könet
		Bostrichidae	*Protephanus truncatus (Horn)*	Kabet Könet
	Lepidoptera	*Gelechiidae*	*Sitotrogacerealella (Olivier)*	*Töhötöhöya*
	Coleoptera	*Tenebrionidae*	*Tribolium castaneum (Herbst)*	*Töhötöhöya*
		Nutidulidae	*Carpophilus dimidiatus (F.)*	*Töhötöhöya*
		Cucujidae	*Oryzeaphilus surinamensis (L.)*	*Töhötöhöya*
	Lepidoptera	*Ptinidae*	*Ptinustectus (Boieldieu)*	Könet kouyé
		Ostomidae	*Tenebroides mauritanicus (L.)*	Könet kouyé
Psichophagous or detritiphagous		*Galleriinae*	*Corcyra cephalonica (Stainton)*	Yémougnet
		Phycitinae	*Plodiainter punctella (Hubner)*	Yémougnet
		Galleriinae	*Paralipsagularis (Zeller)*	Yémougnet
		Phycitinae	*Ephestiakuehniella (Zeller)*	Yémougnet

Table 3 List of main peanut pests

Diet and nutrition	Order	Family	Scientific name	Local/ Soussou name
Cletrophage	*Hemiptera*	*Aphididae*	*Aphis craccivora*	*Könet*
Phytophages	*Dorylaimida or Longidoridae*	*Ascaridida*	*Nématode*	*Kouli hounhouri*
Holometabole	*Lepidoptera*	*Papilionidae*	*Lépidoptères*	*Töhötöhöya*
Pterygotes	*Hemiptera*	*Arthropoda*	*Hémiptères*	*Könet*

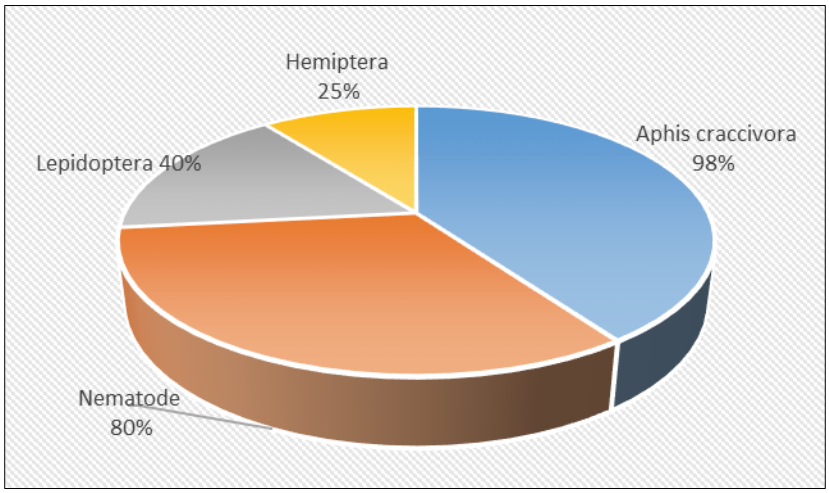

Figure 7 Percentage of peanut pest citations

Insecticidal plants play a key role in seed conservation. This is why, in 2005, Burkina Faso's Ministry of the Environment and the Living Environment stressed that insecticidal plants make a major contribution to agricultural intensification, insofar as they combat the various crop pests whose damage can sometimes affect 50% to 70% of agricultural produce [2]. They also contribute significantly to improving health when used to control the vectors of human and animal diseases [2, 3]. Almost all our respondents were unanimous about the insecticidal properties of species such as *Capsicum chinense, Capsicum frustescens, Capsicum annuum, Capsicum baccatum, Capsicum pubescens, Hyptis suaveolens, Hyptis spicigera, Ocimum americanum, Ocimum basilicium, Allium cepal, Zingiber officinal Rosc, Combretummicranthum, Cymbopogon schoenanthus* and Azadirachta indica. On the other hand, species such as Capsicums are much in demand for preserving agricultural produce. Moreover, the meteoric rise of synthetic pesticides has greatly contributed to the abandonment of phytopesticides. Phytopesticides are more difficult to obtain than synthetic pesticides, which are practically available in every market and store in every locality. This field survey revealed that, despite the many field operations carried out each year in the Republic of Guinea, many citizens are still unaware of the virtues of insecticide plants. In the Boké region in particular, the insecticidal properties of these plants have been tested with great success by the local population on agricultural produce such as groundnuts and maize. Many of the plants used by farmers for seed conservation are aromatic plants, the effectiveness of which has been demonstrated by previous studies [13].

4. Conclusion

This study identified fourteen (14) plant species with insecticidal properties in the Boké Region. The species identified are used to preserve agricultural produce, notably corn and groundnuts. These plants belong to eight (8) botanical families, of which the Solanaceaes family is the most represented, with 5% of plant species. Among the organs used, there is a clear predominance of leaves (58%), followed by fruits (54%). This study provides an insight into traditional seed conservation and highlights the floristic richness of insecticidal plants used by the region's population.

In addition, insect pests have been identified, of which the most targeted by people in this region are Sitophilus zeamaïs of maize and Aphis craccivora of peanuts. These insect pests of agricultural produce can cause huge losses in stocks.

The most frequently mentioned and least studied plants will be the focus of a biological and phytochemical investigation.

Compliance with ethical standards

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Disclosure of conflict of interest

We, the authors of this work, declare that there are no conflicts of interest in the publication of this study.

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