

# Ethnobotanical Survey on the Plants Used in the Control of Nematodes in the Zone of es Niayes de Thies/Senegal

El Hadji Gorgui Diouf<sup>1,\*</sup>, Doudou Diop<sup>2</sup>, Abdoulaye Gueye<sup>1</sup>, Mbaye Diouf<sup>1</sup>, Talibouya Ndior<sup>1</sup>, Mamadou Latyr Ndour<sup>1</sup>, Adama Faye<sup>1</sup>, Mamadou Kébé<sup>1</sup>

<sup>1</sup>Laboratory of Natural Products, Department of Chemistry, Faculty of Science and Technology; Cheikh Anta Diop University of Dakar, Senegal.

<sup>2</sup>Botany Laboratory, Fundamental Institute of Black Africa, Cheikh Anta Diop University of Dakar, Senegal.

Corresponding author\*

goorgui82@yahoo.fr

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## Abstract

Crop losses in vegetable crops due to nematodes are a concern in a country like Senegal where food demand is increasingly high. The use of chemical pesticides has made great progress in increasing harvests in Senegal. But these pesticides have negative effects on the environment and on human health. Crops are often contaminated as well as groundwater. The use of natural products to remedy this phenomenon is very important, especially in areas such as the Niayes zone where the climate and soil are very favorable for market gardening and where water contamination is very sensitive. The aim of our study is to identify the plants used to control nematodes in the Niayes area of Thiès. To this end, we conducted an ethnobotanical survey of 100 people of different ages and sexes in this area. The results showed 17 plant species used to control nematodes in 12 families. Among these species, the most cited were *Azadirachta indica* A. Juss. Juss., *Calotropis procera* (Ait.) F. and *Cassia Occidentalis* L. Leaves (71%) are mostly used. The sample is often dried and ground (45%) or fresh (case of hydrodistillation) (53%) before preparation. Water (92%) is the most used solvent for extraction. Maceration (85%) and infusion are the most common preparation methods. The application of these preparations by systemic action (94%) is more adopted than fumigation. Local people find these preparations rather effective (78%), which is very encouraging. The present study constitutes a database for further studies in the field of Senegalese pharmacopoeia. In addition, scientific research on bionematicidal substances may be conducted in the future to evaluate the effectiveness of these plants identified in the Niayes area of Thiès for the protection of vegetable crops against nematodes.

**Keywords:** Ethnobotanical survey; Senegalese Pharmacopoeia; Nematicidal plants; Market gardening; Niayes area; Niayes area of Thiès.

**Abbreviations:** UCAD: Université Cheikh Anta Diop de Dakar; IFAN: Institut Fondamental d'Afrique Noire.

## INTRODUCTION

Agriculture is a major industry that contributes to socioeconomic development and employs nearly 40% of the world's working population (MOMAGRI, 2016). In West Africa, agriculture contributes about 35% of the countries' gross domestic product (GDP). It remains the main provider of employment (60% of the active population) but also contributes to more than 80% of the population's food needs (Blein R. et al, 2008). The economic development of these countries can only be based on agriculture. In Senegal, agriculture in the Niayes area plays an important role in supplying the population with agricultural products. It provides more than 80% of the national vegetable production (DPS, 2003). Very fertile and favorable for market gardening, the Niayes zone is characterized by a shallow groundwater table (0.5 to 5 meters deep) and is made up of dunes and depressions (ANSD, 2015). The Niayes soils are of the tropical ferruginous type, weakly leached

on sand (dior), with a sandy texture and 90 to 95% total sand. They have very low levels of carbon (0.2% on average), total nitrogen (0.15 to 1%), and exchangeable bases (1.77 meq/100 g). The pH is slightly acidic at 5.5 to 6.5 (Adejumo, 2013). Despite all the advantages of this soil, yields are below expectations because the crops are often attacked by predators that cause huge crop losses. Nematodes are the main pests of vegetable crops. They attack crops such as aubergines, tomatoes, cabbage, potatoes, etc. Thus, the population often resorts to chemical pesticides (or synthetic pesticides) which are certainly effective against these parasites, but at the same time disrupt biodiversity by eliminating insects that are not necessarily harmful and pollute the soil and contaminate the crops. According to the FAO, nearly 750,000 people contract chronic illnesses, including cancers, each year as a result of exposure to pesticides. In addition, several pathologies are directly associated with them in the long term, such as congenital malformations,

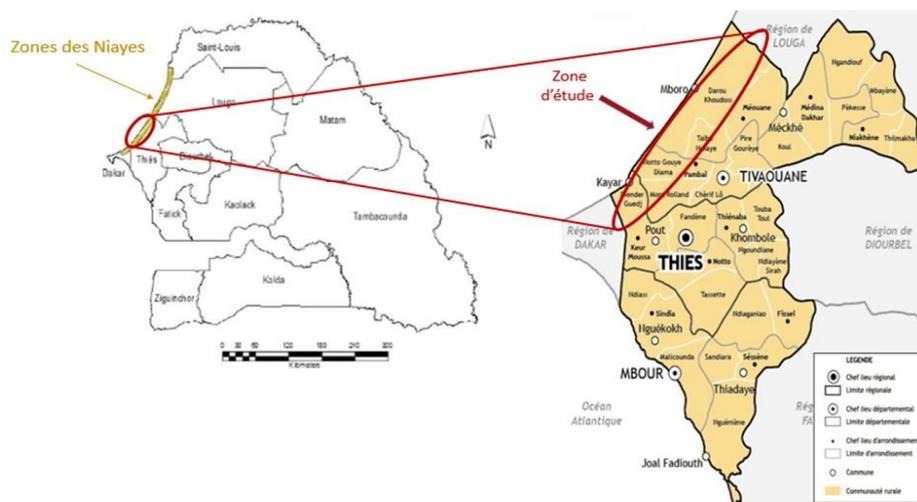
mental deficiencies, neurological and reproductive disorders, endocrine disruptions, weakening of the immune system, and some cases of cancer (Dewailly E, 2000; Petrelli G, 2001; Eriksson M, 2008). Yet in Senegal, chemical nematicides, although classified as extremely toxic, are sold by dealers (Diarra A, 2017) in an uncontrolled manner and with ignorance of the consequences. It is therefore urgent to find solutions against this phenomenon of the spread of chemical pesticides. The idea is to find pesticides that are not toxic to humans and do not pollute the environment. So what better way than to use biopesticides.

Since the discovery of active ingredients of therapeutic interest from plant species selected according to criteria based on medical ethnobotany and ethnopharmacology is more frequent than in a simple random screening of plants (Svetaz L et al, 2010) and given that there are no or almost no nematological studies in the Niayes area of Thiès, we conducted an ethnobotanical survey among local farmers in this area in order to identify the plants used in the fight against nematodes as well as the methods of preparation of extracts from these plants. The present work is also part of the global framework of the valorization of the Senegalese flora.

## MATERIALS AND METHODS

### Selection of the ethnobotanical survey site

The Niayes zone extends from Dakar to Saint Louis, in a strip 180 km long and 5 to 30 km wide (Fall AS, 2001).

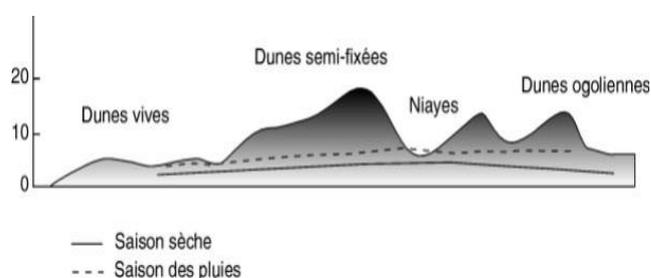


**Figure 2:** Location of the study area. (Source: inspired by (<https://www.au-senegal.com/>), Realisation: authors)

### Method of data collection

The area was divided into different sites and visits were made to each site in July and October 2021. The ethnobotanical study was carried out through a series of

It constitutes a rather original environment characterized by dunes and depressions that are kept wet or flooded for a good part of the year and by a sub-surface water table (see Figure 1) (Cissé I, 2008). Its soils are very favorable for market gardening. Administratively, it covers part of the regions of Saint-Louis, Louga, Dakar, and part of the region of Thiès, namely the departments of Tivaouane and Thiès. Our study area concerns these two departments, more precisely the rural communes/communities of Kayar (located in the north-west of the department of Thiès), Notto Gouye Diama, and Darou Khoudoss (located in the west of the department of Tivaouane) (see Figure 2). Very few studies have been carried out on potential nematicidal plants used for the protection of vegetable crops in this area.



**Figure 1.** Level of fluctuation of the water table according to the seasons (Cissé I, 2008).

surveys using a pre-designed questionnaire divided into two parts. The first question concerned the socio-demographic situation of the respondent and the second question concerned the names of the species used for

nematode control, the parts of the plant used, the times of harvest, the methods of preparation of the extracts, etc. The identification of the scientific names of the plants was carried out in the botanical laboratory of IFAN/UCAD. The scientific name of each species was transcribed into the local language using the lexicon of vernacular names of J. G. Adam (Adam J.G, 1970).

### Data processing

The data recorded on the survey forms were processed and entered into Excel. The data were analyzed using simple descriptive statistical methods. Quantitative variables are described using the mean and qualitative variables are described using percentages.

## RESULTS

In this study, all the respondents were farmers. The population is made up of 100 informants, 43 of whom are from Notto Gouye Diama, 10 from Darou Khoudoss, and 47 from Kayar, i.e. 53 in the department of Tivaouane and 47 in the department of Thiès.

### Description of the study population by age

Figure 1 shows the age distribution of the sample studied. We note that the age extremes of the informants vary between 18 and 78 years with an average age of 48 years. The majority (71%) were in the 30-60 age group, while the under-30 age group had the lowest rate of nematicide users (6%).

### Distribution by gender

Figure 2 shows the gender distribution of the study sample. In this study, the majority of informants were male (90%) and 10% were female, with a sex ratio (male/female) of 9.

### Description of the study population by family status

Regarding the family situation, 94% of the informants have children, 3% say they have no children and 3% gave no answer (see Figure 3).

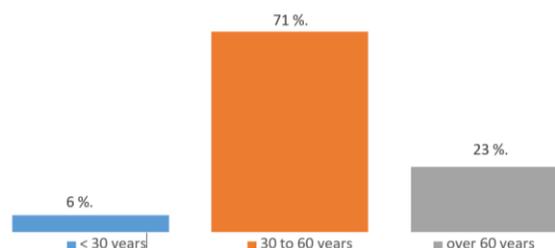


Figure 1. Distribution of respondents by age group.

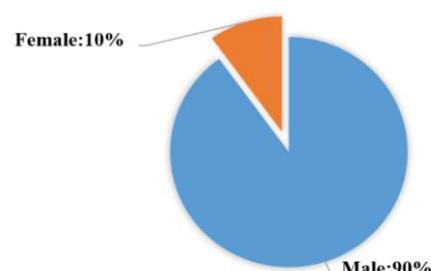


Figure 2. Distribution of respondents by gender.

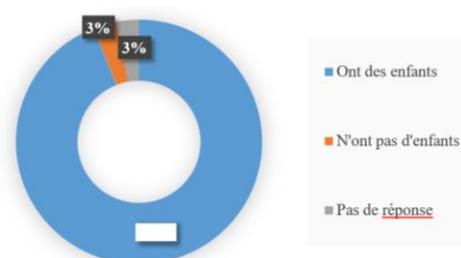


Figure 3. Distribution of the study population by family status.

### Distribution of plants by frequency of citation

The surveys carried out in the Niayes area of Thiès enabled us to identify different plant species used in the control of nematodes. The list of the different plant species selected and their frequency of use are presented in Table 1. The ethnobotanical survey identified seventeen (17) plant species of which *Azadirachta indica* A. Juss. Juss. represents the most used plant with a percentage of 45%, followed by *Calotropis procera* (Ait.) F. (20%) and *Cassia Occidentalis* L. with a percentage of 9%.

Table 1. List of plants used for nematode control in the study area, ranked by frequency of citation.

Family	Scientific name of the plant	Local name	Frequency of citation
Meliaceae	<i>Azadirachta indica</i> A. Juss.	Nim	45%
Asclepiadaceae	<i>Calotropis procera</i> (Ait.) F.	Paftan	20%
Cesalpiniaceae	<i>Cassia Occidentalis</i> L.	Bëntamaré	9%
Fabaceae (= Papilionaceae)	<i>Arachis hypogaea</i> L.	Gèrté, tiga.	7%
Fabaceae (= Papilionaceae)	<i>Capsicum frutescens</i> L.	Kani	3%
Caricaceae	<i>Carica papaya</i> L.	Papaya	2%
Liliaceae	<i>Allium sativum</i> L.	Garlic	2%
Meliaceae	<i>Khaya senegalensis</i> (Desv.) A. Juss	Khaye	2%
Labiatae	<i>Ocimum basilicum</i> basil	Ngungun	2%

Table 1. Cont.

Family	Scientific name of the plant	Local name	Frequency of citation
Combrétacées	<i>Guiera senegalensis</i> J. F. Gmel	Ngèr (in Wolof)	1%
Solanaceae	<i>Datura metel</i> L.	Katidiâdabé	1%
Fabaceae (= Papilionaceae)	<i>Indigofera suffruticosa</i> Mill.	Ngâdj, ngâdièn	1%
Euphorbiaceae	<i>Ricinus communis</i> L.	Khekhem	1%
Moringaceae	<i>Moringa oleifera</i> Lam.	Nevèrday, sap sap	1%
Euphorbiaceae	<i>Euphorbia balsamifera</i> Ait.	Salan	1%
Euphorbiaceae	<i>Jatropha curcas</i> L.	Tabanani	1%
Poaceae (= Grasses)	<i>Zea mays</i> L.	Mbokha	1%

The species listed are divided into twelve (12) families. The most commonly used plants are from the *Meliaceae* (47%) and *Asclepiadaceae* (20%) families.

The species used in the medium range belong to the Fabaceae (11%) and *Cesalpiniaceae* (9%) families (see Table 2).

Table 2. List of plant families used for nematode control in the study area, arranged in alphabetical order.

Family	Scientific name of the plant	Frequency of citation by family
<i>Asclepiadaceae</i>	<i>Calotropis procera</i> (Ait.) F.	20%
<i>Caricaceae</i>	<i>Carica papaya</i> L.	2%
<i>Cesalpiniaceae</i>	<i>Cassia Occidentalis</i> L.	9%
<i>Combrétacées</i>	<i>Guiera senegalensis</i> J. F. Gmel	1%
<i>Euphorbiaceae</i>	<i>Ricinus communis</i> L. <i>Euphorbia balsamifera</i> Ait. <i>Jatropha curcas</i> L.	3%
<i>Fabaceae</i> (= <i>Papilionaceae</i> )	<i>Arachis hypogaea</i> L. <i>Capsicum frutescens</i> L. <i>Indigofera suffruticosa</i> Mill.	11%
<i>Labiatae</i>	<i>Ocimum basilicum</i> basil	2%
<i>Liliaceae</i>	<i>Allium sativum</i> L.	2%
<i>Meliaceae</i>	<i>Azadirachta indica</i> A. Juss. <i>Khaya senegalensis</i> (Desv.) A. Juss	47%
<i>Moringaceae</i>	<i>Moringa oleifera</i> Lam.	1%
<i>Poaceae</i> (= <i>Grasses</i> )	<i>Zea mays</i> L.	1%
<i>Solanaceae</i>	<i>Datura metel</i> L.	1%

### The most commonly used plant parts

The distribution of the study sample according to their use of plant parts for nematode control is shown in Figure 4. The most used parts are leaves (71%) and seeds (27%).

### Harvest times

The plants are harvested during the day, throughout the year, and especially in August.

### The physical state of the plant before the preparation of the extracts

Plant samples are often freshly harvested and then extracted (53%) or first ground and then dried before extracts are prepared (45%). Very rarely is plant material dried without being ground (2%) (Figure 5).

### The solvent used for preparation

Water is the most used solvent (92%) while oils are very little used (8%). Figure 4 shows the distribution of solvents used for the preparation of extracts (Figure 6).

### Method of preparation of extracts

Maceration is widely used (85%), followed by infusion (7%). Hydrodistillation (4%) and the direct use of plant juice (4%) are not widely practiced (Figure 7).

### How to apply the extracts

Figure 9 shows the distribution of application modes of plant extracts. The rate of application by systemic action was 94%, while only 6% of the study sample used fumigation (Figure 8).

**Evaluation of the effectiveness of the plants by the study population**

In the course of our survey, we asked the respondents to give their assessments of the effectiveness of the plant preparations they had to apply to their plantations. Thus, 78% of people said that they were moderately effective, 20% said they were very effective and only 2% said they were not very effective (Figure 9).

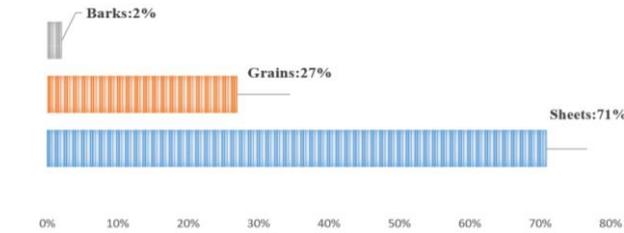


Figure 4. Distribution of plant organs by use.

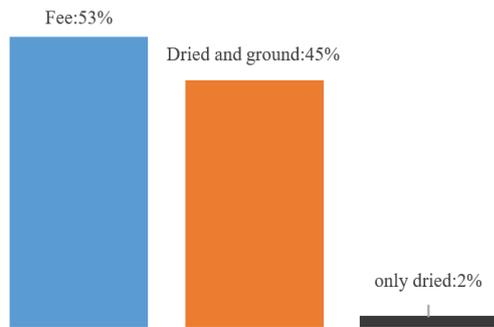


Figure 5. Physical state of the plant before preparation of the extracts.

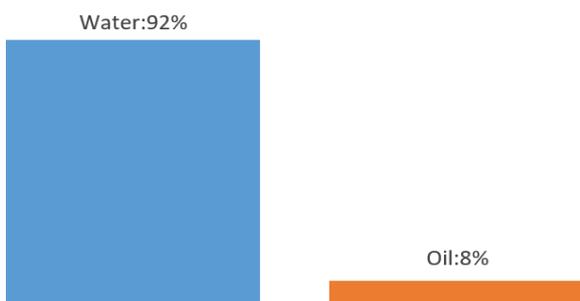


Figure 6. Solvents used.

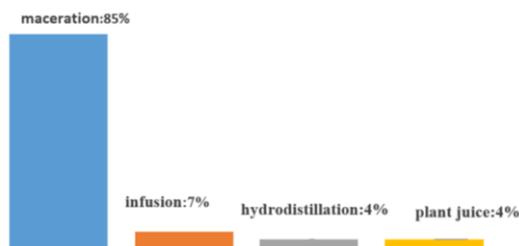


Figure 7. Methods of preparing extracts.

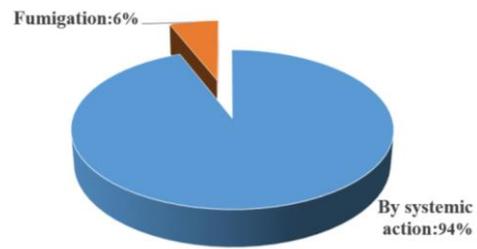


Figure 8. The modes of application of extracts.

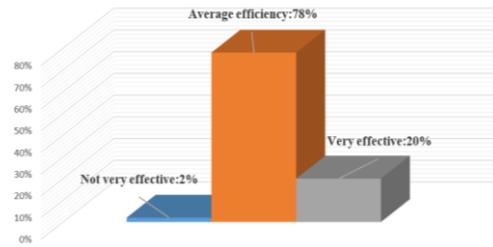


Figure 9. Effectiveness of plants according to respondents.

**DISCUSSION**

The African population is attached to traditional phytopharmacy. In Senegalese households, men traditionally have the role of doing large-scale fieldwork and any other activity that requires muscular effort. Women are only involved in small-scale cultivation. Several ethnobotanical surveys conducted in Senegal have shown that in the field of traditional phototherapy and everything related to agriculture, men are much more represented than women. Thus, men are more likely to have knowledge of nematicidal plants than women. In this sense, our results are similar to those of Barry (male: 91%, female: 9%) (Barry, 20015) and DIOP (Diop, 2015) in which men are forty (43) times more represented than women. Individuals in the 30 to 60 age group are more likely to acquire more knowledge, especially about nematicidal plants, in order to ensure good yields to better feed their families, unlike the very young who do not have many responsibilities (no children to feed). The over-60s are well represented because traditional knowledge is kept by the elderly, who then pass it on to responsible young adults.

The massive use of the species *Azadirachta indica* A. Juss. and the species *Calotropis procera* (Ait.) F. is probably due to their insecticidal powers already observed. The bitter taste, and the insecticidal properties towards mosquitoes (Pousset J.L, 1989) of *Azadirachta indica* A. Juss. have probably led local people to believe that it is also a plant that can be used against nematodes. The great abundance of this plant in Senegal makes it easy to obtain and it is by far the most used plant. *Azadirachta indica* A. does have nematicidal effects (Yarou B.B). *Calotropis procera* (Ait.) F. is also widespread in Senegal. It grows well in the streets of Senegalese

villages. The plant has been reported to have nematicidal properties (Rao et al., 1996; Ahmed et al., 1996). These plants (*Azadirachta indica* A. Juss. and *Calotropis procera* (Ait.) F.) are available throughout the year. However, for the rare plants, it is in August that the harvesting is done because it corresponds to the wintering period. We note a great diversity of plant families used in the fight against nematodes. We note that the *Meliaceae*, *Asclepiadaceae*, *Fabaceae*, and *Caesalpiniaceae* are the most cited plant families, but in terms of the number of species represented, we have 3 species among the *Euphorbiaceae* and 3 species among the *Fabaceae*, and 2 species for the *Meliaceae*. The latter may have a common trait of being rich in nematicidal compounds which are found in these species.

The majority use of plant leaves can be explained by the fact that leaves are rich in active ingredients and are considered the most accessible part of the plant. Leaves are the storage place for secondary metabolites that are responsible for the biological properties of the plant. A study by Diatta et al (Diatta C.D, 2013) (46% for leaves) showed that leaves were the most used as drugs in the preparation of traditional medicinal recipes.

Water is a widely used solvent (92%) compared to oils. This says that most extracted compounds are polar. These are probably polyphenols, among which there are nematicidal molecules. As for preparation methods, maceration and infusion are the most commonly used methods. Maceration is the easiest extraction to implement and does not require any volume of solvent to be boiled beforehand, unlike other extractions. Infusion with a polar solvent allows good extraction of water-soluble active ingredients and even those that are weakly soluble in their pure state (Benlamdini A, 2014). The fumigation method of the application represents only 6%. It is a difficult method to implement compared to systemic action (94%). Fumigation is only more effective if it is carried out in an enclosed area so that the gas has a much greater effect on the pests. But the means of the local population in Thiès, as for most local African populations, are generally modest to manage hectares of field land with fumigation. Many informants found the plants they tested to be moderately or very effective. It may be that these plants contain very good amounts of nematicidal secondary metabolites. This is very encouraging and needs to be verified by biochemical studies.

## CONCLUSION

Ten (17) species of nematicidal plants were selected for this study. The study revealed that men are more knowledgeable about nematicidal plants than women. Individuals in the age group 30-60 years, who most often have children, are more numerous than other individuals. Our survey shows that the foliage is the most used part.

The plants mentioned are available in the study area and people mostly use the species *Azadirachta indica* A. Juss. and *Calotropis indica* A. Juss. and *Calotropis procera* (Ait.) F. for nematode control. They can harvest these plants throughout the year. Before preparation, the plant sample is often dried and crushed or is fresh (case for hydrodistillation). Maceration and infusion are the most common methods of preparing extracts. The application of these preparations by systemic action is more widely used than fumigation. Local people find these preparations rather effective, which is really encouraging. Furthermore, these results can be seen as a source of information for scientific research on biopesticides that may one day permanently replace dangerous chemical pesticides. The plants mentioned in this survey may offer broad answers to nematode-related problems.

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**Authors' Contributions:** El Hadji Gorgui DIOUF designed the study. Mbaye Diouf carried out the fieldwork. Doudou Diop carried out the botanical identification of the species surveyed. El Hadji Gorgui DIOUF and Abdoulaye Gueye analyzed the data and wrote the article. All authors read and approved the final version of the manuscript.

**Competing Interests:** The authors declare that there are no competing interests.

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