Medicinal plants used in the treatment of common mental disorders: an ethnobotanical study in Bondoukou, north-eastern Côte d'Ivoire

Daouda Kola, Blaise Wokapeu Kpan, Gilles N'Dri Konkon, Nouhou Zoungrana

Correspondence

Daouda Kola[1,2*], Blaise Wokapeu Kpan[1,3], Gilles N'Dri Konkon[1], Nouhou Zoungrana[2]

[1]Laboratoire des Milieux Naturels et de Conservation de la Biodiversité (LMNCB), Université Félix Houphouët-Boigny (UFHB), Côte d'Ivoire.
[2]Landscape Alliance, Burkina Faso.
[3]Université de Bondoukou.

*Corresponding Author: dkola.research@gmail.com

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Research

Abstract

Background: Throughout the world and in Ivory Coast, mental disorders such as insomnia, depression, anxiety and nervousness, are emerging pathologies with sometimes serious consequences that affect many of the population, especially in adulthood. The overall objective of this study was to document local knowledge regarding medicinal plants used to treat mental disorders in northeastern Côte d'Ivoire.

Methods: An ethnobotanical survey was conducted in Bondoukou and surrounding villages, using individual interviews and semi-structured focus groups. A total of 74 participants were interviewed including key informants (traditional healers, herbalists), and other knowledgeable community members

Results: Overall, 29 plant species from 23 botanical families were identified. The Combretaceae family was the most represented, with 04 species cited, while *Sarcocephalus latifolius* (Sm.) E.A. Bruce was the most frequently mentioned species. The predominant preparation method is decoction (85%), followed by trituration (18%). Most treatments are administered orally (70%), followed by dermally (21%) and nasally (15%). Index analysis revealed that *Sarcocephalus latifolius* (Sm.) E.A. Bruce is the species with the highest informant consensus index (IFC=006) and the greatest contribution to revenue (Cpr=10.34). Multiple Correspondence Factor Analysis revealed significant relationships between organs, preparation methods and routes of administration. Around 55% of species were reported to be scarce, raising the question of their availability.

Conclusions: This study shows that local populations possess rich traditional knowledge of medicinal plants used to treat emotional disorders, highlighting the importance of documenting and preserving this knowledge.

Keywords: Ethnobotany; Herbal medicine, Mental and emotional disorders; Human diseases, Herbal medicine

Background

Mental disorders, along with psychological and social suffering, are now one of the major health problems worldwide (WHO, 2013). Approximately 450 million people worldwide suffer from mental disorders (WHO, 2023). These conditions affect people in all countries, regardless of age, gender, education level, or income (Doumongue *et al*., 2023). However, despite the emergence and proliferation of these disorders, access to treatment remains difficult, costly, insufficient, and often ineffective in Côte d'Ivoire (Sanogo, 2006). The use of traditional medicine is a legitimate alternative widely used by local communities to treat these disorders (Berhe *et al*., 2024). From ancient times to the present day, plants have always been used as medicines throughout the world (Tadesse *et al*. 2025). In Côte d'Ivoire, this method of medication is deeply rooted in the cultural soul of ethnic peoples (Sidio and N'Guessan, 2019).

In recent years, Côte d'Ivoire has seen a proliferation of publications on various works by several authors on ethnobotanical knowledge (Gnagne *et al*., 2017; Sylla *et al*., 2018), but there has been very little research devoted to the medicinal plants used by knowledge holders to treat mental disorders such as stress, insomnia, depression, anxiety, and nervousness. The overall objective of this study was to document local knowledge regarding medicinal plants used to treat mental disorders in northeastern Côte d'Ivoire. Specifically, the study aimed to: (i) Identify the medicinal plant species used by the people of Bondoukou to treat mental disorders. (ii) Identify the methods of preparation and administration, as well as the specific parts of the plants (leaves, roots, flowers, etc.) used in treatments. (iii) Map the ecosystems where the various species are found and assess their availability across different landscapes.

Materials and Methods

Study area

This study was conducted in north-eastern Côte d'Ivoire, in the Gontougo region, Zanzan district, and more specifically in the sub-prefecture of Bondoukou and eight of its affiliated villages: Abema, Allahladougou, Goly, Kokè, Motioamo, Ouélékéhi, Soko and Takoutou (Fig. 1). The sub-prefecture of Bondoukou is located at the following coordinates: 8°02'23'' North and 20°47'54'' West. Bondoukou, situated approximately 407 km from Abidjan, covers an area of 9,978 km². According to the RGPH (2021), the Bondoukou department has a population of 435,841. The climate of the study area is of the Baoulé type (Ta *et al*., 2011). Climate data collected by the Bondoukou Meteorological Station indicate that between 2000 and 2023, the average temperature was 26.58°C, with 778.6 mm of rainfall recorded (Ahoussi *et al*., 2012).

The landscape of the Gontougo region as a whole is flat, but features a series of mountain ranges, the highest peak of which is known as Mount Zanzan (Ibrahima *et al*., 2016). In terms of watercourses, two (02) major rivers drain this region, namely (Ibrahima *et al*., 2016). The types of vegetation found include dense dry forests, riparian forests, degraded forests, savanna and plantations (Tiebre *et al*., 2016). The families with the highest species richness are the Rubiaceae (31 species), *Papilionaceae* (26 species*), Poaceae* (23 species), and *Apocynaceae* and *Euphorbiaceae* (18 species) (Tiebre *et al*., 2016).

The economy of Bondoukou relies mainly on agriculture (Ahingoua, 2019), livestock farming, fishing (N'Dri *et al*., 2023), forestry (Trotsky *et al*., 2023), industry and services. The indigenous populations of the municipality of Bondoukou are mainly the Abron, the Dègha, the Koulango and the Nafana (Fanny *et al*., 2022).

Material used

The plant material used in the study comprised all the medicinal plants identified by the interviewees in the sub-prefecture of Bondoukou and formally identified using reference materials and existing samples.

The technical equipment used to gather information and collect plant samples included, amongst other things, a smartphone containing a digital questionnaire on the Kobotoolbox data collection tool to record information and photograph the plant species in question, secateurs for collecting samples, newspaper and cardboard folders, presses, for the creation of herbariums for identification purposes.

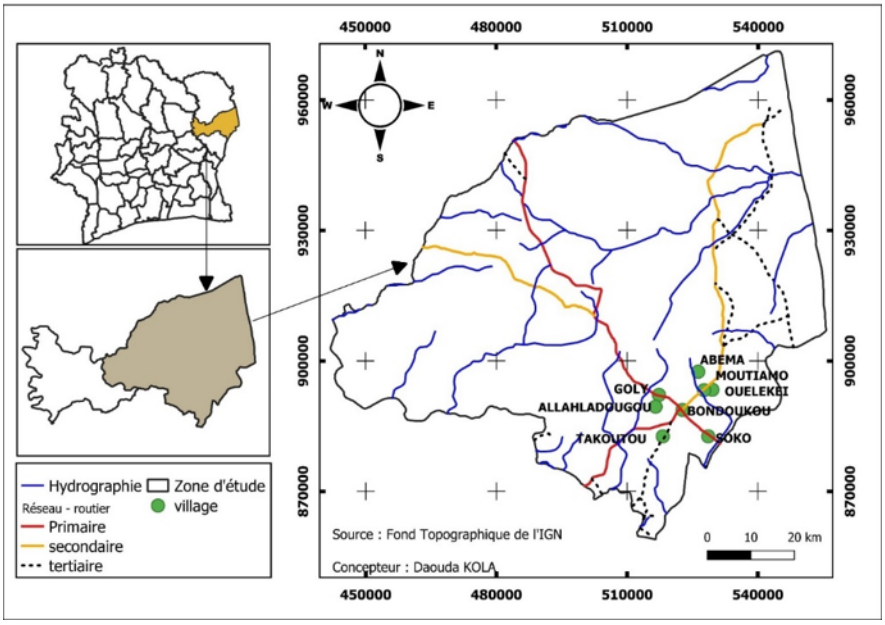

Figure 1. Map of Bondoukou sub-prefecture, Ivory Coast, showing the study area

Sampling and data collection

The sampling method involved grouping respondents into three strata comprising traditional healers, herbalists, and local communities. Most of the interviewees were selected using a snowball sampling method to identify key informants in each village with proven knowledge of medicinal plants. As for the local population, interviews were conducted with anyone of either gender aged 25 or over who had previously used medicinal plants and was able to answer the questions appropriately in line with the study's objectives. The selection of the various study areas was conducted using a non-probabilistic method known as targeted sampling. The villages were selected, for the most part, based on their accessibility and geographical location within the department in order to obtain information that was sufficiently representative of the region (Kouadio *et al*., 2017). Information was collected through individual interviews and semi-structured focus groups in the language in which the respondent felt most comfortable. The interviews were conducted in two ways:

- Or, during a trip into the bush or to the market, as suggested by Cunningham (2002). In this way, the species were identified directly and collected immediately.
- Or, if the informant was too old or too busy, after the interview, we relied on the guide-interpreter's knowledge to collect samples, and a second visit was then made to the healer to validate the collections, following the method of Diatta *et al*. (2013).

Botanical identification

For identification purposes, fresh samples of plant species were collected to compile a herbarium. Clear photographs were taken to supplement the information provided by the herbarium if the samples dried out or deteriorated. In this study, the Angiosperm Phylogeny Group IV (APG IV) nomenclature was used for the identification of the various plant species. The identification itself was conducted either:

- In the field, for certain species.
- Using the flora of Côte d'Ivoire and other works (Arbonnier, 2019).

At the Centre national de Floristique (CNF) at Félix HOUPHOUËT-BOIGNY University, where herbariums are available for the identification and confirmation of certain names.

Data analysis

The data collected was analysed, coded and entered using Microsoft Excel (version 2016). Statistical analyses and graphical representations were then conducted using Python software (version 3.12), utilising the pandas' library for data management, matplotlib and seaborn for graphical visualisation, and scipy, statsmodels and prince for statistical analyses.

Relative Frequency citation

The ethnomedicinal data was assessed using citation frequencies (CF) determined using the formula below (Dassou *et al*., 2014): (Equation1)

$$CF = \frac{NP}{NT} \times 100$$

Where NP is the number of citations of a given species and NT is the total number of citations.

Contribution of each species to medicinal recipes

Each plant's contribution to the composition of recipes (Cpr) was determined using the method developed by Dassou *et al*. (2014). This method made it possible to determine the frequency with which a plant was used in recipes and is expressed by the following formula: (Equation 2)

$$Cpr = \frac{Nr}{Nt} \times 100$$

Nr: number of recipes using the plant; Nt: total number of recipes.

Confirmation indices or Informant Consensus Factor (ICF)

To assess the agreement among informants on the use of plants against the diseases concerned, a factor (degree) of consensus of use or Informant Consensus Factor (ICF) was calculated (Ilumbe *et al*., 2014): (Equation 3)

$$ICF = \frac{Na}{Nt}$$

where Na is the number of informants who cited a species; Nt is the total number of informants. The ICF varies between [0 - 1]. A value close to 1 indicates an important level of agreement on the use of the plant

Results

Socio-professional characteristics of the people interviewed during the survey

This study covered eight (08) localities located around the municipality of Bondoukou. The survey results showed that the 74 respondents were broken down as follows: 51.35% female respondents compared to 41.65% male respondents. The results also showed that the most represented ethnic group was the Koulango, accounting for 66.22% of respondents. The dominant socioeconomic groups were housewives (39.19%) and farmers (33.78%). As for the respondents' level of education, the majority were illiterate, with a rate of 64.86%. Respondents of the Christian religion were the most numerous (67.57%), while those in the 19-35 age group had the highest percentage, at 37.84%. These results also show that the people interviewed had between 0 and more than 60 years of experience, with a higher rate for respondents with between 0 and 5 years of experience. Detailed results on the socio-professional characteristics of the people surveyed during the study are shown in Table 1.

Diversity and ethnobotanical characteristics of the plants surveyed

The ethnobotanical survey conducted among herbal medicine practitioners and local populations identified 29 plant species used in the study area for the treatment of insomnia, depression, nervousness, and other related conditions. These 29 species are distributed across 23 families (fig. 2). The most numerous families was Combretaceae, with species such as *Terminalia avicennioïdes* Guill. et Perr, *Terminalia macroptera* Guil. & Perr, while the most frequently cited species was *Sarcocephalus latifolius* (Sm.) E.A.Bruce. The plants used belonged to different morphological types, including trees, shrubs, and herbs. The complete list of species indicated for the treatment of mood disorders and related conditions is presented in Table 2 along with their botanical family, common name, and morphological type. The parts of the plants used in the recipes included the bark of the stem and roots and the leaves (Figure 3), while the main methods of administration were decoction and trituration. Different routes of administration were used for the application of remedies, namely oral and cutaneous (Figure 4). For each species listed, the numbers of recipes in which that species is a constituent and the total number of citations of use have also been reported in Table 3. This table also includes indicators such as the frequency of citation of species, confirmation indices or Informant Consensus (ICF) and the Contribution index of each species to medicinal recipes. *Sarcocephalus latifolius* (Sm.) was the species with the highest ICF (0.09) but also the highest CPr (10.34). The frequency of citations of the different organs used showed that root bark was the most used part in the preparation of recipes (48%), followed by leaves (36%) (Figure 3). The most used method of preparation was decoction, cited 85% of the time, followed

by trituration (18%) (Figure 4). The most common route of administration was oral, cited 70% of the time, followed by topical (21%) (Figure 5). According to the results obtained, four (04) main ecosystems served as sources of supply for the various plant species used in the preparation of remedies. It should be noted that Farming fields (94%) were the main source of supply, followed by forests (73%) and fallow land (64%) (Figure 6).

Table 1. Socio-demographic characteristics of respondents

Variables	**Categories**	**Counts**	**Percentage (%)**
Gender	Male	38	51,35
	Female	36	48,65
Ethnicity	Dega	11	14,86
	Koulango	49	66,22
	Lobi	10	13,51
	Senoufo	2	2,70
Socio-professional category	Farmer	25	33,78
	Trader	4	5,41
	Hairdresser	2	2,70
	Traditional healer	12	16,22
	Herbalist	1	1,35
	Housewife	29	39,19
	Potter	1	1,35
Education level	Quaranic education	2	2,70
	Illiterate	48	64,86
	Primary	16	21,62
	Secondary	8	10,81
Years of experience	] 0-5]	34	45,95
	] 5-10]	13	17,57
	] 10-15]	8	10,81
	] 15-20]	7	9,46
	] 20 ; + [	12	16,22
Religion	Muslim	13	17,57
	Christian	50	67,57
	Animist	11	14,86
Age category	] 19-35]	9	12,16
	] 35-45]	28	37,84
	] 45-55]	20	27,03
	] 55-65]	9	12,16
	] 65 ; + [	8	10,81

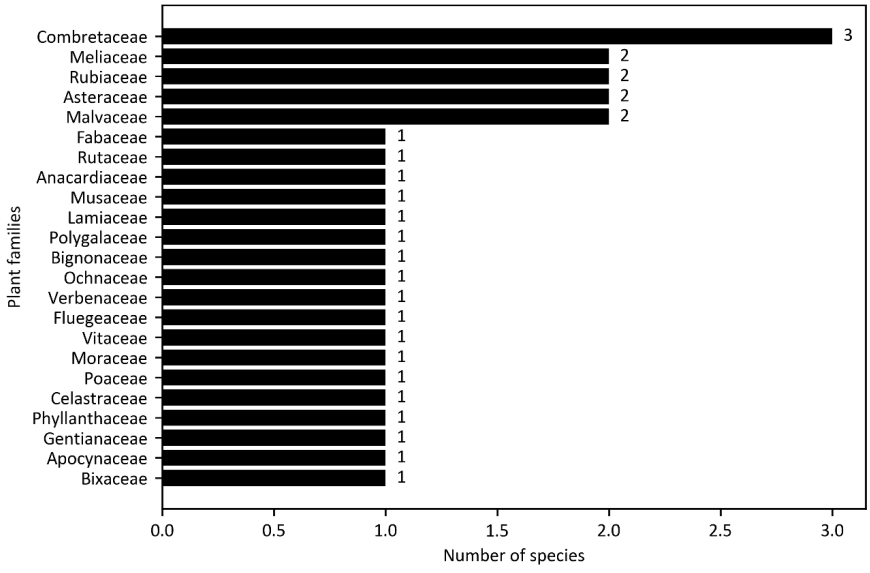

Figure 2. Distribution of medicinal plant species by botanical family recorded in the study area.

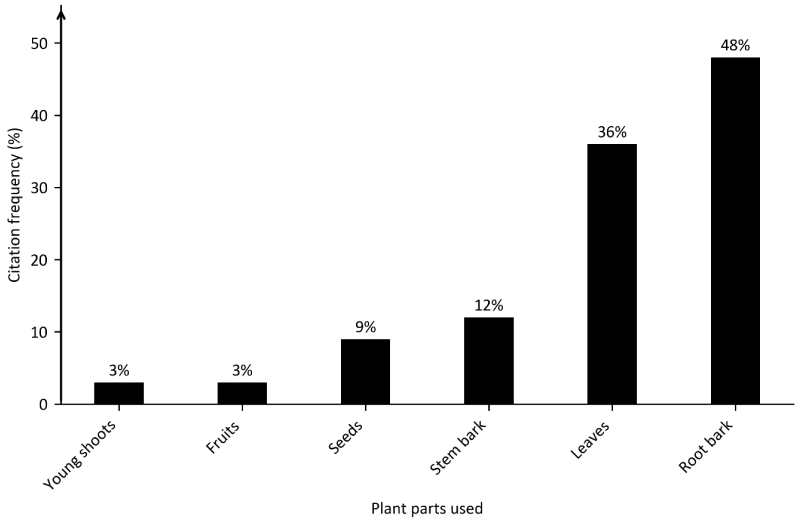

Figure 1. Frequency of citation of the most used plant parts.

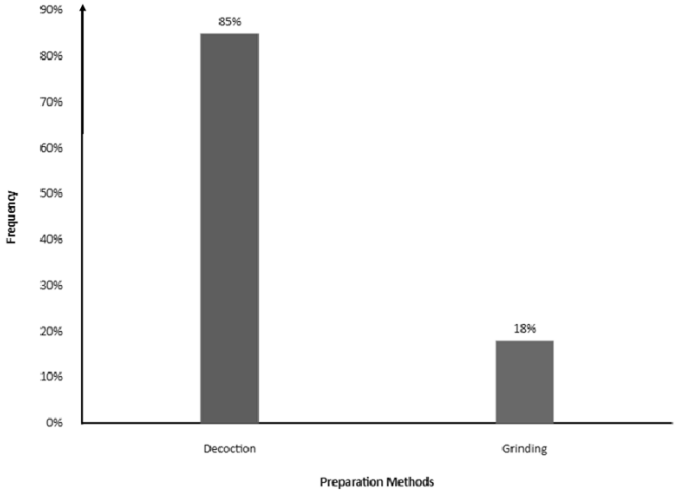

Figure 2. Preparation methods of medicinal plant remedies.

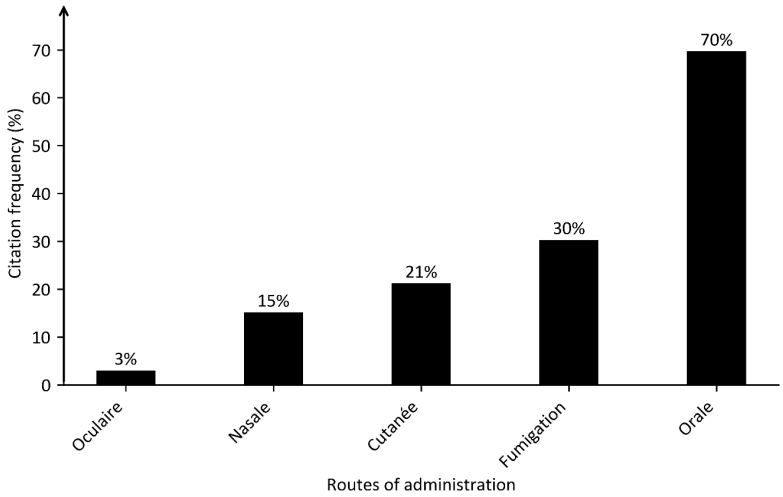

Figure 3. Routes of administration of plant remedies

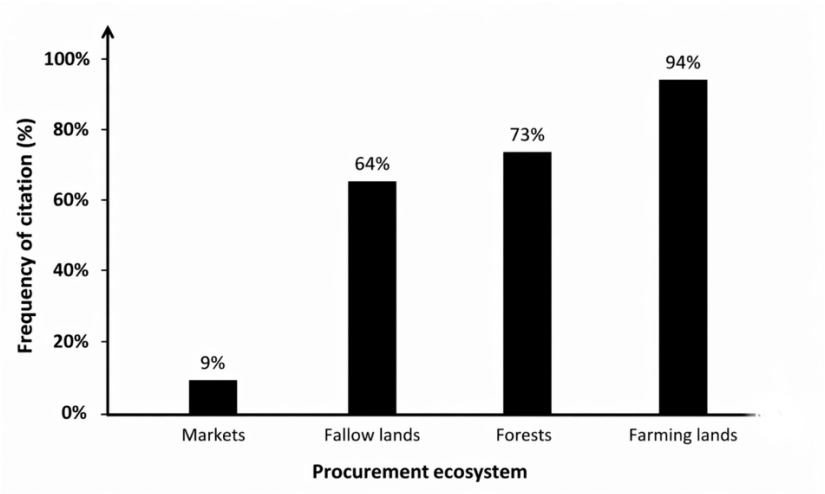

Figure 4. Procurement ecosystems of medicinal plants

Association between plant parts used and species abundance

The Chi-square test revealed a significant association between plant parts used and species abundance ($\chi^2 = 23.84$, df = 12, p = 0.021). The standardized residual heatmap (fig. 7) highlighted the patterns of association between harvested plant organs and the abundance categories of the species.

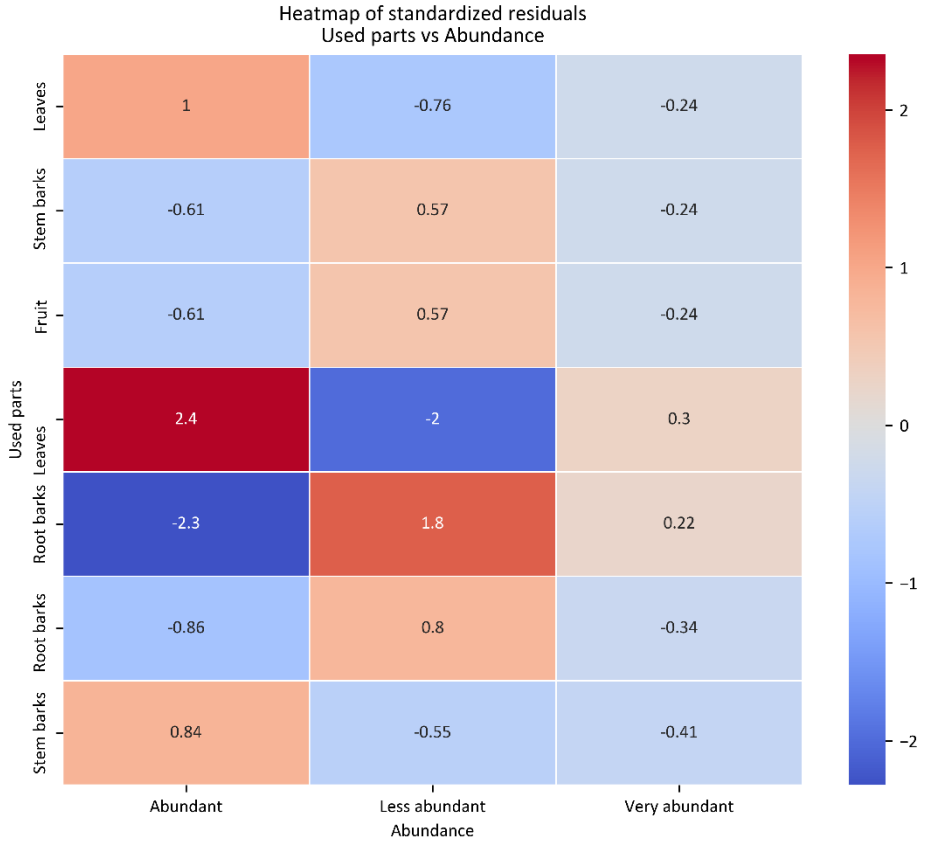

Figure 7. Heatmap illustrating the relationship between plant parts used and species abundance

Association between Respondent Sex and Knowledge of Neuropsychological and Emotional Disorders

Statistical association conducted to establish relationships between the different variables showed that knowledge of depression, anxiety, stress, nervousness, and related disorders was associated with gender. (Table 2)

Table 1. Association between Respondent Sex and Knowledge of Neuropsychological and Emotional Disorders

Variable	Statistical test	Significance(5%)
Sex and knowledge of disorders	Chi-square test (χ^2)	P = 0,040

Association between Plant Parts, Preparation Methods, and Routes of Administration (Multiple Correspondence Analysis)
Multiple Correspondence Analysis (MCA) revealed significant associations between the parts of plants used, methods of preparation, and routes of administration (Figure 8). Two main axes together explain 89.24% of the total inertia. The first axis (74.02%) clearly distinguishes two profiles: on the one hand, remedies prepared by decoction from root bark and administered orally or cutaneously; on the other hand, remedies prepared by trituration from fruits, seeds, and young leaves, often administered nasally. The second axis (15.22%) highlights a specificity of fumigation, mainly associated with the use of leaves.

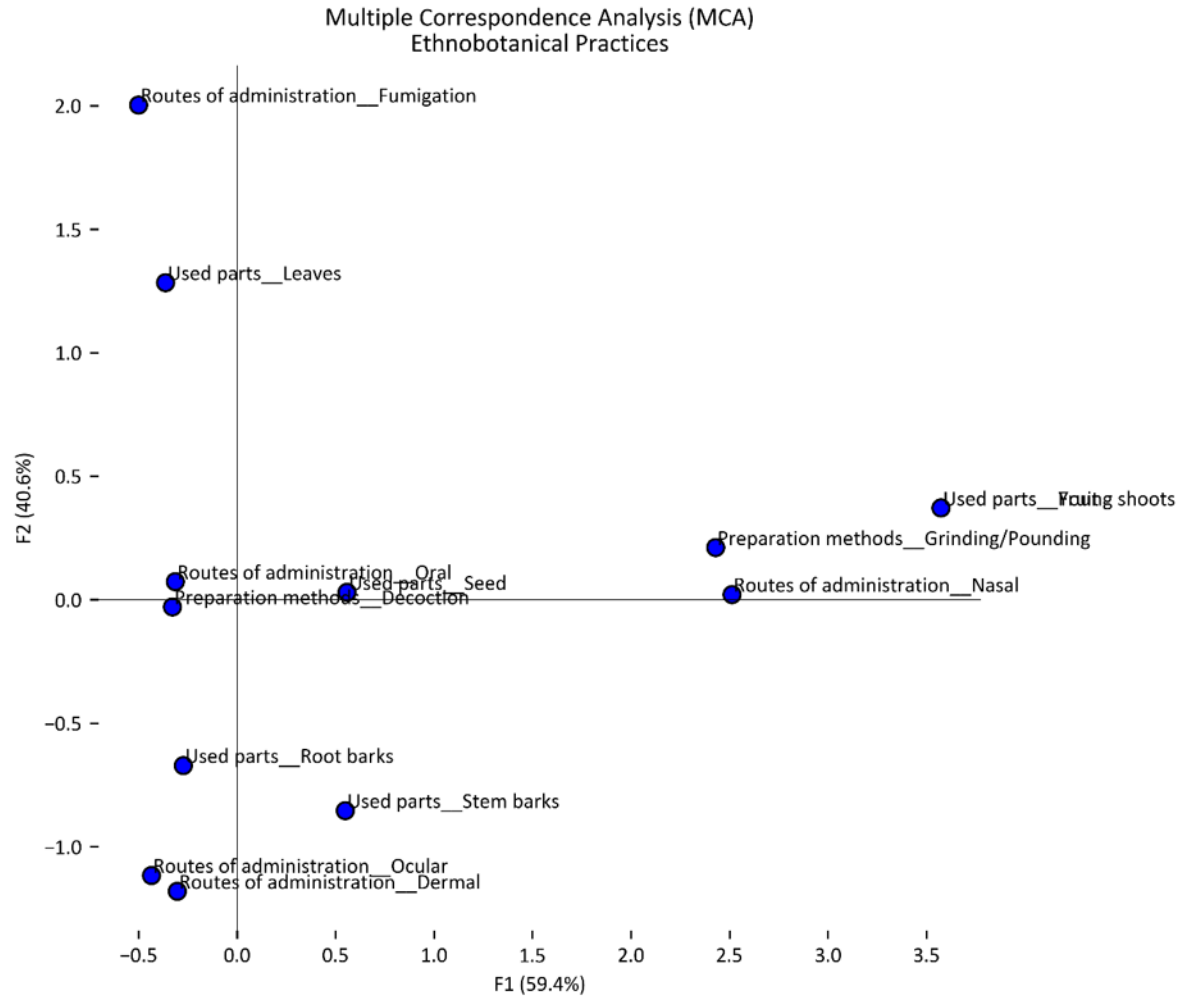

Figure 8:.MCA biplot of plant parts used, preparation methods and routes of administration.

Table 2. Medicinal plants used for the treatment of neurological disorders, including plant parts used, preparation methods and routes of administration.

Scientific name	Vernacular names	Family	Growth forms	Used parts	Preparation methods	Routes of administration
Mangifera indica L.	Manguier	Anacardiaceae	Tree	Leaves ; Root Bark	Decoction	Oral
Calotropis Procera (Aiton) Dryand	Pom-pom (Koulango)	Apocynaceae	Subshrubs	Fruits	Trituration	Nasal
Chromolaena odorata (L.) R.M.King & H.Rob.	Lopo (Lobi)	Asteraceae	Herb	Young shoots	Trituration	Nasal
Vernonia colorata (Benth.)	Koa safan (Mooré)	Asteraceae	Shrub	Leaves	Trituration	Oral
Stereospermum kunthianum Cham	Dithola (Koulango)	Bignonaceae	Tree	Root Bark	Decoction	Oral
Cochlospermum planchonii Hook.f.	Pouglio (Koulango)	Bixaceae	Subshrubs	Root Bark	Decoction	Oral ; Dermal
Griffonia simplicifolia (Vahl ex DC.) Baill.	Allahkiragbabena	Celastraceae	Liana	Leaves	Decoction	Fumigation
Anogeissus schimperi Hochst.	Kalma (Sénoufo)	Combretaceae	Tree	Leaves	Decoction	Fumigation
Terminalia avicennioïdes Guill. et Perr.	Wolo (Sénoufo)	Combretaceae	Tree	Leaves	Decoction	Fumigation
Terminalia macroptera Guil. & Perr	Dagnéla (Koulango)	Combretaceae	Tree	Root Bark	Decoction	Oral
Tipuana tipu (Benth.) Kuntze	Gbabogo+poivre (Koulango)	Fabaceae	Tree	Root Bark ; Stem Bark	Decoction	Dermal
Flueggea virosa (Roxb.ex Willd.)	Dugukoro (Bambara)	Fluegeaceae	Shrub	Root Bark	Decoction	Oral
Anthocleista grandiflora Gilg	Koumadengou (Koulango)	Gentianaceae	Tree	Root Bark	Decoction	Oral
Ocimum gratissimum Forssk	Basilic	Lamiaceae	Perennial herbs	Leaves	Decoction	Oral
Alchornea cordifolia (Schumach. & Thonn.) J.H. Kirkbr.	Djeka (Koulango)	Malvaceae	Shrub	Leaves	Decoction	Oral
Grewia flavescens Juss.	Totien (koulango)	Malvaceae	Shrub	Stem Bark	Decoction	Oral
Azadirachta indica A.Juss.	Kirguené (Koulango)	Meliaceae	Tree	Leaves	Decoction	Oral
Trichilia emetica Vahl.	Soula finzan (Sénoufo)	Meliaceae	Tree	Leaves	Decoction	Fumigation
Ficus ovata Valh	Kalan kono (Bambara)	Moraceae	Tree	Leaves	Decoction	Oral
Musa paradisiaca L.	Banana	Musaceae	Perennial herbs	Leaves	Decoction	Oral
Lophira alata Banks.	Mana (Sénoufo)	Ochnaceae	Tree	Leaves	Decoction	Fumigation
Hymenocardia acida Tul.	Paradio + poivre sécher	Phyllanthaceae	Shrub	Root Bark ; Stem Bark	Decoction	Dermal
*Cymbopogon citratus (*DC.) Stapf	Citronnelle	Poaceae	Perennial herbs	Leaves	Decoction	Oral
Securidaca longepedunculata Fresen.	Dobagni (Koulango)	Polygalaceae	Shrub	Root Bark ; Stem Bark	Trituration	Nasal
Mitragyna inermis (Willd.) Kuntze	Brassio (Dèga)	Rubiaceae	Shrub	Root Bark	Decoction	Oral ; Dermal
Sarcocephalus latifolius (Sm.) E.A.Bruce	Balomé (Koulango) ; Angou (Déga)	Rubiaceae	Shrub	Root Bark ; Leaves	Decoction	Oral ; Dermal ; Nasal
Zanthoxylum zanthoxyloides (Lam.) Zepernick & Timler	Hango (Déga)	Rutaceae	Shrub	Root Bark	Decoction	Oral
Lippia alba (Mill.) N.E. Br.	Coprè (Koulango)	Verbenaceae	Shrub	Root Bark	Decoction	Oral
Cissus populnea Guill. & Perr.	Yolongo (Koulango) ; Taganbanga (Dèga)	Vitaceae	Perennial herbs	Root Bark	Decoction	Oral ; Ocular ; Dermal

Table 3. Ethnobotanical indices (FC, ICF and Cpr) of the recorded medicinal plant species.

Scientific name	Routes of administration	FC (%)	IFC	Cpr	Recipe Number
Alchomea cordifolia (Schumach. & Thonn.) J.H.Kirkbr.	Oral	1,35	0,03	3,45	R16
Anogeissus schimperi Hochst.	Fumigation	1,35	0,03	3,45	R17
Anthocleista grandiflora Gilg	Oral	1,35	0,03	3,45	R5
Azadirachta indica A. Juss.	Oral	1,35	0,03	3,45	R8
Calotropis procera (Aiton) Dryand	Nasal	1,35	0,03	3,45	R2
Chromolaena odorata (L.) R.M.King & H.Rob.	Nasal	1,35	0,03	3,45	R13
Cissus populnea Guill. & Perr.	Oral ; Ocular ; Dermal	2,70	0,06	6,90	R10
Cochlospermum planchonii Hook.f.	Oral ; Dermal	1,35	0,03	3,45	R7
Cymbopogon citratus (DC.) Stapf	Oral	1,35	0,03	3,45	R9
Ficus ovata Valh	Oral	1,35	0,03	3,45	R20
Flueggea virosa (Roxb. ex Willd.) Voigt	Oral	1,35	0,03	3,45	R19
Grewia flavescens	Oral	1,35	0,03	3,45	R18
Griffonia simplicifolia (Vahl ex DC.) Baill.	Fumigation	1,35	0,03	3,45	R17
Hymenocardia acida Tul.	Dermal	1,35	0,03	3,45	R3
Lippia alba (Mill.) N.E. Br.	Oral	1,35	0,03	3,45	R5
Lophira alata Banks.	Fumigation	1,35	0,03	3,45	R17
Mangifera indica L.	Oral	2,70	0,06	6,90	R8
Mitragyna inermis (Willd.) Kuntze	Oral ; Dermal	1,35	0,03	3,45	R13
Musa paradisiaca L.	Oral	1,35	0,03	3,45	R14
Ocimum gratissimum Forssk.	Oral	1,35	0,03	3,45	R22
Sarcocephalus latifolius (Sm.) E.A.Bruce	Oral ; Dermal ; Nasal	4,05	0,09	10,34	R5
Securidaca longepedunculata Fresen.	Nasal	1,35	0,03	3,45	R4
Stereospermum kunthianum Cham	Oral	1,35	0,03	3,45	R5
Terminalia avicennioïdes Guill. et Perr.	Fumigation	1,35	0,03	3,45	R17
Terminalia macroptera Guil. & Perr	Oral	1,35	0,03	3,45	R21
Tipuana tipu (Benth.) Kuntze	Dermal	1,35	0,03	3,45	R1
Trichilia emetica Vahl.	Fumigation	1,35	0,03	3,45	R17
Vernonia colorata (Benth.) Benth.	Oral	1,35	0,03	3,45	R15
Zanthoxylum zanthoxyloides (Lam.) Zepernick & Timler	Oral	1,35	0,03	3,45	R6

Discussion

Among respondents, only 28%, or 21 people (including 12 men and 9 women), have knowledge of therapies related to these disorders. There are two main explanations for this low rate. The first is that emotional disorders are quite complex to diagnose and treat, both in traditional and modern medicine (Ayachi *et al*., 2024). Despite the complexity of emotional disorders, it should also be noted that in both rural and urban areas, these disorders are mostly perceived by the population as normal and common for anyone concerned about a better future (Lemouogue and Douanla, 2024). According to Anjorin and Wada (2022), there is a real shortage of mental health professionals in our African societies, and mental disorders are most often overlooked, misunderstood, and mismanaged. In some African cultures, these types of pathologies are often viewed as minor and temporary problems associated with predispositions that are mostly social or spiritual in nature, rather than serious illnesses requiring real treatment (Levesque and Rocque, 2015). It is also noted that people aged between 35 and 55, particularly males, were the ones who reported being most familiar with cases of emotional disorders. This could be explained by the strong social pressure, stereotypes and imperative for all adult men, especially in rural areas, to assume their social and family responsibilities (Devault, 2011).

As for species diversity, surveys have shown a significant diversity of medicinal species, divided into 29 species and 23 families. The most frequently mentioned family was Combretaceae, with species such as *Anogeissus schimperi* Hochst, *Terminalia avicennioïdes* Guill. and Perr, and *Terminalia macroptera* Guil. & Perr. The predominance of the Combretaceae family in this region is explained by the work of Hennenberg et al. (2005); indeed, Bondoukou is located in the Guinea-Sudan zone, a vegetation belt where the Combretaceae family is widely represented. Among the most common species in this family are Anogeissus spp. and Terminalia spp. (Ouédraogo et al., 2013). Their presence in various ecosystems, such as fields, makes them readily available for traditional medicinal uses (Savadogo et al., 2007). These results corroborate those of Doumongue *et al*. (2023), who found in an ethnobotanical study on medicinal plants used in the treatment of nervous system disorders in Togo that Combretaceae played a key role in the management of these diseases. Combretaceae, such as *Combretum micranthum* G. Don, have anxiolytic and sedative properties attributed to the presence of phytochemical compounds such as flavonoids and tannins (Chandrasekhar *et al*., 2018). These bioactive substances act by modulating the activity of GABA receptors, a mechanism comparable to that of benzodiazepines, thereby promoting a calming effect and reducing anxiety (Amali *et al*., 2020). The most frequently cited species, *Sarcocephalus latifolius* (Sm.) E.A.Bruce, has been documented by Finbarrs-Bello *et al*. (2018) for its antidepressant and anxiolytic properties. This species is widely used by communities in Nigeria to treat certain nervous system disorders. For the other species listed in this study, many authors have highlighted their soporific, antidepressant and anxiolytic properties. This is the case for *Terminalia macroptera* Guill. & Perr., which has high antioxidant activity, suggesting a neuroprotective role against oxidative stress (Tchétagni *et al*., 2021).

This study shows that the roots and bark, followed by the leaves, are the parts of the plant used to treat emotional disorders. Our results are consistent with those of a study conducted by Doumongue *et al*. (2023) on medicinal plants used in Togo for the treatment of nervous disorders, which revealed that root bark was the organ used in the preparation of remedies. The constant availability of root bark throughout the year, regardless of season, explains its preference, as it ensures a stable supply of medicinal material for healers (Ngbolua et al., 2019). In addition, there is a similarity between these results and various previous studies that highlight the significant accumulation of secondary metabolites in the roots (Tugume *et al*., 2016). However, the continued harvesting of roots could lead to the extinction of certain species, which would harm biodiversity.

As for the leaves, they are widely recognised for their accessibility, ease of preparation and, above all, their richness in secondary metabolites (Ngbolua *et al*., 2019).

Decoction is used to extract the active ingredients from medicinal plants. According to Salhi *et al*. (2010), decoction is the best preparation method to use to get the most out of the active ingredients in medicinal plants. In several ethnobotanical studies conducted around the world, decoction was the most frequently cited preparation method (Baggnian *et al*., 2018). According to Bashige-Chiribagula *et al*. (2020), the use of decoction can be justified by the fact that it has the advantage of promoting extraction and releasing volatile toxic components. This finding is all the more compelling given that a study conducted by Omam et al. (2023) on male and female mice revealed that a decoction of Cybopogon citratus significantly increased the mice's ability to withstand stress: the decoction therefore appears to have a proven anxiolytic effect

The study also revealed that the most used route of administration is largely oral (70%). In line with these results, many remedies, including medicinal plants used to treat insomnia, as anxiolytics and antidepressants, are most often administered orally (Doumongue *et al*., 2023). Studies conducted by Amsalu *et al*. (2025); Baressa *et al*. (2024) have also revealed that the

oral route is widely used as the primary method of administering medication in Ethiopia, with usage rates ranging from 52% to 75%. This regional trend toward the oral route as the most preferred method can be explained by the fact that the oral route ensures effective systemic absorption of phytochemical compounds, including flavonoids and alkaloids, which must reach the central nervous system to exert their anxiolytic or antidepressant effects (Manach *et al*., 2004). Secondly, according to Mahomoodally (2013), oral administration is the most practical method for rural communities, which often lack access to the equipment typically required for certain routes of administration; it requires nothing more than the medication itself. Third, oral intake is generally perceived as the most natural and culturally accepted mode of drug delivery in most African traditional medical systems (Iwu, 2014).

However, topical application may be preferred due to the dangers associated with oral ingestion of certain medications, either because of the specific nature of the disease or because of their proven toxicity (Olivier *et al*., 2013). According to some therapists surveyed, the topical application of certain recipes helps to ward off evil spirits if the disorder is of a mystical nature. Some are preferably administered nasally, as this method has the advantage of ensuring rapid penetration of the active substances into the brain, which is the target of the disorders (Abdolali *et al*., 2006).

Furthermore, multiple correspondence factor analysis has made it possible to associate a specific organ, namely root bark, with a method of preparation, namely decoction, and a route of administration, namely oral. This association is significant in that these different variables have been widely mentioned in various scientific studies.

Conclusion

This study forms part of research into alternative remedies to modern medicine, based on local knowledge, for the treatment of insomnia, depression, stress, anxiety, and nervousness. The surveys identified a significant level of plant biodiversity for the management of neuropsychiatric and emotional disorders. A total of 29 plant species across 23 botanical families were recorded. The most frequently mentioned family was the *Combretaceae*, with species possessing either soporific, anxiolytic or antidepressant properties documented in the literature. Furthermore, the most frequently cited plant species was *Sarcocephalus latifolius* (Sm.) E.A. Bruce. Root bark was most frequently cited, prepared as a decoction, and administered orally. Furthermore, knowledge of emotional disorders is linked to the gender of the respondents. It is also important to note that older people were the ones who possessed knowledge of the medicinal plants listed in this study. Looking ahead, it would be advisable to:

- Supplement this research with phytochemical and pharmacological studies on the identified species to identify the molecules and active ingredients responsible for their healing properties, and to determine the appropriate dosages and administration methods.
- Expand the study and undertake an inventory of these species in the region with a view to their conservation or restoration.

We recommend closing collaboration between practitioners of traditional and modern medicine and biodiversity scientists to bridge the gap.

Declarations

List of abbreviations: APG IV - Angiosperm Phylogeny Group IV; MCA - Multiple Correspondence Analysis; CNF - Centre National de Floristique; Cpr - Specific Contribution to Medicinal Recipes; FC - Frequency of Citation, ICF - Informant Consensus Factor, WHO (World Health Organization), RGPH - Recensement Général de la Population et de l'Habitat.

Ethics approval and consent to participate: Prior informed consent was obtained from all participants before the interviews were conducted. Informants were informed about the objectives of the study and their voluntary participation. The research followed the ethical guidelines of the International Society of Ethnobiology.

Consent for publication: All participants provided informed consent for the publication of the data collected during this study.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare no competing interests.

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Author contributions: K.D and K.W.B designed the study. K.D conducted the field surveys, conducted data collection and analysis, and drafted the manuscript. KOLA D and KPAN B identified the plant specimens. K.B, K.G and Z.N critically revised and corrected the manuscript. All authors read and approved the last version of the manuscript.

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