Utilitarian diversity of *Senna occidentalis* in Benin, West Africa: Ethnobotanical insights and sustainable management

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Research

Abstract

Background: *Senna occidentalis* (L.) Link is a medicinal plant whose therapeutic properties have been widely appreciated in medicinal preparations throughout the world. This study investigates the indigenous knowledge and use of *S. occidentalis* throughout Benin.

Methods: The study was carried out in nine communes of Benin. From September to November 2023, semi-structured interviews were conducted in 72 villages, involving 195 respondents from 14 different sociolinguistic groups. Cramer's test was used to determine the degree of relationship between socio-linguistic groups and the forms and parts of the plant used. In addition, a Correspondence Analysis (CA) was performed to examine variations in species consensus values.

Results: Our results showed that the species is primarily used for medicinal purposes (93.57%), with smaller proportions allocated to food (3.21%) and medico-romantic applications (3.21%). The uses of the species varied with socio-linguistic affiliation. Decoction (71.88%), infusion (7.63%), toothpick (6.42%) and trituration (6.02%) were the forms mainly used by the local population. The leaves (71.08%) were the most commonly used part of the plant. Roots (20.08%) and seeds (8.83%) were used, but to a lesser extent. In addition, leaves and roots were mainly used parts of the species to treat malaria and typhoid fever, while seeds were used for constipation.

Conclusions: These results demonstrate the medicinal importance of *S. occidentalis* in Benin and suggest the need for priority actions for the sustainable management and use of the species. Further research on the medicinal components of different parts of the plant could aid its promotion and valorization.

Keywords: Ethnobotany; Asteraceae, Indigenous communities; Human diseases, Herbal medicine

Background

The use of plant genetic resources for medicinal purposes is one of the oldest human practices, driven by the need to maintain health (Angmo *et al.* 2024, Daskum *et al.* 2019). These resources are widely sought for the treatment of various diseases, with global demand steadily increasing (Singh *et al.* 2019). In developing countries, especially among low-income populations, traditional medicine remains a primary healthcare option (Sánchez *et al.* 2020). The preference for traditional medicine is primarily driven by the chemical properties of medicinal plants and user satisfaction. In addition, the rising cost of modern treatments, coupled with their potential side effects, further reinforces the reliance on traditional remedies (Singh *et al.* 2025, Singh *et al.* 2019). Traditional remedies are widely used to treat various conditions, including cancer, malaria, bacterial infections, and diabetes (Moshi *et al.* 2012). The prolonged lack of treatment for some of these diseases can result in secondary health problems, such as sexual dysfunction (Lankatillake *et al.* 2019). Historically, the development of traditional knowledge, particularly in rural areas, has enabled the treatment of many diseases using plants collected from the wild or cultivated gardens based on their therapeutic properties (Amjad *et al.* 2020). *Senna occidentalis* (L.) Link, commonly known as **false kinkeliba** (Aké Assi 1983) or **coffee senna**, is a medicinal plant widely recognised for its therapeutic properties. It belongs to the order Fabales and family Fabaceae. Originally from South America, *S. occidentalis* (Neuwinger 1996) has shown a strong capacity to expand and is now found in tropical regions throughout the world (Aké Assi 1983). The plant produces numerous flattened, brownish seeds that turn greyish with age, arranged transversely in pods, with each pod containing 20 to 60 seeds measuring approximately 4 mm in length (Oudhia 2007). Various parts of *S. occidentalis* possess anti-hyperglycemic, anti-hyperlipidemic and antioxidative, anti-hepatotoxic, anti-inflammatory, antibacterial and anti-diabetic properties (Badock *et al.* 2024, Nde *et al.* 2022, Arya *et al.* 2013) making it a valuable medicinal resource for the treatment of diseases such as diabetes, typhoid, malaria and rheumatism.

Numerous studies worldwide have investigated the uses and chemical properties of *S. occidentalis*, highlighting its potential in the treatment of various diseases. Recent studies on extracts from the leaves, roots and seeds of *S. occidentalis* have demonstrated its strong antibiotic properties, making it a valuable resource for addressing a range of health conditions (Nde *et al.* 2022, Tamasi *et al.* 2021, Yakubu *et al.* 2021, Kamsi *et al.* 2020, Daskum *et al.* 2019, Singh *et al.* 2019, Kankara *et al.* 2018, Gidado *et al.* 2016).

Despite these phytochemical studies, the ways in which a species is used can vary considerably within a country, particularly between different socio-linguistic groups. This variation reflects the different ways in which individuals interact with their environment and the ecosystem products on which they depend (Amjad *et al.* 2020).

This study is the first ethnobotanical investigation of *S. occidentalis* in Benin, a species renowned for its high therapeutic value. Despite its widespread medicinal use, no formal management strategy has been established. Notably, herbalists regard it as one of the most sought-after medicinal plants in local markets (Adomou *et al.* 2012). This study aims to document indigenous knowledge of *S. occidentalis* in 14 socio-linguistic groups in Benin, assess the diversity of its uses and propose strategies for its sustainable management.

We hypothesize that:
i) Indigenous knowledge of *S. occidentalis* varies significantly between socio-linguistic groups.
ii) Effective management strategies are essential to sustain both the species and associated traditional knowledge.

Materials and Methods

Study area

Located between latitudes 6º30’ and 12º30’ N and longitudes 1º and 3º40’ E, Benin is bordered by Niger to the north, the Atlantic Ocean to the south, Nigeria to the east, Togo to the west, and Burkina Faso to the northwest (Fig. 1). This study was conducted across Benin, focusing primarily on nine departments where the species had been pre-identified. The country comprises twelve departments, divided into 77 communes, which are distributed across three climatic zones: Guinean-Congolean, Sudano-Guinean, and Sudanian (Adomou *et al.* 2006). In the south, Benin has a subequatorial climate with two rainy seasons, while the north has a tropical climate with a single rainy season. Annual rainfall ranges from 900 mm to 1,450 mm and temperatures vary between 22°C and 37°C (Adomou *et al.* 2006). Vegetation in the south consists of patches of forest, wooded and scrub savannah, wetlands and some mangroves, while the north is predominantly wooded savannah. In the south, Benin has a subequatorial climate with two rainy seasons, while the north has a tropical climate with a single rainy season. Vegetation in the south consists of patches of forest, wooded and scrub savannah, wetlands and some mangroves, while the north is predominantly wooded savannah (Zinsalo *et al.* 2017).

Soils in Benin can be divided into four main categories: ferralitic red soils, formed on the terminal continental deposits of the southern sedimentary basin; vertisols, found in the Lama depression; hydromorphic alluvial soils, either sandy or clayey, found in flood-prone alluvial and shallow valleys; and tropical ferruginous soils, more or less sandy, over a base of gneiss, granite or schist, found mainly in the central and northern regions (Adomou *et al.* 2006). Agriculture remains the dominant economic activity and the country's main source of income (Dayou *et al.* 2020).

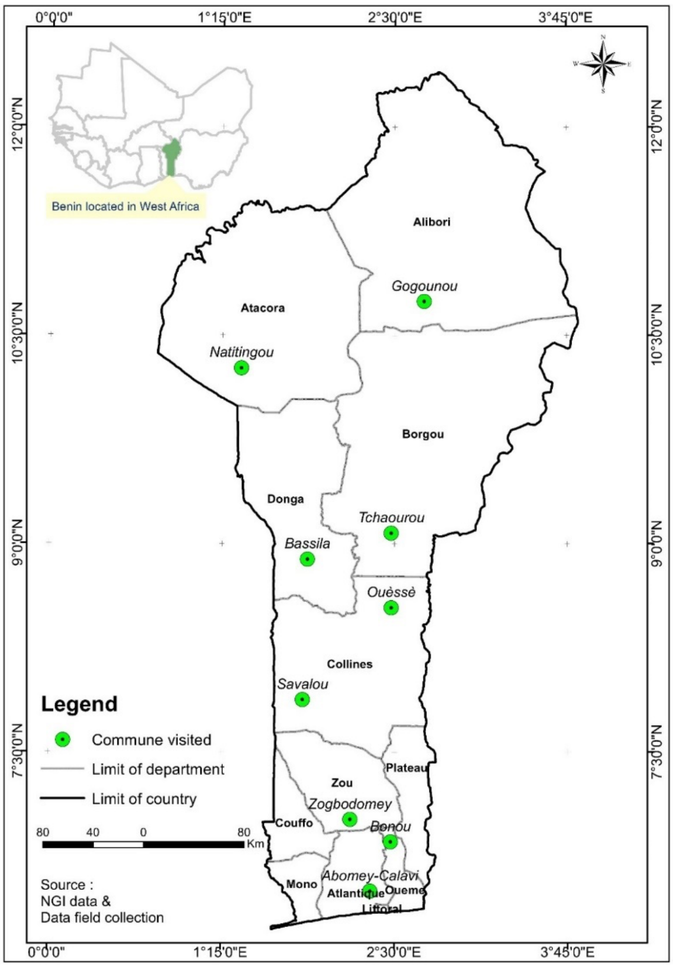

Figure 1. Map showing the location of the communes within the study area

Sampling strategy and Data collection

The questionnaire was designed to gather information from local experts and traditional healers, incorporating images of the species and its various parts to aid identification. Data on local knowledge and use of the species were collected from populations in nine selected communes (Gogounou, Natitingou, Tchaourou, Bassila, Ouèssè, Savalou, Zogbodomey, Bonou and Abomey-Calavi) from September to November 2023 representing the three biogeographical zones of Benin (Guinean-Congolean, Sudanian and Sudano-Guinean). These sites were selected on the basis of occurrence records from the Global Biodiversity Information Facility (GBIF).

A total of 195 respondents, primarily traditional healers, participated in focus group discussions and semi-structured interviews. The survey and interview guides covered key topics such as local species names, perceived changes in availability over time, identification methods, usage types and forms, plant parts used, associations with other species, ailments treated, cultural beliefs and taboos, and local conservation strategies. The sample size for each community was determined using Dagnelie's formula (Dagnelie 1998).

$$n = \frac{U^2_{1-\frac{\alpha}{2}} p(1-p)}{d^2}$$

Where:
n is the total number surveyed;
$U^2_{1-\frac{\alpha}{2}}$ is the value of the normal random variable for a probability value of a = 0.05, α=0,05
$U_1 - \frac{\alpha}{2} = 1{,}96$
p is the report/ratio of the farming population by the total population and d is the margin of error for any parameter to be calculated starting from the investigation, which is fixed at 7 %.

Data Analysis

In order to assess the level of knowledge and use of *S. occidentalis*, a quantitative analysis based on statistical measures was carried out. Several ethnobotanical indices were used to analyse the data: Interviewee diversity value (ID); Interviewee equitability value (IE); Use diversity value (UD); Use equitability value (UE); Consensus value for the form of use (CMU); Consensus value for parts of plants used (CPP) (Byg & Balslev 2001). These indices help to determine how *S. occidentalis* is used and how knowledge of its uses is distributed among respondents. To estimate the diversity of use (UD), specific uses were categorized into different groups (Table 1).

Correlation analysis was used to test for relationships between variables. The Chi-square test, implemented using the Chi square test function in R 4.2.0 (R Core Team 2021) was used to identify potential associations between variables. In addition, Cramer's V test, using the *assocstats()* function, available in the *vcd* package (Meyer *et al.* 2020), was used to assess the strength of the relationship between socio-linguistic groups and the forms and parts of the plant used. Cramer's V values range from 0 to 1, with values above 0.3 indicating a strong relationship.

In addition, the consensus values for plant parts (CPP) and forms of use (CMU) were subjected to Correspondence Analysis (CA) using the Factoshiny v2.4 package (Vaissie *et al.*2021) under R 4.2.0 (R Core Team 2021) for a better description of the difference between the socio-linguistic groups use.

Table 1. Indices of knowledge and uses calculated for *Senna occidentalis*

Index	**Explanation**	**Reference**
Interviewee diversity value (ID); ID = Ux/Ut	ID, number of uses-citations per total number of uses (Ut). This index measures how many interviewees used *Senna occidentalis* and how its uses are distributed among the respondents	(Byg & Balslev 2001)
Interviewee equitability value (IE); IE = ID/IDmax	IE, interviewee diversity value (ID) per ID's maximum value. It allows to estimate the degree of homogeneity of the respondent's knowledge.	(Byg & Balslev 2001)
Use diversity value (UD); UD = Ucx/Uct	UD, number of citations per use category (Ucx). Measures the importance of category uses and how they contribute to the total value of uses.	(Byg & Balslev 2001)
Use equitability value (UE); UE = UD/UDmax	UE, use-diversity value (UD) per UD's maximum value. It allows measuring the homogeneity degree of knowledge about use categories.	(Byg & Balslev 2001)
Consensus value for plant parts (CPP); CPP = Px/Pt	CPP is, the number of times a given part of the plant was cited (Px) per total number of citations of all parts (Pt). It measures the degree of agreement among respondents concerning the plant part used.	(Albuquerque *et al.* 2006)
Consensus value for the form of use (CMU); CMU = Mx/Mt	CMU, number of citations for a given form of use (Mx) per the total number of citations for all forms (Mt). Measure the degree of agreement among respondents concerning the form of use of *S. occidentalis*	(Albuquerque *et al.* 2006)

Results

Characteristics of respondents

The results revealed key demographic characteristics of the population surveyed, including gender, age and ethnic composition. Men accounted for 70.26% of the respondents, indicating a male-dominated sample. The Fon ethnic group was the most represented with 40.51% of the respondents, followed by Bariba (16.92%) and Goun (13.84%). The other ethnic groups were represented in smaller proportions. In addition, the majority of participants were adults, making up 91.28% of the sample. A detailed breakdown of the socio-linguistic characteristics of the respondents is given in Table 2.

Table 2. Socio-demographic characteristics of the respondents per commune

Commune	Sample size	Sociolinguistic groups	Gender (%)	Gender (%)	Age (%)	Age (%)	Total per Sociolinguistic groups (%)
Commune	**Sample size**	**Sociolinguistic groups**	**Women**	**Men**	**≤ 40 years**	**> 40 years**	**Total per Sociolinguistic groups (%)**
Abomey-Calavi	73	Adja	0.00	1.54	0.51	1.03	1.54
Abomey-Calavi	73	Fon	9.23	17.95	2.05	25.13	27.18
Abomey-Calavi	73	Goun	3.59	4.10	0.00	7.69	7.69
Abomey-Calavi	73	Saxhè	0.00	1.03	0.00	1.03	1.03
Bassila	17	Ana	0.51	1.54	0.00	2.05	2.05
Bassila	17	Ani	1.03	1.54	0.51	2.05	2.56
Bassila	17	Lokpa	0.51	1.54	0.00	2.05	2.05
Bassila	17	Nago	0.51	1.54	0.00	2.05	2.05
Bonou	17	Goun	1.03	2.05	0.51	2.56	3.08
Bonou	17	Wémè	1.03	4.62	1.03	4.62	5.64
Gogounou	15	Bariba	1.03	6.67	0.51	7.18	7.69
Natitingou	13	Bariba	0.51	0.00	0.00	0.51	0.51
Natitingou	13	Biali	0.51	1.03	0.51	1.03	1.54
Natitingou	13	Ditamari	1.54	2.56	0.51	3.59	4.10
Natitingou	13	Wama	0.00	0.51	0.00	0.51	0.51
Ouèssè	2	Fon	0.00	1.03	0.00	1.03	1.03
Savalou	18	Fon	2.05	5.13	0.51	6.67	7.18
Savalou	18	Goun	0.51	1.54	0.00	2.05	2.05
Tchaourou	28	Bariba	1.03	7.69	0.51	8.21	8.72
Tchaourou	28	Peulh	2.05	3.59	0.00	5.64	5.64
Zogbodomey	12	Fon	2.05	3.08	0.51	4.62	5.13
Zogbodomey	12	Goun	1.03	0.00	1.03	0.00	1.03

Diversity of knowledge of *S. occidentalis*

All respondents in the study area reported using *S. occidentalis*. The informant diversity index (ID) ranged from 0.03 to 0.61. Overall, men showed greater knowledge of *S. occidentalis* use (ID = 0.61; IE = 0.99), with older men (age > 40) having the highest knowledge, followed by younger men (age ≤ 40) (ID = 0.06; IE = 0.10). Women also demonstrated considerable knowledge of the species (ID = 0.29; IE = 0.48), particularly those over 40, followed by younger women (ID = 0.03; IE = 0.05). The species is known by different local names in different ethnic groups, with a total of ten names recorded. However, "**kinkéliba**" is the most widely known name across all groups. A detailed breakdown of knowledge diversity is presented in Table 3.

Table 3. Knowledge assessment of *S. occidentalis* according to sex and age

Total number of surveyed		195
Number of specific uses cited		13
Number of use categories cited		3
	ID	IE
Women ≤ 40	0.03	0.05
Women > 40	0.29	0.48
Men ≤ 40	0.06	0.10
Men > 40	0.61	1

Diversity of uses of *Senna occidentalis*

Three main categories of use of *S. occidentalis* were identified: medicinal, food and medico-magic. Medicinal use was the most prevalent in all the communities surveyed (UD ≥ 0.77), with different parts of the plant used to treat various ailments, particularly malaria. Food and magical uses were further reported, but were less prominent. Consumption of *S. occidentalis* as food was mainly observed in the communes of Gogounou and Natitingou, where only the leaves were used as vegetables. However, the diversity of food-related uses remained low, with a maximum Use Diversity (UD) value of 0.08. In contrast, the species was not considered as a food source in the other communes. The medico-magic category, which includes spiritual rather than medicinal uses, was reported mainly in Bonou (UD = 0.15; UE = 0.2; Table 4).

The results of the chi-square test indicate a significant dependence between forms of use and socio-linguistic groups, with a p-value of 2.2e-16, $X^2 = 480.62$, and df = 65, which is less than 0.05. In addition, the result of Cramer's V-test (V = 0.53; V > 0.30) confirms a strong correlation between the variables, indicating that the forms of use are influenced by socio-linguistic knowledge and traditions. The correspondence analysis (CA) applied to the different forms of use explains 73.4% of the observed variation along two main axes. These axes highlight the relationship between ethnic groups and usage patterns. Table 6 shows the coefficient of variation between types of use and the two axes. The first axis is positively correlated with food, toothpick and decoction, while infusion, powder and trituration are negatively correlated. The second axis is positively correlated with all uses except food and infusion (Table 6).

Table 6. Correlation between forms of use of *S. occidentalis* and the FCA axis

	Dim.1	**Dim.2**
Food	0.359	-1.290
Toothpick	1.617	1.111
Decoction	1.059	0.261
Infusion	-0.421	-0.306
Powders	-0.707	0.254
Trituration	-1.062	0.732

Table 4. Use diversity value (UD) and equitability value (UE) according to various uses of *S. occidentalis*

Category of uses	Abomey-Calavi	Abomey-Calavi	Bassila	Bassila	Bonou	Bonou	Gogounou	Gogounou	Natitingou	Natitingou	Ouèssè	Ouèssè	Savalou	Savalou	Tchaourou	Tchaourou	Zogbodomey	Zogbodomey
Category of uses	UD	UE	UD	UE	UD	UE	UD	UE	UD	UE	UD	UE	UD	UE	UD	UE	UD	UE
Food	0.03	0.03	-	-	0.01	0.01	0.1	0.1	0.10	0.11	-	-	0.04	0.04	-	-	0.07	0.08
Medicinal	0.96	1	0.95	1	0.77	1	0.94	1	0.90	1	1	1	0.96	1	0.95	1	0.86	1
Medico-magic	0.01	0.01	0.05	0.05	0.15	0.20	0.06	0.07	-	-	-	-	-	-	0.05	0.06	0.07	0.08

Consensual value of forms of uses of *S. occidentalis*

The study identified several methods used by the population to extract the active constituents of *S. occidentalis*. These methods include decoction, infusion, grinding, powder preparation, ingestion and use as a toothbrush (Table 5). Of these, decoction was the most commonly reported (CMU = 0.719), followed by infusion (CMU = 0.076) and toothbrushing (CMU = 0.064). Other forms, such as grating, powder and food use, were reported but in smaller proportions. Overall, decoction was found to be the most effective method of extracting the active constituents of the plant, as shown in Table 5.

Table 5. Consensual value of forms of uses (CMU) of *S. occidentalis*

Forms of use	Abomey-Calavi	Bassila	Bonou	Gogounou	Natitingou	Ouèssè	Savalou	Tchaourou	Zogbodomey
Food	0.03	0.02	0.04	0.71	0.8	0.00	0.04	0.00	0.02
Toothpick	0.10	0.00	0.15	0.33	0.00	0.04	0.08	0.00	0.00
Decoction	0.73	0.73	0.54	0.75	0.03	0.47	0.76	0.31	0.71
Infusion	0.08	0.8	0.08	0.06	0.20	0.00	0.00	0.05	0.02
Powders	0.01	0.09	0.15	0.06	0.00	0.00	0.04	0.11	0.07
Trituration	0.04	0.14	0.00	0.00	0.00	0.33	0.08	0.07	0.00

The projection of different forms of use across ethnic groups (Fig. 2) reveals distinct preferences. Powder and grind methods are mainly used by the Ani, Nago, Peulh and Lokpa socio-linguistic groups. The Ani and Biali ethnic groups prefer infusion to extract the active ingredients of the plant. In the north-west, the Otamari and Waama ethnic groups use *S. occidentalis* mainly as food. In the southern regions, decoction and toothpick use are more common among the Wémè, Goun, Fon and Saxhè socio-linguistic groups.

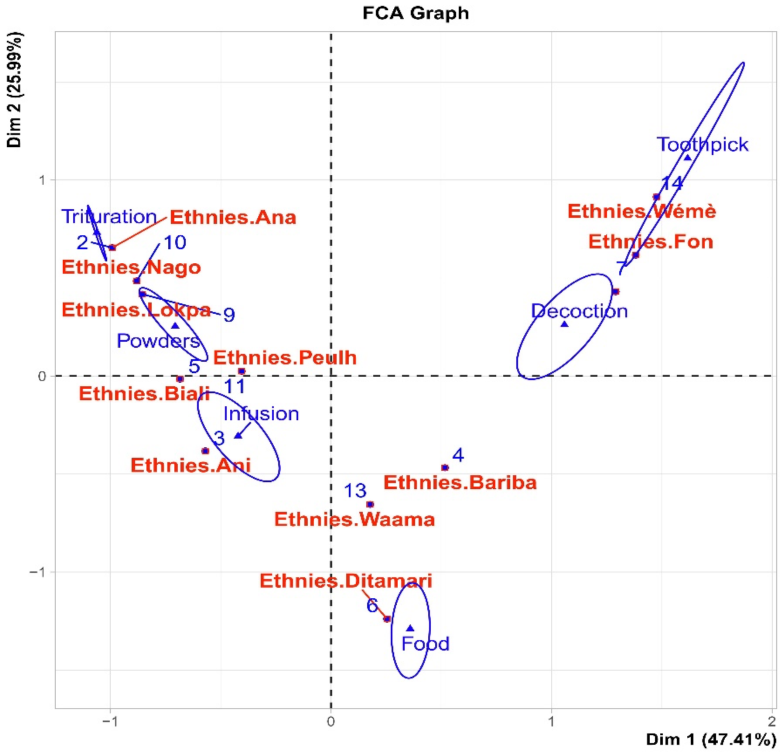

Figure 2. Uses identified for *S. occidentalis* according to sociolinguistic groups

Consensual value for the parts uses

The different parts of *S. occidentalis* play an important role in the treatment of diseases (Table 7). Among them, the leaves are the most commonly used with the highest consensus value (CPP = 0.79), followed by the roots (CPP = 0.33) and the seeds (CPP = 0.20). These plant parts are widely used in the preparation of medicines, particularly for the treatment of malaria. The roots, in particular, are used to treat sore throats and typhoid fever. Although all of these plant parts are used in the surveyed communities, their use varies according to regional knowledge and traditional practices.

Table 7. Consensus values for the parts of *S. occidentalis* (CPP) per commune

Parts used	Abomey-Calavi	Bassila	Bonou	Gogounou	Natitingou	Ouèssè	Savalou	Tchaourou	Zogbodomey
Leaves	0.69	0.73	0.69	0.75	0.70	0.67	0.72	0.71	0.79
Seeds	0.08	0.09	0.08	0.06	0.20	0.00	0.00	0.11	0.14
Roots	0.22	0.18	0.23	0.19	0.10	0.33	0.28	0.18	0.07

The chi-squared test indicates a significant dependence between the variables, with a p-value of 2.2e-16 (X^2 = 135.91 and df = 26), which is well below the 0.05 threshold. In addition, the Cramer's V test shows a strong correlation (V = 0.48; V > 0.30), confirming that the plant parts used are strongly influenced by the socio-linguistic groups and consequently by their traditional knowledge.

Regarding the use of plant parts, the results of the correspondence analysis (CA) show that 100% of the variation is explained by the two axes, which effectively capture the relationships between the variables (Table 8).

The projection of *S. occidentalis* parts across socio-linguistic groups (Fig. 3) shows that seeds are mainly used by the Biali, Peulh, Lokpa, Ani and Ana ethnic groups, which are mainly located in northern Benin. Leaves are mainly used by the Fon, Bariba and Waama groups, while roots are mainly used by the Wémè, Goun, Saxhè and Adja groups.

Table 8. Correlation between parts of *S. occidentalis* and the axes

	Dim.1	Dim.2
Leaves	-0.309	-0.218
Seeds	0.930	0.081
Roots	-0.567	0.841

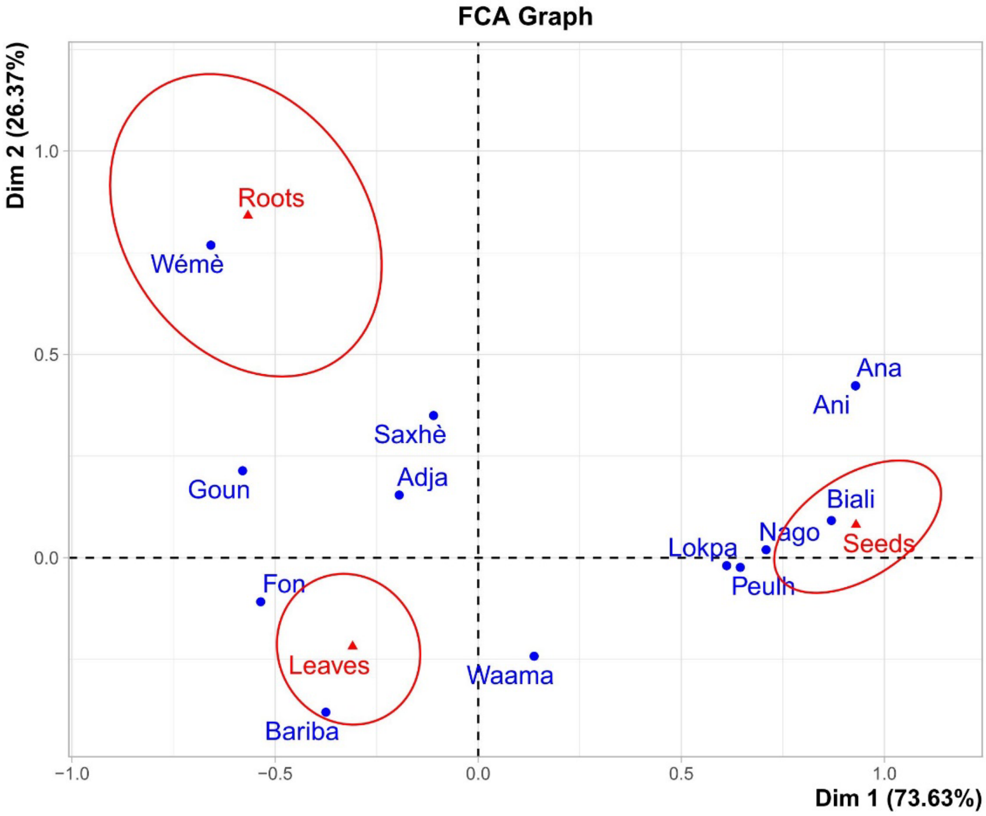

Figure 3. Projection of the sociolinguistic groups in the axis system defined by the parts of the plant

Discussion

Ethnobotanical knowledge of *S. occidentalis*

The present ethnobotanical study of *S. occidentalis* offers an in-depth understanding of its various therapeutic aspects. Widely used in medicinal preparations across Benin and beyond, the species plays a significant role in traditional healing practices. Knowledge of *S. occidentalis*, a highly valued species in the treatment of malaria, varied according to gender and age, with those over 40 years of age generally having greater familiarity with its uses. This variation suggests that older people possess more extensive indigenous knowledge of the species, reflecting a level of maturity in traditional plant-based practices. Such knowledge is part of a continuous transmission chain, passed down from one generation to the next (Amjad *et al.* 2020). These findings align with those of Chandra and Uniyal (2021), who observed a decline in ethnobotanical knowledge among younger populations (<25 years) compared to adults in the Himalayan region of India. Codjia *et al.* (2018) reported that knowledge of Garcinia kola Heckel is more prevalent among older individuals than among younger generations.

Medicinal importance and form of uses of *S. occidentalis*

Assessing the importance of *S. occidentalis* use among communities revealed that traditional medicine is the most important use across all socio-linguistic groups. Due to its medicinal properties, the species is increasingly being used in the development of herbal remedies for various diseases. This growing interest is attributed to its rich phytochemical composition, including flavonoids, saponins, alkaloids, tannins, terpenes and glycosides, which contribute to its therapeutic potential (Nde *et al.* 2022, Tamasi *et al.* 2021, Singh *et al.* 2019,). The plant's extracts have shown antibacterial, antifungal, antidiabetic, and anticancer activities (Kalombo *et al.* 2022). Like *S. occidentalis*, several medicinal species such as *Parkia biglobosa* (Jacq.) R.Br. ex G.Don and *G. kola*, are more commonly used in medicinal preparations than in the food form known to the majority of the populations (Codjia *et al*. 2018, Koura *et al.* 2011). The same is true for the studies carried out on *Matricaria recutita* L., *Valeriana officinalis* L., *Tilia spp*. L., and *Aloe vera* (L.) Burm.f., which are the species most used for medicinal purposes in Spain in the area of Madrid (Sánchez *et al.* 2020). The analysis of the level of knowledge of the forms of use of *S. occidentalis* showed that the ways in which the species are used differ across regions and socio-linguistic groups. However, in some cases it remains the same as in the current study. In order to extract the desired active ingredient, the decoction method is used more by all socio-linguistic groups, especially in the treatment of malaria. These results are similar to other works completed on medicinal plants in Pakistan (Kankara *et al.* 2018), Nigeria (Amjad *et al.* 2020), Ethiopia (Asfaw & Abebe 2022), Côte d'Ivoire (Akakpo-Akue *et al.* 2020, Kouakou *et al.* 2024), Indonesia (Jadid *et al.* 2020), and Morocco (Idm'hand *et al.* 2020). The findings of this study align with the research conducted in Morocco by Jeddi *et al.* (2021) on medicinal and aromatic plants. According to these authors, 40% of the medicinal uses practised are based on the decoction of plant organs. This form of preparation is widely adopted today, often in combination with various plants, allowing the obtained substance to be preserved for a longer period. However, its effectiveness also depends on the plant species used, the intended treatment, and the geographical or socio-linguistic context. Nevertheless, these results contradict the work of Emre *et al.* (2021) on *Rhus coriaria* L., *Quercus coccifera* L*., Pinus brutia* Mill.*,* and *Hypericum perforatum* L. in Turkey. For Emre *et al.* (2021), the medicinal plants are used for therapeutic purposes are used via the infusion technique (27.6%), followed by direct application (22.2% without any procedure of preparation), decoction (18.9%). On the other hand, in the work completed on medicinal plants in the North-Eastern Ethiopia, the triturated form is highly used (41.12 %) followed by powder (24.37%) (Assen *et al.* 2021). The variation in usage observed in their study may be attributed to the active compounds present in different plant parts, as well as the specific types of diseases being treated. The large number of forms of use identified explains the high level of knowledge of the species by the population, which implies an increased endogenous knowledge of the population in the treatment of diseases based on plants (Kassa *et al.* 2016).

Socio-linguistic groups variation and parts use of *Senna occidentalis*

The organs of the plants are a reservoir of active ingredients used in the treatment of various diseases but their uses also depend on the plant. The leaves of *S. occidentalis* are used more in treatments than the other organs and are in fact part of all the categories of use. This pattern is the case in the ethnobotanical studies carried out by Jiménez-Romero *et al.* (2019) in the Valencia Canton. According to these authors, 84.9 % of the listed medicinal plants are used by the population because of their leaves for medicinal preparations. Similar results were found in ethnobotanical studies conducted by Belgica *et al.* (2021) in the Philippines; in Northeastern Ethiopia by Assen *et al.* (2021) and Jadid *et al.* (2020) in Morocco. Overall, we found a similar use of parts of *S. occidentalis*, as have been found for 221 medicinal plants where most commonly used organs are leaves (21%), followed by fruits (21%), seeds (17%), whole plant (14%), root (9%), the bark (9%), flowers (7%) and gums (2%) (Hussain *et al.* 2020). Contrary to the results reported by Belgica *et al.* (2021), Assen *et al*. (2021), Jadid *et al.* (2020), Hussain *et al.* (2020) and Jiménez-Romero *et al.* (2019), the studies carried out in China on 456 medicinal plants gave different results, indicating that the leaves of these plants are not the most used (Hu *et al.* 2020). Their results showed that for all these species, the whole plant is used (182 species, 33.46%), followed by roots (73 species, 13.42%), stem (46 species, 8.46%), and the leaves are only used for 44 species, that is, an average of 8.09 % of the listed plants. These differences in the results obtained could therefore be due, on the one hand to the types of plants and, on the other hand to the active ingredients required in these plants. It can be seen that the use of the organs varies according to the socio-linguistic groups. Although the majority of the organs are used by the sociocultural groups, the ethnic groups Biali, Otamari, Lokpa, Nago and Peulh show some differences. These ethnic groups use more seeds than others. The seeds are often used in form of infusion and called senna coffee. These findings corroborate the results obtained by Koura *et al.* (2011). According to these authors, the use of the parts of *P. biglobosa* in Northern Benin varies from area to area and is strongly influenced by socio-linguistic groups.

Strategies for the management of *Senna occidentalis*

Sustainable management of *Senna occidentalis*, an exotic species, is crucial for balancing its ecological impact and the benefits it offers to local communities. While the species is classified as "Least Concern" on the IUCN Red List, indicating it is not at significant risk of extinction, overexploitation, particularly the harvesting of its roots for medicinal use, has led to its scarcity in certain regions of Benin. This highlights the need for strategic management to ensure the continued availability of the species without jeopardizing its sustainability. As noted by (Adomou *et al.* 2012) this plant is widely used in traditional medicine to treat various ailments, contributing to its decline in some areas. Despite its therapeutic value, *S. occidentalis* is considered an invasive species in certain regions. For instance, Fufa *et al.* (2017) identified *S. occidentalis* as an invasive species in Ethiopia, recommending its removal from agricultural fields. Similarly, Shabbir and Bajwa (2006) reported that *S. occidentalis* poses a threat to biodiversity, comparable to other invasive species like *Parthenium hysterophorus* L., *Malvastrum coromandelianum* (L.) Garcke, and *Lantana camara* L.

However, there is also evidence suggesting that *S. occidentalis* can play a beneficial role in agriculture. Fleet and Young (2000) proposed that cultivating this species could help combat crop pests, as it may act as a mutualistic host for certain protective ants that deter crop-damaging butterflies. Additionally, Kamel and Sakr (2009) highlighted its ability to absorb soil pollutants, thus reducing chemical contamination in agricultural fields (Lai *et al.* 2023). The complexities surrounding *S. occidentalis* — its potential invasiveness alongside its agricultural and medicinal benefits — necessitate a nuanced approach to its management. Strategies should focus on regulating its use, and monitoring its ecological impact. This could involve designing sustainable harvesting techniques, such as selective harvesting, and educating local communities on the importance of responsible use to avoid overexploitation. Moreover, integrating *S. occidentalis* into agroecological systems where its ecological roles, such as pest control and soil pollution mitigation, are maximized could ensure that the species contributes positively to agriculture while minimizing its environmental risks. Balancing its economic, medicinal, and ecological roles is key to its sustainable management in Benin.

Conclusion

This study evaluated the ethnobotanical knowledge and applications of *S. occidentalis* in Benin. Our findings indicate that *S. occidentalis* is well-known among the population and serves as a significant resource in medicinal preparations. The knowledge of *S. occidentalis* is diverse and influenced by social factors such as age, gender, and socio-linguistic group. Various forms of *S. occidentalis* are utilized in treatments; however, decoction is the most commonly used method. The preference for specific forms varies among socio-linguistic groups. All parts of the plant are employed in medicinal preparations for different treatments. The leaves are most commonly used among the *Fon*, *Bariba*, *Waama*, and *Lokpa* groups. *Senna occidentalis* is widely recognized as a valuable resource for human health. However, it is currently facing threats due to over-exploitation and is considered an invasive species in certain regions. To ensure its sustainable use and conservation, it is essential to implement strategies such as cultivating the plant in gardens. This approach can help manage and utilize the species without contributing to its decline, especially in the northern and urbanized areas of Benin where it has become scarce**.**

Declarations

List of abbreviations: GBIF – Global Biodiversity Information Facility; ID - Index of diversity of respondents; IE - Index of equality of the people interviewed; UD - Index of diversity of use; UE - Index of Equitability of Uses; CMU - Consensus value for the form of use; CPP - Consensus value for parts of plants used; CA - Correspondence Analysis.

Ethics approval and consent to participate: An Ethic statement was prior shared with respondent before gathering information for this research.

Consent for publication: Authors agreed upon the content and publication.

Availability of data and materials: The data included in this research will be made available upon reasonable request.

Competing interests: Authors declare no conflict of interest.

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Author contributions: C.F.S. collected the data, analyzed, and wrote the text. S.Z. participated in the theoretical background, monitoring data collection and analysis, helping with discussions, and wrote the final version of the text.

YW: Writing - Original Draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. RI: Writing – review & editing, Formal analysis, Conceptualization. EA: Methodology, Conceptualization. AD: Writing - Original Draft, Methodology.

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