



# Quantitative analysis of *Cola nitida* (Vent.) Schott & Endl., 1832 (Malvaceae) uses in southern Benin communities

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## Research

### Abstract

**Background:** *Cola nitida* (Vent.) Schott & Endl., 1832 is a highly valued multipurpose species in Benin, where it plays important socio-cultural, medicinal and economic roles. Despite its wide use, quantitative data on how local communities mobilise and prioritise, its various uses remain limited. The aim of this research was to assess the communities' endogenous knowledge of *C. nitida*.

**Methods:** In this research, an ethnobotanical survey was carried out among 203 people randomly selected from predefined stakeholder groups (herbalist, healers, dignitaries, Fa priests and users) in six municipalities in southern Benin. Data were collected through individual interviews from September to November 2021. The ethnic coverage rate (ECR), ethnobotanical use value (UV), diversity index (DI), and equitability index (EI) and were calculated to assess the knowledge and uses of *C. nitida* in the communities with Correspondence Analyses (CA) applied as a multivariate approach.

**Results:** The results show that the name *Gbanja* is the one most commonly used by local people to designate *C. nitida* (ECR = 75%) in southern Benin. The species is used for food (100%), cultural (95%), medicinal (83%), medicinal and magical (69%), magical and religious (65%), timber and service wood (19%) and firewood (12%) purposes. The ethnobotanical use value is higher for older people (UV = 11.29), people with an endogenous religion (UV = 10.11) and illiterate people (UV = 11.00). The diversity index (DI) varies widely within the socio-demographic profiles considered and the equitability value (EI) tends towards 1 whatever the socio-demographic profile, thus reflecting an equitable distribution of knowledge within the populations surveyed about the use of *C. nitida*.

**Conclusions:** It is therefore important to define policies to promote the species in order to limit the adverse effects of global change on its availability and ensure its sustainable use in communities.

**Keywords:** *Cola nitida*, quantitative ethnobotany, use value, local communities, Benin

## Background

The benefits derived from biodiversity by communities to meet their needs are diverse and vary between them due to the multiplicity of endogenous practices that constitute a source of knowledge. Indeed, populations in developing countries are heavily dependent on this natural heritage for their livelihoods and income (Dossou *et al.* 2012; Lougbégnon, 2015). According to Gueye *et al.* (2012), populations benefit from an immense diversity of biological resources that are useful and necessary for their survival. These include medicinal resources, food, timber and firewood, perch. Ethnobotanical knowledge is therefore important to communities because it enables them to meet their basic needs.

This dependence of communities is evident in the various uses of biological resources to solve their daily problems, particularly in terms of food, health and others. The contribution of these resources to food security and basic healthcare is well established, as nearly 80% of the population in developing countries use them for healthcare or sustenance (de Wet *et al.* 2010; Gueye *et al.* 2012). Indeed, several studies carried out in different regions have shown that sociolinguistic groups have extensive knowledge of the endogenous use of plants (Pathak *et al.* 2011; Singh and Singh, 2012). This knowledge and use of plant resources range from herbaceous plants to various parts of woody plants (Ezebilo, 2010; Gouwakinnou *et al.* 2011; Akpi *et al.* 2019; Sobakin *et al.* 2022).

Over the past decades, ethnobotanical research in Benin has increasingly focused on documenting local knowledge systems related to the use of indigenous plant species, particularly in the context of food security, traditional medicine, cultural practices and income generation (Gouwakinnou *et al.* 2011; Lougbégnon *et al.* 2015; Wédjangnon *et al.* 2016; Ajavon *et al.* 2020, Ndiaye *et al.* 2022). These studies, often based on quantitative ethnobotanical approaches, have highlighted the central role of plant resources in rural livelihood and the importance of analysing the distribution and intensity of knowledge across sociocultural groups. Such approaches have been applied to several multipurpose species in southern Benin, allowing the identification of priority uses, levels of consensus and patterns of knowledge transmission within communities (Assogbadjo *et al.* 2009; Akouèhou *et al.* 2014; Amouzoun *et al.* 2019). These works have significantly contributed to conservation and valorisation strategies by providing robust quantitative indicators of species importance.

Several ethnobotanical studies have already addressed *C. nitida* in Benin, highlighting its sociocultural, medical and economic importance (Lawin *et al.* 2015; Dassou *et al.* 2015; Gbesso *et al.* 2017). For instance, Dah-Nouvlessounon *et al.* (2015) documented indigenous knowledge and socio-economic values of Cola species while Savi *et al.* (2018) analysed the synergy between traditional uses and population structure for sustainability purposes. More recently, Tokannou *et al.* (2024) examined the cultural and socio-economic drivers of conservation and cultivation while Kpatinnon *et al.* (2023) focused on identifying the suitable habitats of the species under climate change scenarios. These studies provide valuable insights into specific dimension of *C. nitida* use and management.

However, most of these work focus on particular such as conservation strategies, population structure, cultivation drivers or selected use categories. To date, a comprehensive quantitative ethnobotanical assessment that simultaneously analyses the diversity of uses, the relative importance of each use, the level of consensus and the distribution of knowledge across multiple sociocultural groups in Benin remains limited on *C. nitida*. Therefore, the present study seeks to complement existing research by assessing the endogenous knowledge of local populations through an integrated quantitative ethnobotanical approach.

## Materials and Methods

### Study area

Southern Benin (Figure 1), particularly the Guinea-Congo zone (GC), stretches from the coast to the latitude of Djidja municipality. The climate in this zone is characterised by four seasons (two dry and two rainy seasons). The average annual rainfall is around 1000-1300 mm, while average annual temperatures range from 26°C to 28°C. The annual temperature range is between 5°C and 10°C (Yabi *et al.* 2017). This region is closely linked to the 'Dahomey Gap' phenomenon, an interruption in the forest belt that was supposed to connect the forest blocks of Central and West Africa (Neuenschwander *et al.* 2011). As a species of hot and humid ecosystems (Kpatinnon *et al.* 2023), this climatic variation means that *C. nitida* is found in southern and part of central Benin. Furthermore, Benin's population is constantly growing, and the fourth population census identified 10 ethnic groups belonging to various religious groups (INStAD, 2016). The existence of this diversity of sociolinguistic groups and religious denominations promotes a plurality of endogenous knowledge on the use of biological resources, particularly *C. nitida*.

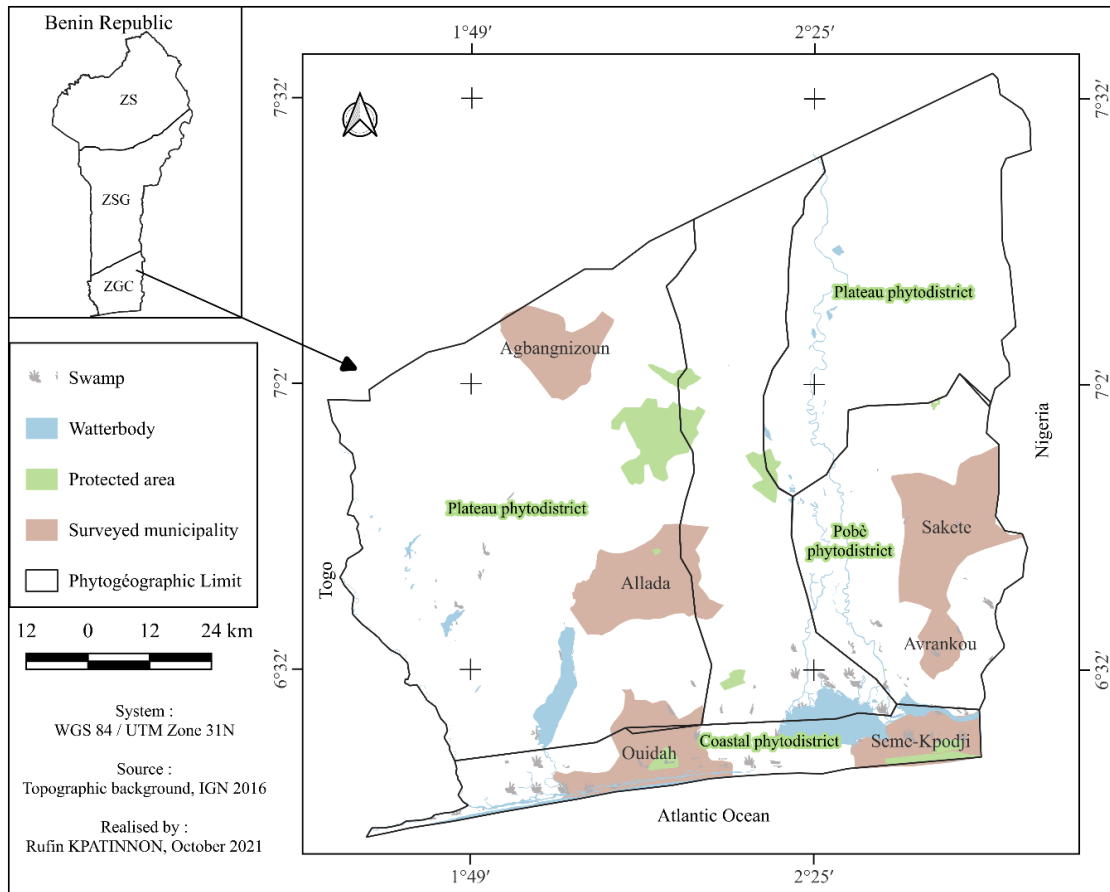


Figure 1. Geographical location of the research area

#### Data collection

Data was mainly collected in southern Benin using simple random sampling, specifically in municipalities where the species is abundant based on occurrence data available on the GBIF database. Accordingly, the survey was conducted in six municipalities namely Ouidah and Sèmè-Podji in the Coastal phytodistrict, Sakété and Avrankou in the Pobe phytodistrict, and Agbangnizoun and Allada in the Plateau phytodistrict. The sample size was determined using a normal approximation of the binomial distribution (Dagnelie, 1998).

$$n = U^2_{1-\alpha/2} * P(1 - P) / d^2$$

With  $U_{1-\alpha/2} = 1.96$ : the value of the normal random distribution with a probability of  $1-\alpha/2$  (0.975);  $p = 0.5$ : is the proportion of the population using *C. nitida*, estimated at 50% (Asseh *et al.* 2019) and  $d = 3\%$ : margin of error (Houetchegnon, 2016). Overall, 203 people were surveyed including market herbalists, users of *C. nitida* organs, traditional healers, community dignitaries and Fa priests (traditional diviners and custodians of the Fa divination system in Benin). These actors (healers, herbalists, dignitaries and Fa priests) were identified using the snowball technique while users were systematically surveyed through contact established with herbalists. Table 1 presents the distribution of this sample across the selected municipalities.

Table 1: Sample distribution across the selected municipalities

Selected municipalities	Sample
Agbangnizoun	18
Allada	32
Avrankou	26
Ouidah	41
Sakété	29
Sèmè-Podji	57
<b>Total</b>	<b>203</b>

Data collection mainly involved the use of an ethnobotanical questionnaire. Data were collected through individual interviews in the local language or in French with the selected stakeholders via KoboCollect. Main topics related to local names of the species, uses and importance, probable existence of myths/prohibition.

### Data Analysis

The statistical analysis combined descriptive and inferential approaches to examine the sociocultural determinants of ethnobotanical knowledge. The data collected were exported from the KoBoToolbox platform and analysed using R 4.0 software. Several parameters were calculated (ethnic coverage rate, relative frequency of citation, diversity index, equitability Index and consensual value of usage types). Correspondence Analysis (CA) was used to explore the associations between ethnics and vernacular names as well as between ethnics and uses categories. The interpretation of the factorial axes was based on inertia values, contribution and squared cosines ( $\cos^2$ ) of the modalities allowing the identification of ethnolinguistic and usage patterns (Table 2).

Table 2: Calculated ethnobotanical parameters

Calculated indices	Methods	Interpretations	Sources
<b>Ethnic coverage rate</b> $ECR = (N * 100) / Nte$	<b>ECR</b> = Ethnic coverage rate; <b>N</b> : number of ethnic groups using a given name to locally refer to <i>C. nitida</i> and <b>Nte</b> : the total number of ethnic groups surveyed.	To understand the extent of use of a local name within ethnic groups	(Adomou <i>et al.</i> 2018)
<b>Relative frequency of citation</b> $RFC = Fc * 100 / N$	<b>RFC</b> = Relative frequency of citation; <b>Fc</b> = number of respondents who mentioned a category and <b>N</b> = total number of respondents	To determine the proportions of the areas of use cited by the respondents	(Dossou <i>et al.</i> 2012)
<b>Total use value</b> $UV = \frac{\sum_{i=1}^n si}{n}$	<b>UV</b> = total use value of the species for a profile; <b>si</b> = use score assigned by respondents; <b>n</b> = number of respondents for the profile.	To meaningfully determine the importance of species, use according to sociodemographic profiles	(Lykke <i>et al.</i> 2004)
<b>Diversity Index</b> $DI = - \sum_{i=1}^x pi \log_2 pi$ $DI \in [0 ; n]$	<b>DI</b> = Diversity index; <b>ni</b> = number of use categories cited by an interviewee and <b>n</b> = total number of use categories cited by all respondents for the species.	To measure the diversity of species, use categories within the socio-demographic profiles of the respondents	(Byg and Baslev, 2011)
<b>Equitability Index (EI)</b> $EI = DI / DI_{max}$ $EI \in [0 ; 1]$	<b>EI</b> = Fairness index; <b>DI</b> = Diversity Index; <b>DI<sub>max</sub></b> = Maximum Diversity Index	Measures the degree of homogeneity of respondents' knowledge. <b>EI &lt; 0.5</b> ; non-homogeneous diversity of knowledge	(Byg and Baslev, 2011)
<b>Consensual value of usage types (Cv)</b> $Cv = (2ni/n) - 1$ $Cv \in [-1 ; 1]$	<b>ni</b> : number of people using <i>C. nitida</i> in a given use category and <b>n</b> : number of respondents in this category. If <b>ni = 0</b> => <b>Cv = -1</b> and if <b>ni = n</b> => <b>Cv = 1</b> .	To measure the degree of agreement between respondents with regard to the uses made of the species in socio-demographic profiles	(Monteiro <i>et al.</i> 2006)

## Results

### Diversity of local names of *C. nitida* in southern Benin communities

Field surveys revealed the use of five local names (**golo**, **obi gbanja**, **godo**, **gbanja** and **bissi**) to refer to the species by sociolinguistic groups in southern Benin. The name **gbanja**, with a coverage rate of 75%, is widely used by the Fon, Goun, Nago, Tori Défi (an ethnolinguistic group from southern Benin), and many others to refer to *C. nitida*. It is followed by **golo**, with a coverage rate of 50%. The name **bissi** (33%) remains the preserve of worshipers of the deity Thron, but is gradually becoming more widespread in communities. The names **godo** and **obi gbanja** (17% each) are rarely used (Table 3).

The correspondence analysis (CA) revealed clear associations between ethnic groups and the vernacular names of *C. nitida*. The first two dimensions explain 76.20% of the total inertia, indicating a strong representation of the relationships. This figure shows that the **godo** is used specifically by the Xwéda and Adja communities. In contrast, the name **gbanja** is shared by several ethnic groups (Nago, Défi, Sèto, Xwla, Goun and Tori), probably reflecting ancient linguistic contacts, cultural

exchanges or the widespread circulation of ethnobotanical knowledge. Furthermore, **obi gbanja** appears to be the preferred name among the Yoruba, while **golo** and **bissi** are mainly used by the Fon, Wémè and Aïzo. These results highlight the simultaneous existence of regional linguistic continuities and cultural specificities in the vernacular nomenclature of the species studied (Figure 2).

Table 3. Ethnic coverage rate (ECR) of *Cola nitida* in southern Benin

Local name	Sociolinguistic groups	N	Nte	ECR en %
<b>gbanja</b>	Défi, Fon, Goun, Nago, Sèto, Tori, Wémè, Xwla et Yoruba	09		75
<b>golo</b>	Aïzo, Fon, Goun, Tori, Wémè et Xwla	06		50
<b>bissi</b>	Aïzo, Fon, Goun et Xwéda	04	12	33
<b>godo</b>	Adja et Xwéda	02		17
<b>obi gbanja</b>	Nago et Yoruba	02		17

**Legend:** N: number of ethnic groups using a vernacular name to locally refer to *C. nitida*; Nte: the total number of ethnic groups surveyed and ECR =Ethnic coverage rate (percentage)

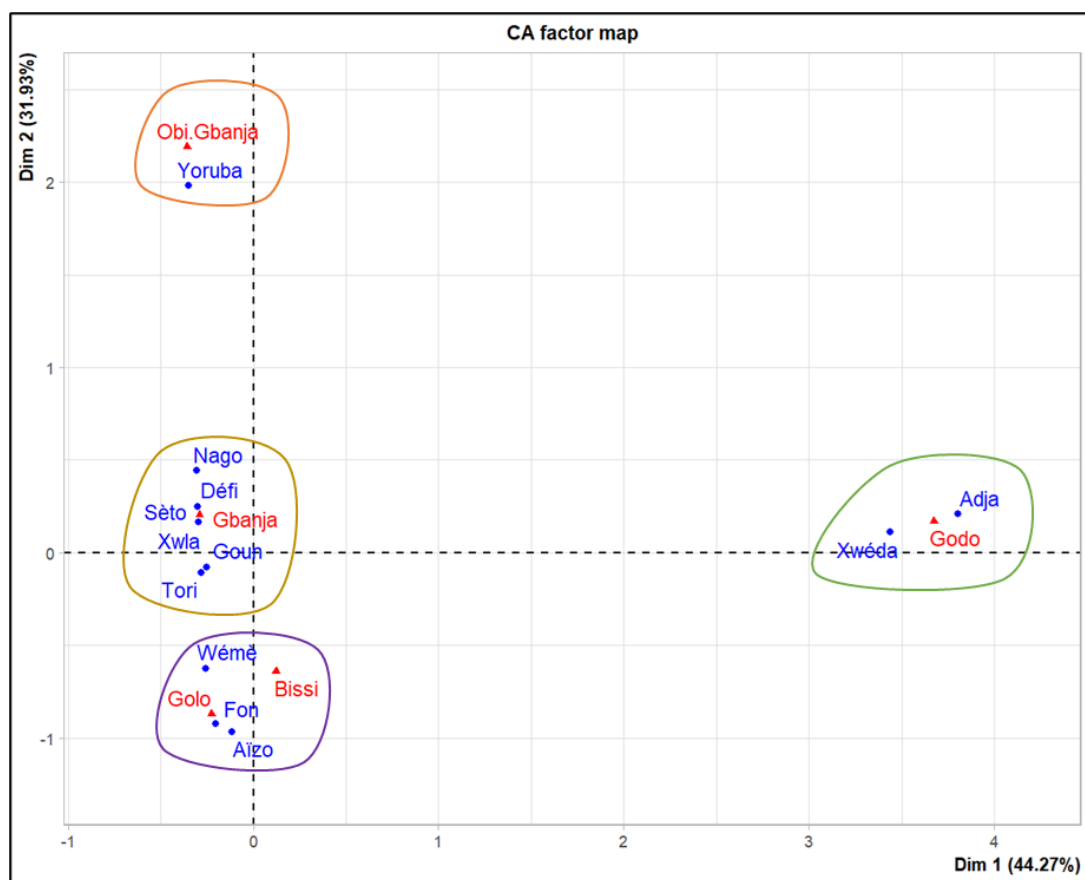


Figure 2. Correspondence analysis (CA) of the relationship between ethnic groups and vernacular names of *C. nitida*

#### Uses of *Cola nitida* in southern Benin

The species *C. nitida* is used for various purposes by communities in Benin. Ethnobotanical surveys have identified seven (07) different use categories for *C. nitida* by communities in southern Benin. Analyses reveal that *C. nitida* is widely used for food (100%) by local populations. The seeds of *C. nitida* are the only parts of the plant that are directly consumed and the only ones used for cultural purposes (95%). In addition, *C. nitida* is widely used for medicinal (83%), medico-magical (69%), magical and religious (65%) purposes. However, it is less commonly used as timber and service wood (19%) and firewood (12%). Furthermore, certain parts of *C. nitida*, notably the seeds, leaves, bark and roots, have commercial value, recognised by all respondents. Indeed, as trade involves buying and selling, it remains the preserve of herbalists who purchase the parts of *C. nitida* for selling them to dignitaries, healers, Fa priests (Figure 3).

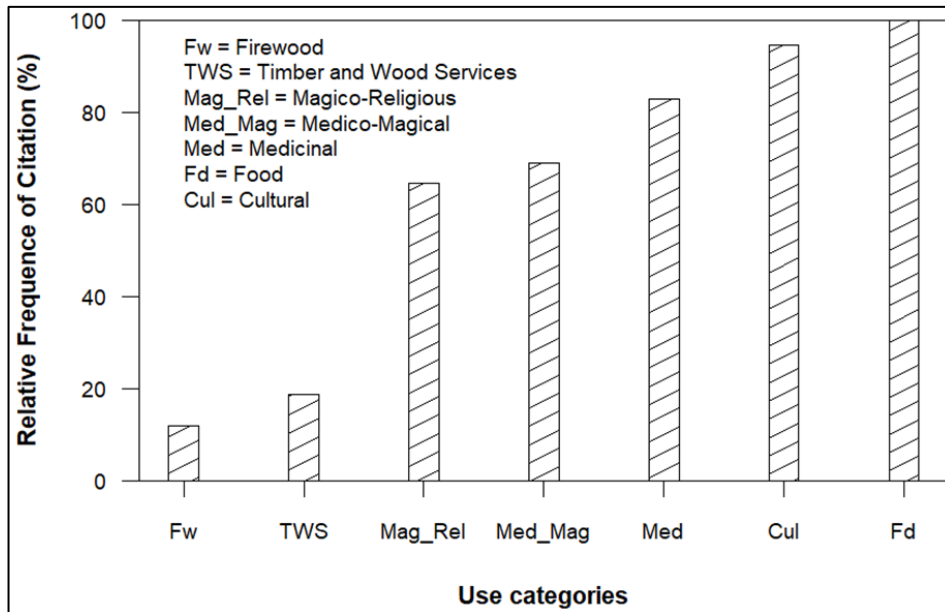


Figure 3. Use categories of *C. nitida* in southern Benin

The correspondence analysis (CA) applied to the uses categories of *C. nitida* according the ethnic groups reveals differentiated associations. The first two dimensions explain 71.93% of the total inertia, reflecting a good representation of the relationship between variables. Axis 1 (42.65) mainly contrasts the uses of timber and wood services associated in particular with the Wémè and Adja groups with uses related to firewood, which appear to be more specific to certain groups (Sèto and Nago). These uses (firewood, timber and wood service) are therefore not universal. The axis 2 (29.28) highlights associations between cultural and magical-religious uses and the Yoruba, Aizo, Défi and Xwéda groups. The areas of use located near the origine are shared by several ethnic groups, suggesting a wide dissemination of ethnobotanical knowledge within the study area (Figure 4).

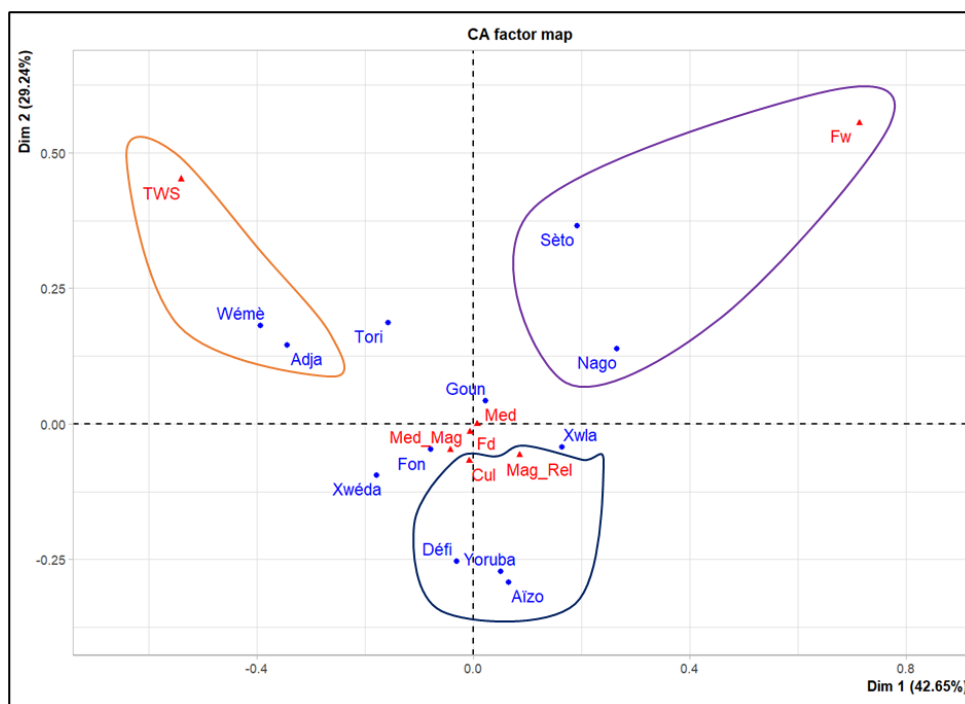


Figure 4. Correspondence analysis between ethnic groups and use categories of *C. nitida*  
 Legend: Fw = firewood; TWS = timber and wood services; Mag\_Rel = magical-religious; Med\_Mag = medicinal-magical; Med = medicinal; Fd = food; Cul = cultural

In traditional communities, the magico-religious uses of *C. nitida* are expressed through the offering of its seeds to the deity "Thron" accompanied by prayers and ritual practices (Photo 1.1). The deity "Thron" is intrinsically associated with *C. nitida* as the species is believed to possess supernatural protective powers that constitute the spiritual foundation of this divinity. Furthermore, Photo 1.2 illustrates the use of *C. nitida* seeds during traditional wedding ceremonies, where they are offered as part of bridewealth ritual and symbolize the alliance between the two families, encompassing both the living members and their ancestors. Beyond these contexts, *C. nitida* seeds are also used during child-naming or presentation ceremonies, to welcome guests or spiritual entities and as part of prayer practices within traditional religious systems (Figure 5).

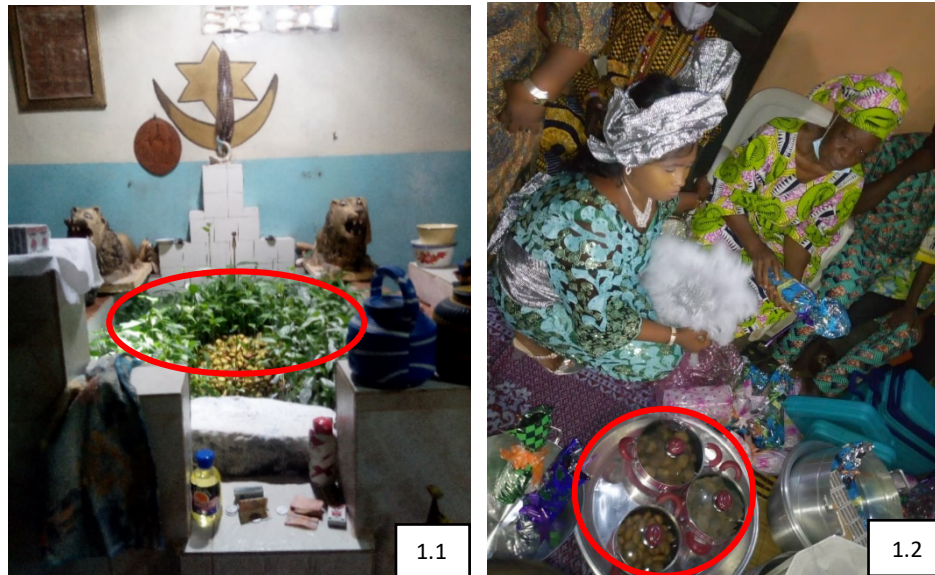


Figure 5. Magical, religious and cultural uses of *C. nitida* in Allada. Photography: Kpatinnon, October 2021.

Analysis of the associations between sociodemographic variables and categories of use (table 4) reveals a significant structuring of ethnobotanical knowledge according to sociocultural determinants. Ethnicity emerges as the most discriminating factor, influencing six of the seven categories of use ( $p < 0.05$ ). Although food use is universally recognised by all respondents, it shows significant associations with several factors, not because of a difference in the presence of use, but because of a variation in the frequency of citations between groups. This variability reflects cultural and social differences in the use of the species. Medicinal practices show cross-sectional associations with gender, ethnicity, age, religion and level of education, reflecting a homogeneous dissemination of ethnomedical knowledge. These results highlight the deep cultural roots of local botanical knowledge and its differential transmission across social groups (Table 4).

Table 4. Statistical Significance (Chi-Square Tests) of sociodemographic factors on *C. nitida* use categories

Use Category	Sex	Ethnicity	Age	Religion	Level of education
Food	< 0.001***	< 0.001***	< 0.001***	< 0.001***	< 0.001***
Firewood	0.953	0.010*	0.701	0.981	0.031*
Timber and Wood Services	0.109	0.006**	0.127	0.245	0.117
Cultural	0.747	< 0.001***	0.604	0.113	0.795
Magico-Religious	0.152	0.008**	0.393	0.561	0.528
Medicinal	0.004**	0.256	0.127	0.975	0.075
Medico-Magical	0.016*	0.001**	0.081	0.004**	0.377

Reported p-values are from chi-square tests. Significance levels: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Degrees of freedom (ddl): Sex (1), Ethnicity (11), Age (2), Religion (3), Level of education (4).

#### Ethnobotanical use values of *Cola nitida*

The populations surveyed attach varying degrees of importance to the use of *C. nitida*. The figure 4 below reveals a wide variation in usage value between the socio-demographic profiles considered. Indeed, *C. nitida* is used more by men than women because of its aphrodisiac properties. Depending on ethnicity, the Tori (UV = 07.36) and Défi (UV = 08.33) place less importance on the use of *C. nitida* than the Goun (UV = 09.96), Nago (UV = 10.60), Yoruba (UV = 10.81) and Fon (UV = 10.86) ethnic groups. The species is used more by older people (> 60 years) than by young and adults to treat cases of hypotension.

Furthermore, divorced people (UV = 10.22) and widowed people (UV = 10.08) use the species more than engaged people (UV = 09.32) to attract good luck or protection, depending on the circumstances. The same applies to religious affiliation where, people of endogenous belief place more value (UV = 11.11) on the use of *C. nitida* than Christians (UV = 08.60). In terms of educational attainment, people with primary education use the species less (UV = 09.18), unlike illiterate people (UV = 11.00). In view of these different values, it appears that older people with endogenous beliefs and no schooling attach greater importance to the use of *C. nitida* (Figure 6).

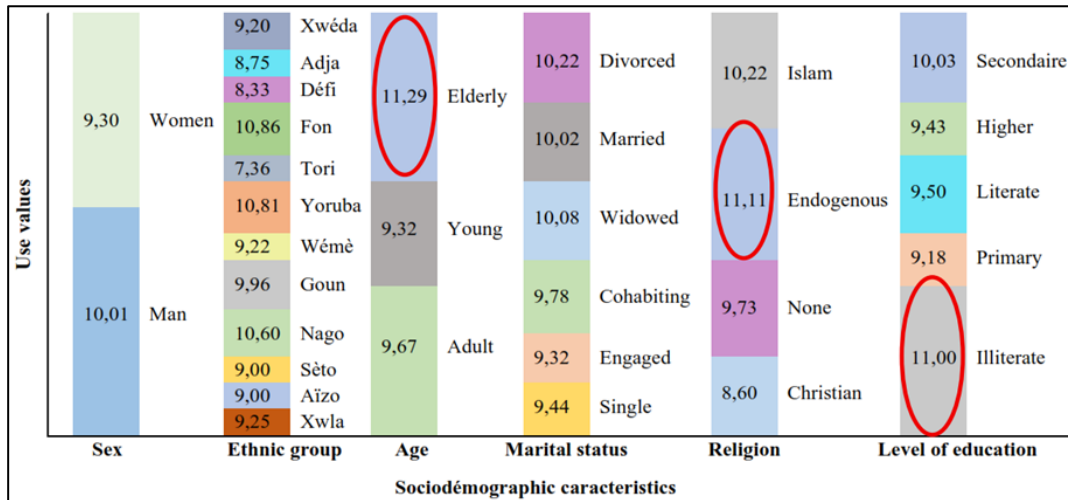


Figure 6. Variation in the ethnobotanical use value of *C. nitida* according to sociodemographic profiles. Legend: Young = (< 30 years old), Adult = (30 - 60 years old) and Elderly = (> 60 years old)

**Diversity and equitability in the uses of *C. nitida***

Knowledge about the use of *C. nitida* in different categories of use is assessed quantitatively using diversity indices (DI in bits) and equitability indices (EI) according to socio-demographic characteristics. Table 5 shows that the diversity index (DI) varies according to profile. Considering ethnicity, low diversity is observed among the Seto (DI = 1.44 bits), Aïzo (DI = 1.58 bits) and Défi (DI = 1.58 bits), unlike the Goun (DI = 5.23 bits) and Fon (DI = 5.59 bits), which have high values. These values indicate that the Seto and Aïzo use fewer species in each category than the Fon and Goun. Furthermore, the equitability index (EI) value tends towards 1 regardless of the socio-demographic profile considered. The minimum value is obtained among the Goun (EI = 0.931) and the Sèto (EI = 0.937), and the maximum value among the Xwla (EI = 0.996) and the Xwéda (EI = 0.997). As all these values are > 0.5, there appears to be an equitable distribution of knowledge among the populations surveyed on the use of *C. nitida* in the categories of use (Table 5).

Table 5. Diversity and equitability in the uses of *C. nitida*

	DI (bits)	EI
<b>Sex</b>		
Male	7,16	0,994
Female	5,78	0,995
<b>Ethnic group</b>		
Adja	1,95	0,98
Aïzo	1,58	0,995
Défi	1,58	0,995
Fon	5,59	0,995
Goun	5,33	0,949
Nago	4,59	0,988
Sèto	1,44	0,906
Tori	3,40	0,982
Wémè	3,15	0,995
Xwéda	3,31	0,997
Xwla	3,98	0,995
Yoruba	4,36	0,993
<b>Age</b>		
(< 30 ans)	5,19	0,990
(30 - 60 ans)	6,63	0,994
(> 60 ans)	5,95	0,995
<b>Marital status</b>		
Single	4,70	0,989
Cohabiting	6,01	0,988
Divorced	3,13	0,987
Engaged	4,21	0,991
Married	5,78	0,995
Widowed	4,55	0,992
<b>Religion</b>		
None	3,88	0,993
Christian	5,90	0,992
Endogenous	6,44	0,995
Islam	5,15	0,989
<b>Level of education</b>		
Literate	3,77	0,990
Illiterate	5,01	0,994
Primary	5,74	0,993
Secondaire	6,25	0,994
Higher	4,47	0,989

**Consensus values for the use of *Cola nitida***

Investigations carried out among stakeholders revealed their degree of consensus on the different categories of uses of *C. nitida*. Table 6 reveals broad consensus among respondents on the medicinal, cultural and, above all, dietary uses of *C. nitida* in Beninese communities. Magical-religious and medicinal-magical uses obtain relatively average levels of consensus, unlike uses as firewood, timber and service wood, which have low levels of consensus according to various socio-demographic characteristics. This shows that the majority of respondents use *C. nitida* very little as firewood, timber and service wood (Table 6)

Table 6. Consensus degree among respondents on the use categories of *C. nitida*

Profils	Use categories						
	Fw	TWS	Mag-Rel	Med-Mag	Med	Cul	Fd
<b>Sex</b>							
Male	-0.76	-0.56	0.22	0.48	0.76	0.90	1
Female	-0.79	-0.79	0.46	0.11	0.39	0.86	1
<b>Ethnic group</b>							
Adja	-1	0	0	0	1	1	1
Aïzo	-1	-1	1	0.33	0.33	1	1
Défi	-1	-1	-0.33	1	1	1	1
Fon	-0.88	-0.55	0.47	0.63	0.51	1	1
Goun	-0.71	-0.63	0.06	0.10	0.67	0.92	1
Nago	-0.28	-0.76	0.52	0.68	0.68	0.84	1
Sèto	-0.33	-0.33	1	-1	1	0.33	1
Tori	-0.82	-0.45	-0.45	-0.09	0.27	0.09	1
Wémè	-1	0.33	0.56	0.78	0.78	1	1
Xwéda	-1	-0.60	-0.40	1	1	1	1
Xwla	-0.63	-0.88	0.50	0.38	1	1	1
Yoruba	-1	-1	0.52	0.05	0.52	0.90	1
<b>Age</b>							
(< 30 ans)	-0.68	-0.68	0.11	0.37	0.79	0.84	1
(30 - 60 ans)	-0.78	-0.71	0.31	0.25	0.55	0.92	1
(> 60 ans)	-0.78	-0.46	0.37	0.59	0.75	0.87	1
<b>Marital status</b>							
Single	-0.78	-0.78	0.04	0.63	0.63	0.78	1
Cohabiting	-0.74	-0.62	0.32	0.50	0.53	0.85	1
Divorced	-1	-0.33	-0.11	1	0.78	0.78	1
Engaged	-0.79	-0.79	0.26	0.05	0.58	1	1
Married	-0.75	-0.61	0.36	0.14	0.79	1	1
Widowed	-0.75	-0.50	0.50	0.33	0.75	0.83	1
<b>Religion</b>							
None	-0.73	-0.60	0.07	0.73	0.60	0.87	1
Christian	-0.77	-0.74	0.26	0.06	0.68	0.81	1
Endogenous	-0.78	-0.51	0.28	0.57	0.66	0.98	1
Islam	-0.73	-0.73	0.46	0.30	0.62	0.84	1
<b>Level of education</b>							
Literate	-1	-0.29	0.14	0.57	0.71	0.86	1
Illiterate	-0.52	-0.82	0.39	0.45	0.76	0.94	1
Primary	-0.85	-0.71	0.24	0.35	0.45	0.85	1
Secondaire	-0.82	-0.62	0.38	0.44	0.79	0.92	1
Higher	-0.57	-0.39	0.04	0.04	0.48	0.83	1

**Legend:** Fw = Firewood; TWS = Timber and wood service; Mag-Rel = Magical-Religious; Med-Mag = Medical-Magical; Med = Medicinal; Cul = Cultural; Fd = Food

## Discussion

### Local taxonomy of *Cola nitida* in Beninese communities

Ethnobotanical surveys show that the species *C. nitida* is known by various names in the communities surveyed in Benin. Indeed, **gbanja**, **golo**, **bissi**, **godo** and **obi gbanja** are among the local names used by the population to refer to *C. nitida*. This diversity of vernacular names reflects a rich local taxonomy, which is commonly observed in ethnobotanical studies and often mirrors the cultural, symbolic and functional importance of plant species within communities (Byg and Baslev 2011; Albuquerque *et al.* 2014). The name **gbanja** is the most popular for the species and refers to its two cotyledons (slices). Such morphology-based naming has been widely documented in West Africa ethnobotany, where visible plant traits constitute a primary criterion for folk classification systems (Assogbadjo *et al.* 2008; Sop *et al.* 2012).

On the other hand, the name **golo** alludes to its spiritual protective properties (against spells, witchcraft). **Golo** means "protection" among the Fon sociolinguistic groups. This symbolic association between vernacular nomenclature and spiritual protection is consistent with observations made for other culturally important species in southern Benin, where names encode ritual or metaphysical functions attributed to plant (Loughbégnon *et al.* 2019; Gbesso *et al.* 2021). The name **bissi** is used by initiates of the deity Thron (worship) and comes from *Bismilahi*, which means "In the name of Allah (God)". The god referred to by these worshippers in this statement (*Bismilahi*) is the deity Thron, which is based on the species *Cola nitida*, as the species is believed to embody protective spiritual properties within this religious system. This result highlights the syncretic nature of religious practices in Benin, where Islamic expression, traditional beliefs and local deities coexist and are expressed through plant symbolism, as previously reported in ethnobotanical and anthropological studies (Dah-Nouvlessounon *et al.* 2015; Savi *et al.* 2018).

In recent works, the names **gbanja** and **golo** have already been identified by Dah-Nouvlessounon *et al.* (2015) to refer to *C. nitida* in Benin. In Guinea Conakry, *C. nitida* is referred to by vernacular names **goro**, **ouro** and **kollo** (Carrière, 2000), whereas in Burkina Faso, the species is locally known as **woro** (Zerbo *et al.* 2011). More recent studies conducted in Ivory Coast and Ghana also report similar names such as Goro and Kola, indicating a share cultural heritage and historical diffusion of knowledge related to Kola nuts across West Africa (N'Guessan *et al.* 2018; Amon-Armah *et al.* 2022). Thus, in local communities, the vernacular names of species are often tied to social representations, spiritual and medicinal properties, morphology, flavour, phylogeny, habitat. This observation aligns with broader ethnobotanical theory which recognizes vernacular nomenclature as a key entry point for understanding how societies conceptualise biodiversity and attribute value to plant resources (Albuquerque *et al.* 2014; Otieno *et al.* 2015; Addi *et al.* 2022;). It is therefore common for different local names to refer to the same species or for different species to have the same vernacular name.

### Forms of use of *Cola nitida*

The present study shows that *C. nitida* is widely used by local communities, with food use being the most frequently cited category. This predominance of food use highlights the importance of *C. nitida* as a daily stimulant and social commodity within local livelihood rather than merely a medicinal or ritual plant as observed for many culturally significant species in West Africa (Assogbadjo *et al.* 2008; Gbesso *et al.* 2021). This result is consistent with previous ethnobotanical studies conducted in southern Benin and neighbouring countries, which have highlighted the central role of *C. nitida* seeds in daily consumption and social interaction (Dah-Nouvlessounon *et al.* 2015; Savi *et al.* 2018).

The preference for food use is mainly related to the caffeine content of the seeds, which are commonly consumed for their stimulating effects and their perceived ability to enhance alertness and digestion. Several recent studies confirm that kola nuts are primarily valued for their psycho-stimulant properties particularly among farmers traders and elders who use them to reduce fatigue, suppress hunger and maintain concentration during prolonged activities (N'Guessan *et al.* 2018; Amon-Armah *et al.* 2022). Similar dominance of food use for *C. nitida* has also been reported in West Africa communities, where the species plays an important role in both nutritional practices and socio-cultural exchanges (Carrière, 2000; Zerbo *et al.* 2011). More recent research emphasizes that kola nuts function as "social foods", commonly exchanged during ceremonies, negotiations and hospitality rituals thereby reinforcing social cohesion and symbolic communication across ethnic groups (Nnyagu and Igwedibia, 2023; Rafiu *et al.* 2025).

However, respondents in the present study also emphasized that excessive consumption of the seed may induce undesirable effects such as increased blood pressure or nervous agitation, indicting a nuanced local perception of both the benefits and limitation associated with its use. This awareness of potential adverse effects reflects an empirical knowledge of dosage and moderation frequently documented in ethnobotanical studies where stimulant plants are involved (Albuquerque *et al.* 2014;

Savi *et al.* 2018). Such perceptions are consistent with pharmacological evidence linking high caffeine intake to cardiovascular and neurological effects (Umoren *et al.* 2009; Salahdeen *et al.* 2014).

Nevertheless, respondents report that dogs do not consume the seeds, as this could lead to death or rabies. Although rabies is not directly associated with plant toxicity this belief likely reflects local ethno-veterinary knowledge and symbolic interpretations of toxicity which often attribute strong plants with protective or dangerous properties to animals (Ndou *et al.* 2023; Oda *et al.* 2024). Similar beliefs regarding the toxicity of stimulant plant to animals have been reported elsewhere in Africa and contribute to the cultural regulation of plant use (McGaw *et al.* 2008; Anywar *et al.* 2026).

#### **Ethnobotanical importance of *Cola nitida* in southern Benin communities**

Respondents do not attach the same importance to the use of *C. nitida* across their socio-demographic characteristics. This differentiation highlights that ethnobotanical importance is not homogeneous within communities but is strongly influenced by age, belief system and educational background as commonly reported in ethnobotanical research (Byg and Baslev 2011; Sop *et al.* 2012). This research highlights that older people with endogenous beliefs and no formal education are those who attach great importance to the use of *C. nitida*. Such patterns suggest that traditional knowledge related to culturally important species is mainly held by elder who serve as custodian of ancestral practices and beliefs (Agize *et al.* 2016). Comparable trends have been observed for other multipurpose species in West Africa where ethnic affiliation and worldview significantly shape the perceived importance and diversity of uses of plant resources (Sop *et al.* 2012). These present results align with these studies confirming that ethnobotanical importance is a socially constructed attribute that reflects cultural identity, belief systems and lived experience rather than mere availability or frequency of use (Quiroz and van Ande, 2018; Diop *et al.* 2021).

Overall, the high ethnobotanical importance of *C. nitida* by specific socio-cultural groups underscores its role as a keystone species within local knowledge system, combining food, medicinal, magical-religious and symbolic functions. Such species are often resilient to cultural erosion, as their importance is deeply embedded in social practices and belief structures (Coe and Gaoue, 2020).

#### **Diversity of knowledge about *Cola nitida* within communities**

The uses of *C. nitida* in different areas vary according to the socio-demographic profiles of respondents (Byg and Baslev, 2011), with the exception of its use in food, and knowledge is consistent across these areas. This relative homogeneity of food-related knowledge suggests that alimentary uses are socially shared and widely transmitted within communities, regardless of age, gender or belief system, as commonly observed for staple or stimulant plant of high cultural relevance (Salako *et al.* 2018; Akakpo and Achigan-Dako, 2019). Thus, ethnobotanical knowledge constitutes socio-cultural realities that are intrinsic to peoples and may vary between them. This variability reflects the dynamic integration between cultural identity, spiritual beliefs, livelihood strategies and historical transmission pathways, which collectively shape how plant knowledge is acquired, conserved or transformed over time (Rafiu *et al.* 2025; Diop, 2021). It therefore appears that *C. nitida* is a species with strong magical-religious, medicinal-magical, medicinal, cultural and food values. This coexistence of multiple use categories within the same species highlights its multifunctional role and explains the high level of shared knowledge observed among communities, positioning *C. nitida* as a culturally resilient species within local ethnobotanical system (Coe and Gaoue, 2020; Rafiu *et al.* 2025).

#### **Research limit**

The ethnobotanical surveys conducted in this research covered only southern Benin, given the resources and time available. This geographical limitation may have influenced the diversity of knowledge recorded as ethnobotanical practices and cultural perceptions of plant species are known to vary along ecological and socio-cultural gradients (Powell *et al.* 2014; Tamene *et al.* 2023). Although *C. nitida* is a species native to the Guineo-Congolese zone, it is widely used by all communities for socio-cultural purposes. However, the intensity of use, symbolic meaning and relative importance attributed to the species may differ between southern, central and northern region of Benin, as reported for other culturally important species in the country (Avohou *et al.* 2012; Salako *et al.* 2018; Ahamidé *et al.* 2020). It would therefore be beneficial to visit communities in central and northern Benin to gather their knowledge of the species. Similarly, the number of municipalities from which ethnobotanical data is collected could be increased to two per phytodistrict. Expanding the geographical scope would allow a more comprehensive assessment of intra-cultural and inter-cultural variability in the use and representations of *C. nitida* thereby strengthening the external validity of the findings. These approaches could enrich the data collection process. Despite these limitations, the present study provides a robust baseline for understanding the ethnobotanical significance of *C. nitida* in southern Benin and offers a valuable reference for future comparative and large-scale studies.

## Conclusion

This research revealed the endogenous knowledge of communities in southern Benin regarding the use of *C. nitida*. Surveys indicate that **gbanja** and **golo** are the most commonly used local names for *C. nitida*. In the communities surveyed, *C. nitida* is used in seven areas. In fact, food is the use most cited by respondents because of its caffeine content, a stimulant of the nervous system. The calculated indices indicate an equitable distribution of knowledge among populations and a broad consensus on medicinal, cultural and above all, food uses, highlighting the central role of *C. nitida* in daily life and socio-cultural practices. Beyond these descriptive results, this study demonstrates that the uses and perceptions of *C. nitida* are strongly structured by socio-cultural determinants, particularly ethnicity, age, belief system and education level. The correspondence analyses further revealed clear associations between ethnic groups, vernacular names and use categories, illustrating both regional linguistic continuities and culturally specific knowledge systems. These findings confirm that *C. nitida* functions as a multifunctional and culturally resilient species, integrating food, medicinal, magical-religious and symbolic roles within local knowledge systems.

For the local communities, this research contributes to the recognition and valorisation of endogenous knowledge, reinforcing the cultural identity attached to *C. nitida* and highlighting its importance in social cohesion, ritual practices and traditional health systems. Such recognition can support community-based initiatives for knowledge transmission and sustainable use of the species. From scientific perspective, this study enriches ethnobotanical research by combining quantitative indices with multivariate analyses, offering a robust methodological framework for analysing the structuring of plant knowledge across socio-cultural gradients. It also provides original data on vernacular taxonomy, use diversity and consensus level for *C. nitida* thereby contributing to comparative studies at national and regional scales in West Africa.

In terms of policy and institutional implications, the results underline the need to integrate culturally important species such as *C. nitida* into biodiversity conservation strategies, non-timber forest product management policies and traditional medicine development programs. Public institutions and decision-makers could use these findings to design culturally sensitive policies that promote sustainable harvesting, local value chains and the safeguarding of traditional knowledge. Given the increasing pressure of environmental changes on the distribution and availability of *C. nitida* this study provides a valuable baseline for future research and policy actions aimed at ensuring its sustainable management. Strengthening collaboration between local communities, researchers, and institutions will be essential to preserve both the biological resource and the rich ethnobotanical knowledge associated with this emblematic species.

## Declarations

**List of abbreviations:** NTFPs - Non-Timber Forest Products

**Ethics approval and consent to participate:** This work complies with the ethical protocol established by the Laboratory of Forest Sciences (LFS) as part of the Regional Master's Programme in Biodiversity Informatics and has been approved by the LFS. An informed consent form is sent to respondents before they are interviewed.

**Consent for publication:** Not applicable

**Availability of data and materials:** Data will be made available on request

**Competing interests:** Not applicable

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**Author contributions:** Noudossessi Rufin Kpatinnon was responsible for conceptualisation, data collection and analysis. He wrote the manuscript and oversaw its revision. Supervision was provided by Nouangnon Gérard Gouwakinnou and Jean Cossi Ganglo. Dèhouégnon Thierry Houéhanou and Romain Lucas Kakaï Glele assisted in the evaluation of the work.

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