Ethnobotanical knowledge and traditional uses of Omvong (*Dialium* spp., Fabaceae) tree species in Gabon: a sociocultural and phytotherapeutic perspective

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Research

Abstract

Background: Omvong (*Dialium* spp., Fabaceae) tree species are integral to the traditional medicinal and cultural practices of many ethnolinguistic groups in Gabon. Despite their widespread cultural importance, the ethnobotanical diversity and sociocultural dynamics underpinning their use remain poorly documented.

Methods: Ethnobotanical surveys were conducted among 15 ethnolinguistic groups across five provinces in Gabon. A total of 1,180 semi-structured interviews were carried out with knowledgeable practitioners of traditional herbal medicine, in order to document local perceptions, therapeutic uses, preparation techniques, and the sociocultural contexts associated with the use of *Dialium* species. Data were analyzed using Multiple Correspondence Analysis (MCA) to identify distinct ethnobotanical patterns among communities.

Results: Significant variations were observed in the transmission and application of traditional knowledge, strongly influenced by sociocultural factors such as marital status. Elderly respondents, along with married or widowed individuals, exhibited notably deeper ethnobotanical knowledge, highlighting their key roles as custodians of traditional practices. Medicinal uses dominated, particularly for the treatment of febrile illnesses (e.g., malaria, typhoid), reproductive disorders, and parasitic infections. Additionally, ritualistic and practical uses underscored the multifunctional nature of Omvong species. MCA revealed distinct usage patterns correlated with ecological availability and cultural specificities: the Baka community displayed highly homogeneous knowledge transmission, whereas groups such as **Akele** and **Galoa** exhibited more fragmented knowledge systems.

Conclusions: This study underscores the cultural and therapeutic significance of Omvong in Gabonese ethnomedicine, highlighting the necessity of integrating traditional ethnobotanical knowledge into sustainable healthcare and natural resource management strategies. Further research should focus on isolating and validating bioactive compounds to enhance the scientific foundation of traditional knowledge, supporting culturally respectful and ecologically sustainable healthcare interventions.

Keywords: Forest species; *Dialium sp.*; Gabon; Potential utilizations; local knowledge

Background

Central African forests cover approximately 180 million hectares and remain among the most critical reservoirs of global biodiversity (FAO, 2020). They play a central role in the subsistence strategies and healthcare systems of over 60 million people (De Wasseige *et al.* 2014), while also contributing significantly to the GDP of the countries they span, primarily through the provision of commercial timber. To ensure these multiple functions can be sustainably maintained, Gabon has committed since 2022 to a nationwide sustainable forest management approach by imposing forest management norms standards equivalent to FSC (Forest Stewardship Council) standards across its entire territory (FSC 2023). This label, recognized by numerous authors as one of the most stringent globally, ensures the social rights of local communities while enabling sustainable timber production (ATIBT 2023, Doucet 2024, Jeffery *et al*. 2014).

However, the availability of certain high-value heliophilous timber species has declined due to harvesting restrictions aimed at minimizing canopy disturbance (Karsenty & Gourlet-Fleury 2006). Combined with increased inland transportation costs and falling export prices, the shrinking volume of exploitable resources threatens the long-term viability of this management model. Consequently, diversifying timber species is now more inevitable than ever to ensure the sustainability of forest management.

Among Gabon's numerous valuable timber species, some species in the genus *Dialium* (Fabaceae, Dialioideae), commonly referred to as "Omvong," stands out as particularly promising. It is currently ranked as the tenth most abundant secondary timber species in Central Africa, with an estimated 321325 m^3 available for harvest annually (FRMi 2019). Moreover, *Dialium* species are mainly shade-tolerant and regenerate appropriately under low-impacted canopy. Their wood is dense, generally durable, and resistant to fungi and xylophagous agents (Doucet *et al.* 2022, Gérard *et al.* 1996, Meunier *et al.* 2015). As such, this timber complex emerges as a promising candidate to complement the production of heliophilous heavy wood species like Azobé (*Lophira alata* Banks ex. C.F.Gaertn.) and Okan (*Cylicodiscus gabunensis* Harms) (Makemba *et al.* 2022). However, the sustainable management of these species requires a clear understanding of their uses and the needs of local communities to integrate them effectively into forest management plans.

The uses of African *Dialium* vary considerably across regions. For instance, fruits of some species are widely valued as a food source in West Africa (Moronkola *et al.* 2017, Ogu *et al.* 2013), while they are primarily consumed by wildlife particularly primates and elephants in Central African forests, notably in the Republic of the Congo and Gabon (Bengono *et al.* 2021). Among local communities in west Africa, various parts of these plants are traditionally used for medicinal, nutritional, artisanal, and domestic purposes. Leaves are employed in Benin both as food and in traditional medicine; fruits serve in fishing practices and for ornamental purposes; essential oils are extracted for household use; and bark and roots are processed into powders used to treat malaria and promote wound healing in Democratic Republic of Congo (Bengono *et al.* 2021, Jeffrey *et al.* 2014, Nguyen 2022, White & Abernethy 1996). Nevertheless, a detailed description of *Dialium* traditional uses in Gabon is lacking, particulary for species grouped under the Omvong complex.

Considering taxonomic classification divergence between authors Rojo and Steyaert, *Dialium* genus should comprise approximately 22 species within the Guineo-Congolian region (Bengono *et al.* 2021, Doucet 2024), with distributions aligned to White's phytogeographic subcentres of endemism (White 1979, 1993). These are small to large-sized trees, occasionally shrubs. Their trunk is cylindrical or features basal swellings or buttresses. The bark is either smooth or irregularly flaky. The slash of bark is odorless and produces a characteristic red exudate. The leaves are alternate and imparipinnate (3-21 leaflets), with a cylindrical rachis. Stipules are present but very early caduceous (Doucet 2024). Leaflets are alternate, or sometimes subopposite, except for the terminal one, with straight to somewhat wrinkled petiolules and no stipels. Blade margin is always entire and the tertiary reticulation often form a dense network. The flowers, arranged in panicles, are hermaphroditic, with 5(-6) sepals, 0-3 petals, and 2-5 stamens and one ovary (Doucet 2024). The fruit is an indeshicent one-seeded pods with dry pulp, also called camara, either globular or discoid.

In Gabon the Omvong complex consists of at least three *Dialium* species: *D. pachyphyllum* Harms, *D. polyanthum* Harms, *D. lopense* Breteler and probably a new one, *Dialium* sp. nov., which is currently under description (Doucet 2024). Unlike other *Dialium* species, typically called *Eyoum* in Gabon, these species are characterized by flaky barks, 3-5(-7) leaflets, 5 sepals, 1 petal, 2 stamens and velutinous pods (Doucet 2024).

Due to morphological overlap among species, particularly when observed in a vegetative state, all four Omvong species are confused by local population which refers to them as a unique entity. As such, all references to *Omvong* during fieldworks were treated as pertaining to one of those four species, without differentiation at the species level.

This study therefore aims to gain a better understanding of the traditional uses of large trees in the African dense humid forest and to help prevent potential conflicts of use between rural communities and logging operators by:

1. Documenting traditional uses of Omvong among Indigenous and local communities;
2. Highlighting the cultural and practical significance of these species across diverse domains, including medicine, nutrition, craftsmanship, and household applications;

Identifying knowledge gaps and under-reported practices to guide future research and support the sustainable valorization of these locally important complex.

Materials and Methods

Study area

This study was conducted in Gabon (Figure 1), a Central African country bordered by the Atlantic Ocean along more than 300 kilometers of its western coastline (Bekale 2024, Walters *et al.* 2024). Gabon experiences a hot and humid equatorial climate, characterized by high annual rainfall and alternating wet and dry seasons. Precipitation ranges from approximately 1500 mm in the northeastern and savanna regions to over 3300 mm in the northwestern and southwestern parts of the country (Harris *et al.* 2012). These climatic conditions support a rich and diverse vegetation cover, ranging from dense rainforests to more open forested areas, resulting in approximately 83% forest cover across the country's total land area of 266667 km^2 (De Wasseige *et al.* 2012).

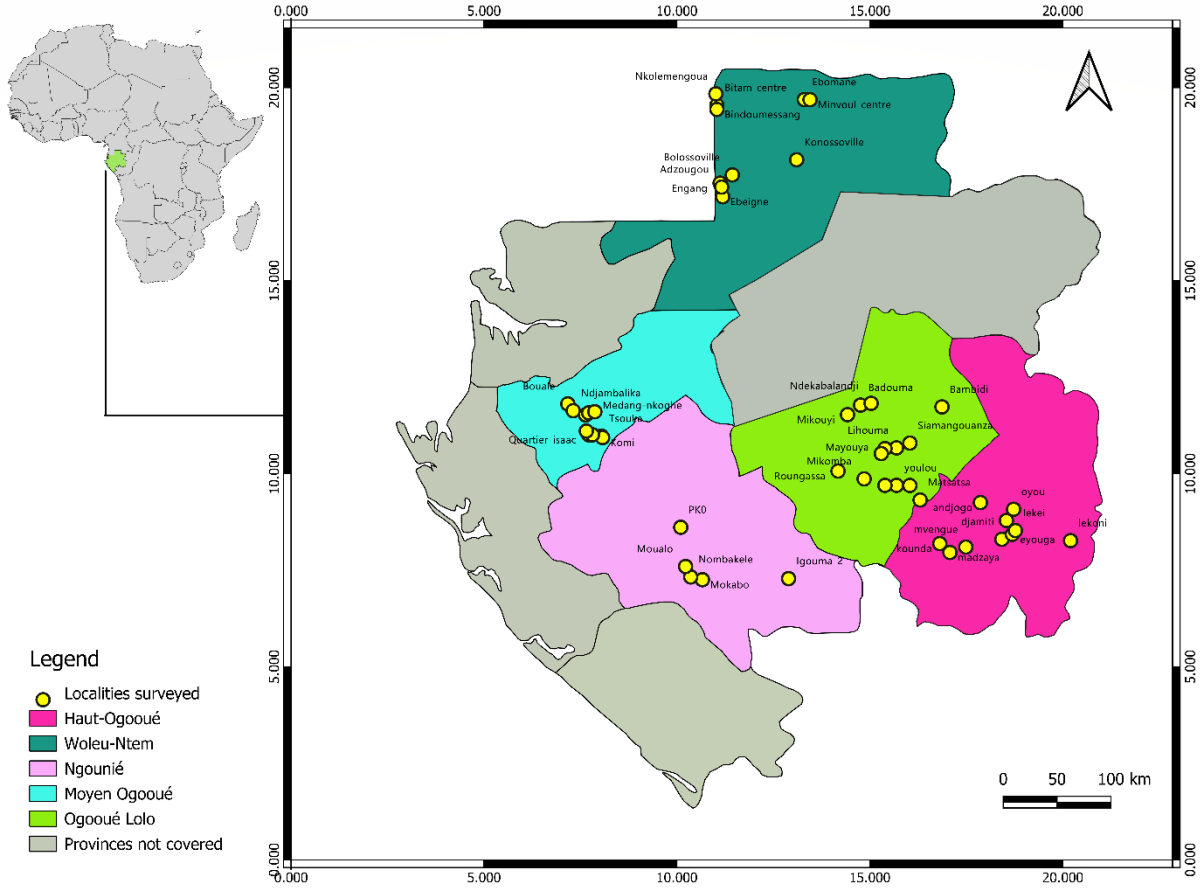

Figure 1. Survey coverage across Gabonese provinces and their localities (surveyed region in color; unsurveyed in grey)

Ethnobotanical fieldwork was conducted between June 2020 and December 2021, encompassing a total of 1180 participants (681 men and 499 women). Respondents were stratified into two distinct groups: key informants (n = 140) and general informants (n = 1040). The selection of key informants was carried out using a stratified random sampling method, guided

by recommendations from district administrators, local authorities (including village and cluster chiefs), and respected elders.

Key informants included traditional healers, members of indigenous communities (notably Baka groups), and forest workers, recognized for their specialized knowledge of the local flora and practices related to the Omvong species complex (*Dialium* spp.). In contrast, general informants represented a broader demographic, consisting of individuals deemed likely to possess general knowledge or usage experience concerning *Omvong* (Andrade-Cetto & Heinrich 2011, Tongco 2007).

To comply with COVID-19 health and safety protocols, data collection was organized in small, semi-structured focus groups, each comprising a maximum of eight participants. This approach ensured both safety and optimal engagement, while allowing for the collection of diverse perspectives across gender, age, and occupational categories (Gary 2004).

Surveys were conducted across five provinces of Gabon Haut-Ogooué, Moyen-Ogooué, Ngounié, Ogooué-Lolo, and Woleu-Ntem (Figure 1). These regions were accessed by foot, car, or train depending on terrain and infrastructure availability. The selection of provinces was guided by two main criteria: (i) the known distribution of *Dialium* species within these areas, (ii) the presence of key knowledge holders, such as forestry workers, traditional healers, and Indigenous communities, particularly among Baka populations, who are considered to possess in-depth ethnobotanical knowledge relevant to the study and (iii) the logistical resources available to us.

Ethnolinguistic context of the study area

The current ethnolinguistic landscape of Gabon reflects the outcome of successive waves of human migration, primarily involving Bantu-speaking populations. These groups historically imposed their languages on assimilated populations such as Baka communities, adopted the languages of encountered groups, or engaged in linguistic blending (Doucet 2003). As a result of these processes, Gabon today comprises 52 distinct ethnolinguistic groups, unevenly distributed across its territory (UNESCO 2024). During our fieldwork, interviews were conducted in 15 languages, reflecting the linguistic diversity of the study sites. These included: **Fang** spoken by approximately 32% of the national population as well as **Teke**, **Kota**, **Nzebi**, **Akele**, **Galoa**, **Vili**, **Enenga**, **Tsogo**, **Massango**, **Bapunu**, **Baka**, **Adouma**, **Samaye**, and **Kwele** (Raponda-Walker & Sillans 1961, Ndingua-Koumba-Binza 2007). The use of local languages allowed for culturally sensitive communication and facilitated more accurate documentation of traditional plant knowledge within each community.

Ethnobotanical survey

Ethnobotanical fieldwork was carried out in accordance with international ethical and methodological guidelines for ethnobotanical and ethnopharmacological research (Alexiades 1996, Andrade-Cetto & Heinrich 2011). Surveys were conducted in major rural settlements across the study provinces, targeting communities known to interact closely with local plant resources.

Data collection was carried out using a combination of structured and semi-structured interviews, following established ethnobotanical survey protocols (Gary 2004, Tadesse *et al.* 2025). Interviews were conducted with individuals and small community groups using a culturally adapted questionnaire. The survey gathered demographic information (e.g., age, gender, education level, marital status) and documented local knowledge related to the tree locally known as *Omvong*.
Focus group discussions were also conducted with key informants in each locality to triangulate individual responses and enrich contextual understanding. These sessions addressed themes such as medicinal plant conservation, threats to species availability, antidotal practices, and dosage knowledge, in line with participatory approaches recommended by (Gary 2004).
To support an accurate Omvong recognition and minimize misidentification, informants were presented with a reference kit including samples of leaves, bark, fruits, and high-resolution photographs. In several cases, direct field identification of living specimens was undertaken jointly with informants. Plant materials used for reference kit were subsequently matched to voucher specimens and deposited in the National Herbarium of Gabon (HNG) for future reference.

Data processing

Quantitative data analysis

Data collected through the questionnaires were organized and analysed using standard descriptive statistical methods. To investigate the influence of sociocultural and educational patterns among the study populations, Multiple Correspondence Analysis (MCA) was performed. This multivariate technique allowed for the visualization of associations between categorical variables. All statistical analyses were conducted using R software (version 4.4.2) (Figure 2).

Figure 2. A. Flaky bark of *Dialium pachyphyllum*; B. Slash bark with red exudate from *D. lopense*, C. Upper sid of *Dialium sp*. nov. leaves, D. Flower of *D. pachyphyllum*, E. Mature fruit *of Dialium* sp. nov., F. *D. polyanthum* leaflets, G. Lower part of *D. polyanthum* leaves.

Results

Ethnic groups and traditional uses of Omvong

This ethnobotanical study was conducted among 15 ethnolinguistic groups distributed across five provinces in Gabon. Each group employs its unique vernacular term to designate the Omvong tree (*Dialium* sp.), illustrating the linguistic diversity and cultural specificity inherent to their traditional botanical knowledge. The vernacular names identified are: Teke (**Wenda**), Kota (**Imbowu**), Nzebi (**Mubambe**), Galoa (**Nkoma**), Vili (**Orobe**), Enanga (**Tesa**), Mitsogho (**Orobe**), Massango (**Mouyoubi**), Bapunu (**Mugubi**), Baka (**Recombo**), Adouma (**Matote-mandzibu**), Samaye (**Ngongou**), Kwele (**Pâa**) and Fang (**Omvong**, **Evele Omvong** or **Akong-meki**). In Fang, **Evele-Omvong** and **Akong-meki** were glossed by informants as "red Omvong" and "blood vacuole," respectively, referring to the reddish exudate observed on fresh cuts. (Orthographic variants reflect dialectal usage; diacritics were harmonized where possible).

All surveyed communities predominantly reside in rural settings, maintaining livelihoods intricately linked to forest ecosystems. Their reliance on natural resources for medicinal purposes and daily subsistence facilitates the active transmission and preservation of ethnobotanical knowledge across generations. This socio-cultural and ecological framework enabled the collection of comprehensive and nuanced data on the local perceptions, classifications, and applications of Dialium species among Gabon's diverse ethnic groups.

Number of principal informants by ethnic group

The distribution of informants between these groups was unbalanced, though the **Teke** and **Fang**, two of the most populous groups, accounted for a larger proportion of participants. Each group demonstrated unique preferences and cultural uses of *Omvong* species, suggesting that traditional knowledge is shaped by both ecological availability and socio-cultural norms.

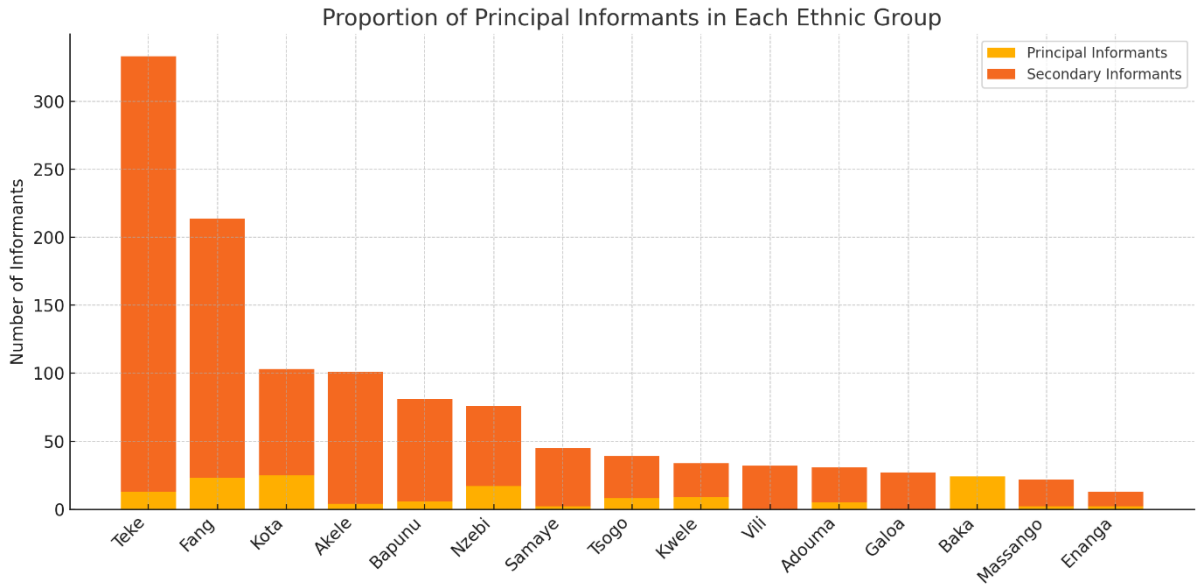

Figure 3. Ethnic group-wise proportion of informants recognized for advanced ethnobotanical knowledge.

The relative importance of principal informants within each ethnolinguistic group provides insight into the depth and concentration of traditional knowledge. As shown in Figure 3, the Baka community stands out with a remarkable 100% of informants identified as principal informants, suggesting an exceptional preservation and homogeneity of ethnobotanical knowledge within this group. This result may reflect the Baka's close reliance on forest resources, and their strong intergenerational transmission of medicinal plant uses.

Other ethnic groups such as the Enanga (15.4%), Adouma (16.1%), and Kwele (26.5%) also show relatively high proportions of principal informants. In contrast, groups like the Akele (4.0%) and Galoa (0.0%) exhibit markedly lower ratios, indicating either more fragmented knowledge transmission or a possible marginalization of traditional practices in favour of biomedical approaches.

This proportional analysis provides a first layer of interpretation by emphasizing the *intensity* of traditional knowledge within each group. It sets the stage for a more detailed understanding of the *absolute contribution* of each group to the overall ethnobotanical dataset, as developed in the following section.

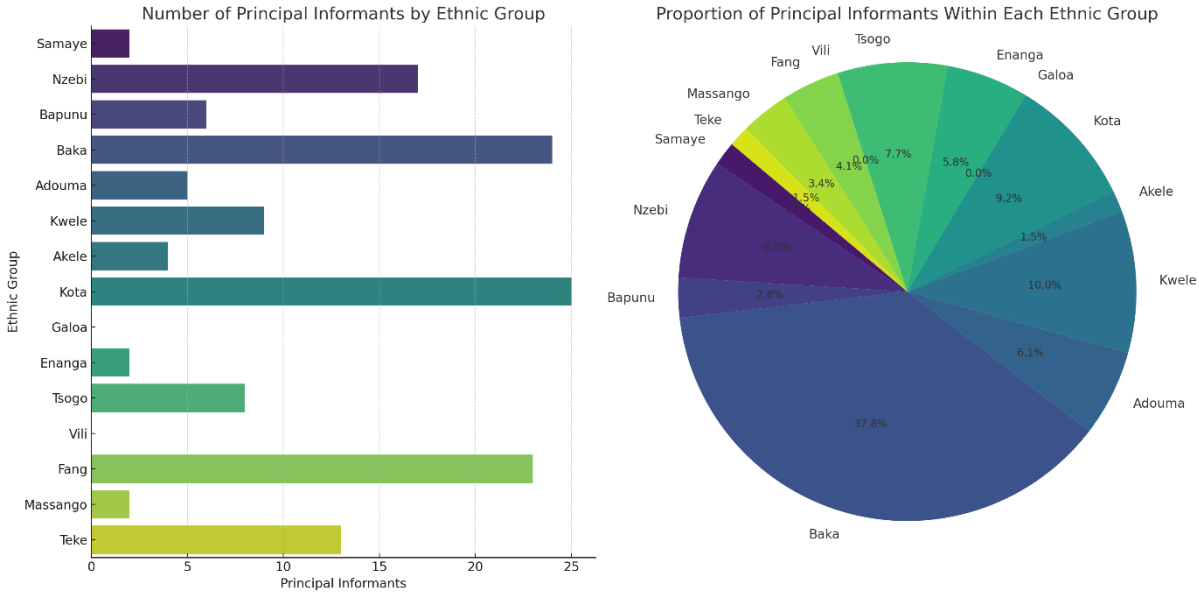

Figure 4. Ethnic group distribution of the number of informants.

$$\%Pn = \frac{\frac{PI_n}{TI_n}}{\sum_{n=1}^{15} \frac{PI_n}{TI_n}} \textbf{ (i)}$$

$\%P_n$ **:** Proportion of principal informants within ethnic group (n)
PI_n **:** Principal informant in ethnic group (n)
TI_n **:** Total informants by ethnic group (n)

This pattern reflects the depth of ethnobotanical knowledge retained among Baka informants. Other groups, like the Kota and Nzebi, also demonstrate relatively high proportional involvement.

Together, these visualizations reveal both the scale and intensity of knowledge transmission within communities, highlighting the importance of considering both absolute and relative indicators in ethnobotanical investigations.

Traditional uses of Omvongs

The ethnobotanical survey conducted across five provinces in Gabon revealed that tree species locally known as *Omvong* are predominantly used for medicinal purposes. These therapeutic uses were consistently cited more frequently than other applications such as food, fuelwood, or ritual practices, highlighting the central role of *Dialium* in traditional healthcare systems.

Informants reported medicinal applications targeting a wide range of health concerns, including febrile illnesses, reproductive and hormonal disorders, and parasitic infections. In several cases, traditional healers described the use of combined plant parts, including bark, leaves, and roots, to formulate remedies adapted to specific symptoms or ailments. Notably, preparations for treating malaria and related febrile syndromes were among the most frequently cited uses (Table 1).

The analysis of traditional uses of *Omvong* species revealed a broad spectrum of applications, predominantly medicinal, with certain practices showing exceptionally high levels of citation among informants. As illustrated in Figure 5, the most frequently cited, among medicinal uses, included the treatment of febrile illnesses such as malaria, chikungunya, and typhoid fever (1147 citations), male sexual enhancement (1020 citations), and treatment of anemia (1095 citations). These high values emphasize the central role of *Omvong* bark in traditional medicine for managing systemic and reproductive health disorders.

Table 1. Ethnobotanical practices related to the use, preparation, and administration routes of Omvong species (citation frequency).

Traditionnal used	Parts used	Method of preparation	Mode of use
Medecinal			
Asthma **(483)**	Barks x banana leaves	Decoction **(1179)**	Inhalation of steam **(780)**
Prostatitis **(415)**	Barks **(1179)**	Decoction	Drink **(1179)**
Hemorrhoids **(149)**	Barks x fruits seeds	Decoction and infusion	Drink and purge
Cough **(475)**	Barks	Decoction	Drink
Back pain **(405)**	Leaves x olive oil	Decoction	Massage
Male virility **(1020)**	Barks	Grind	Powder in food or drink
Dewormer **(439)**	Barks x soap	Infusion **(1162)**	Purge **(1179)**
Fills anaemia **(1095)**	Barks x hibiscus flowers	Decoction	Drink
Child's fever **(324)**	Bark x red caolin	Grind **(691)**	Apply to the head **(824)**
Lymphatic filariasis **(43)**	Barks	Infusion	Bath **(1179)**
Malaria/ Chikungunya/ Typhoid fever **(1147)**	Barks	Decoction	Drink/steam bath
Fertility in women **(722)**	Root x small aubergines	Infusion	Drink
Chlamedya **(252)**	Root	Infusion	Drink/bath
Burns/wounds **(327)**	Bark/sap	Crush and loosen **(1179)**	Superficial application
Lower blood pressure **(208)**	Barks	Decoction	Drink
Toning the body **(392)**	Barks	Infusion	Bath
Dental pain **(105)**	Leaves x salt	Grind	Mastication **(721)**
Eye cleaning **(109)**	Leaves x water	Maceration **(1179)**	Drain into the eyes
Pneumonia **(110)**	Barks x salt	Decoction	Inhalation of steam
Acne/body complexion **(297)**	Fruit x olive oil	Grind **(691)**	Boddy ripples
Ritual			
Protection against the evil eye **(943)**	Barks x leaves of others plants	Maceration	Bath
Initiation ritual during circumcision **(941)**	Bark x indigenous chili x others leaves	Mastication	Spitting on the sex of the circumcised
Protection ritual for twins **(955)**	Root x others leaves	Grind **(691)**	Rubbing the body of newborn babies
Use as a practical tool			
Use as a practical tool **(114)**	Wood **(317)**	Planing wood	Household tools **(109)**
Wood as energy			
Firewood **(94)**	Wood	Use of wood twigs	Cook
Food **(402)**	Fruits	Mature fruits	Food
Food	Leaves **(1151)**	Boil leaves	Food

In addition to medicinal applications, ritual uses also featured prominently, particularly those linked to twin protection (955 citations), circumcision rites (941), and spiritual protection against the evil eye (943). These findings underline the importance of *Omvong* in both health-related and cultural contexts.

Non-medicinal uses such as food (notably boiled leaves with 1151 citations), practical applications (e.g., woodworking), and firewood were cited less frequently but confirm the multifunctionality of the species. Overall, the high frequency of use across distinct domains attests to the cultural and practical significance of *Omvong* species in Gabonese ethnobotanical knowledge.

Sociocultural factors influencing ethnobotanical use

The distribution of ethnobotanical knowledge among various groups reveals important socio-cultural dynamics.

Ethnobotanical uses according to age and gender

The distribution of ethnobotanical knowledge varied significantly across age groups. Elders over 62 years accounted for the highest proportion of respondents (n = 573; 48.6%), followed closely by adults aged 28-62 (n = 553; 46.9%). Youth under 28 years were underrepresented (n = 54; 4.6%), suggesting limited involvement in traditional practices. This trend underscores the central role of older individuals in preserving and transmitting ethnobotanical knowledge, particularly through farming, traditional medicine, and forest resource use.

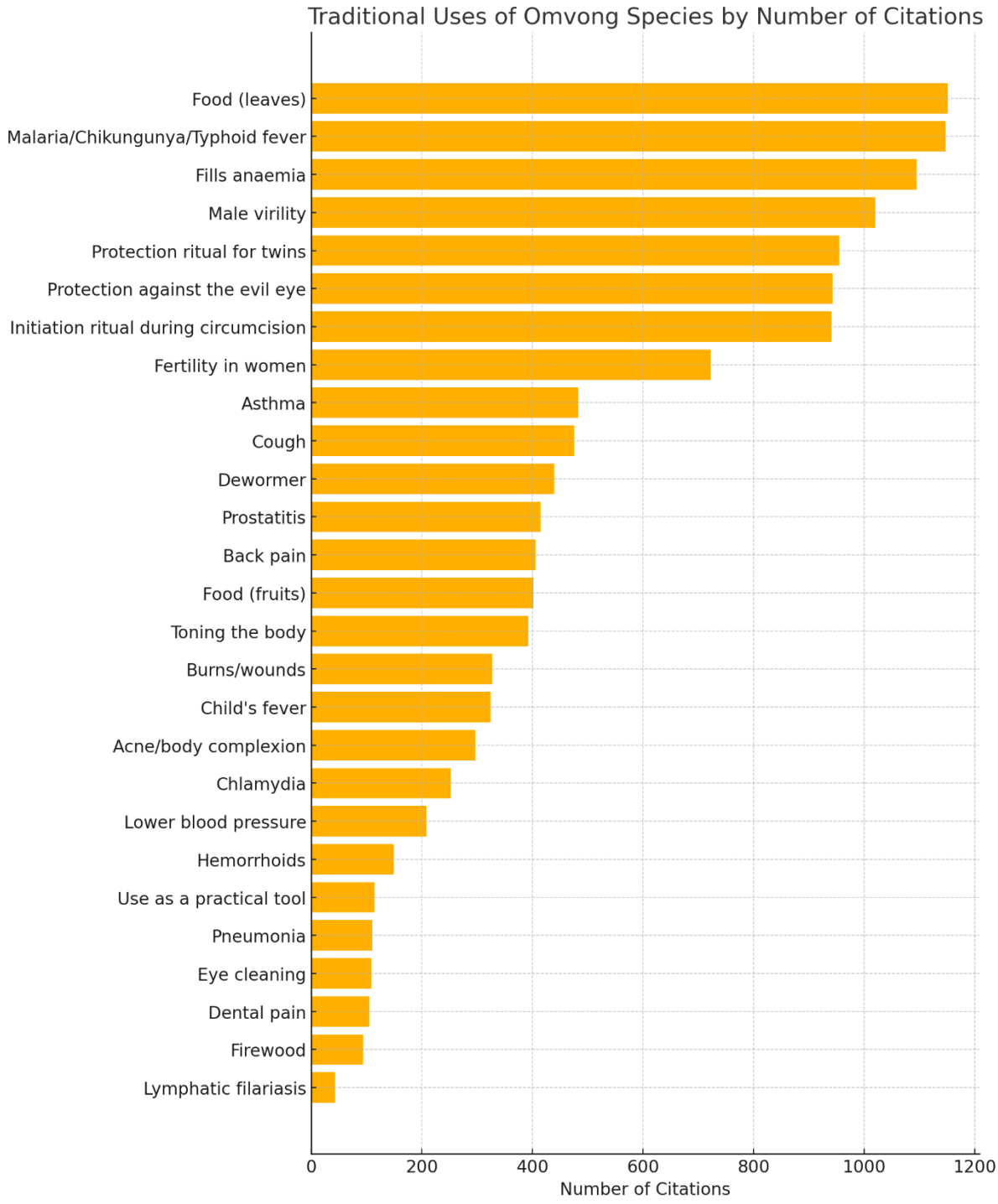

Figure 5. Ethnobotanical applications of Omvong species based on informant citation counts.

Figure 6. Socio-cultural characteristics and experience of interviewed population.

Gender distribution revealed a predominance of male informants (n = 754; 63.9%) over female informants (n = 426; 36.1%). This imbalance may reflect gendered roles in knowledge access and plant use, where men are often more engaged in practices involving forest products, while women's expertise may be centered on domestic or health-related uses, potentially under-reported in structured surveys.

Family status

Out of the 1,180 individuals surveyed, the majority were married (n = 683; 57.9%), followed by single individuals (n = 289; 24.5%) and widowed persons (n = 208; 17.6%). The predominance of married and widowed respondents suggests a greater involvement of socially established individuals in ethnobotanical practices, potentially due to their roles in household healthcare and intergenerational knowledge.

Education background

Educational levels among respondents were generally low. Nearly half of the participants were either illiterate (n = 511; 43.3%) or had only primary education (n = 212; 18.0%). Secondary education was reported by 359 individuals (30.4%), and only a minority (n = 98; 8.3%) had attained university-level education. These results reflect the strong representation of rural and traditionally oriented populations, for whom local knowledge is often transmitted orally rather than through formal education.

Motivation for medicinal plant use

When asked about their reasons for using medicinal plants, an overwhelming majority of respondents cited either the perceived efficacy (n = 1139; 96.5%) or the affordability of these remedies (n = 1139; 96.5%) as primary motivations. Only 40 individuals (3.4%) reported no specific reason, indicating that plant-based treatments are deeply embedded in local medical practices, driven by both cultural familiarity and practical necessity.

Medicinal uses by 15 ethnolinguistic groups

The analysis of the distribution of *Dialium* uses across surveyed localities revealed that these species are primarily employed in the treatment of a broad spectrum of health conditions (Figure 3). Seven categories of use were identified, each comprising multiple disease types or pathological conditions. Among them, the categories "fevers and general healthcare" and "reproductive and hormonal disorders" were the most frequently cited by informants.

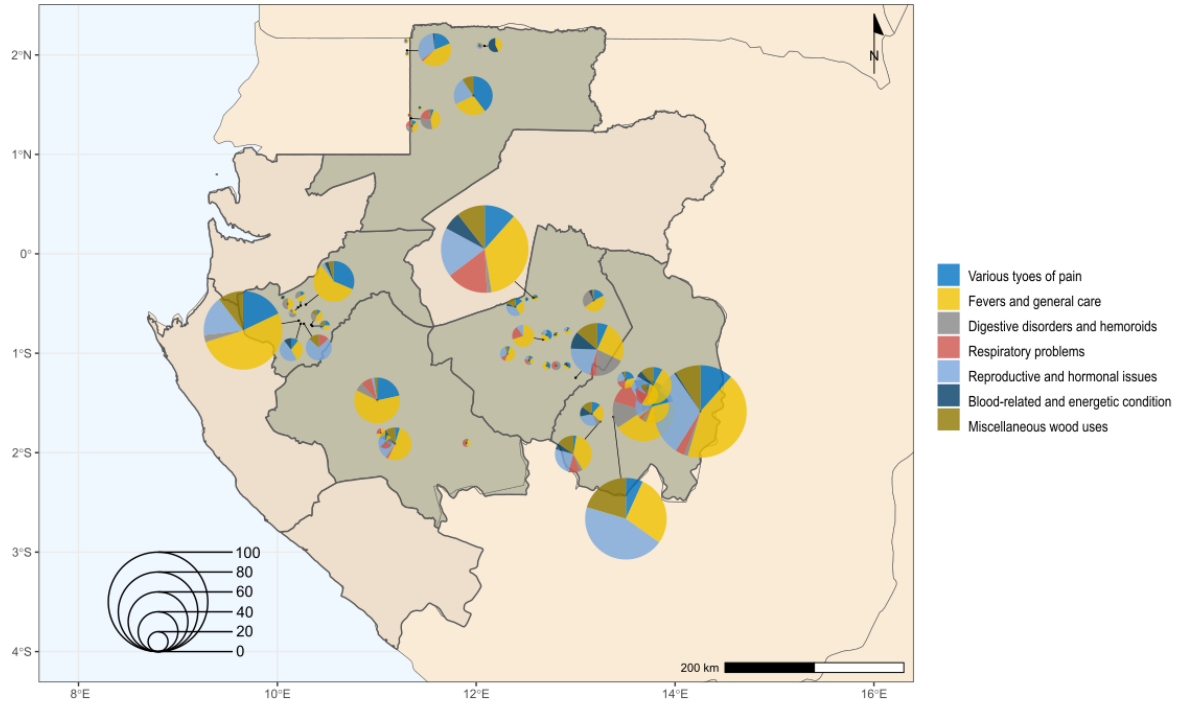

Figure 7. Distribution of ethnobotanical uses of Omvong across five provinces of Gabon. The size of each pie chart is proportional to the number of respondents in each region.

The "fevers and general healthcare" category includes uses targeting malaria, infectious and parasitic diseases, typhoid fever, generalized febrile states (e.g., non-specific fever, diffuse body pain), hematological symptoms such as anemia, and emerging febrile illnesses such as chikungunya. The "reproductive and hormonal disorders" category encompasses treatments for female infertility, male sexual weakness, and sexually transmitted infections, including chlamydia.

Multiple Correspondance Analysis (MCA)

Multiple Correspondence Analysis (MCA) allowed the visualization of distinctive usage patterns among the 15 ethnolinguistic groups surveyed in Gabon. The MCA plot highlighted two main dimensions that explained 13.51% and 8.86% of the variance, respectively. (Figure 8a) representing the **Nzebi**, **Samaye**, **Teke**, **Tsogo**, and **Vili** groups, revealed variance explained by Dim 1 and Dim 2. Dimension 1 contrasted skin-related remedies (acne and wound treatments) against internal therapeutic practices (anemia and cardiovascular health). The **Teke** and **Tsogo** showed closely aligned usage patterns, indicating balanced applications across these categories. Conversely, the Vili stood apart due to highly specialized therapeutic practices, notably emphasizing specific internal remedies.

In the second MCA (Figure 8b), analyzing **Fang**, **Galoa**, **Kota**, **Kwele**, and **Massango** groups, dimensions explained (Dim 1) and (Dim 2) of the variance. Dim 1 distinguished between general therapeutic applications (e.g., malaria treatments) and more specific medicinal uses (e.g., dental and burn treatments). **Fang** and **Kota** groups, overlapping significantly, predominantly utilized treatments for malaria, while **Massango** focused notably on remedies for dental issues and burns.
The third MCA (Figure 8c), encompassing the **Adouma, Akele**, **Baka**, **Bapunu**, and **Enanga** groups Dimension 1 mainly distinguished medicinal uses (e.g., respiratory ailments, body toning) from ritualistic practices (initiation and protection

rites). The **Adouma** and **Akele** ethnic groups, clustering closely, showed a preference for medicinal uses, particularly respiratory care and body-toning practices, whereas the **Bapunu** were distinct in their emphasis on ritualistic applications. The **Baka** group was uniquely positioned, indicating an emphasis on practical and utilitarian uses.

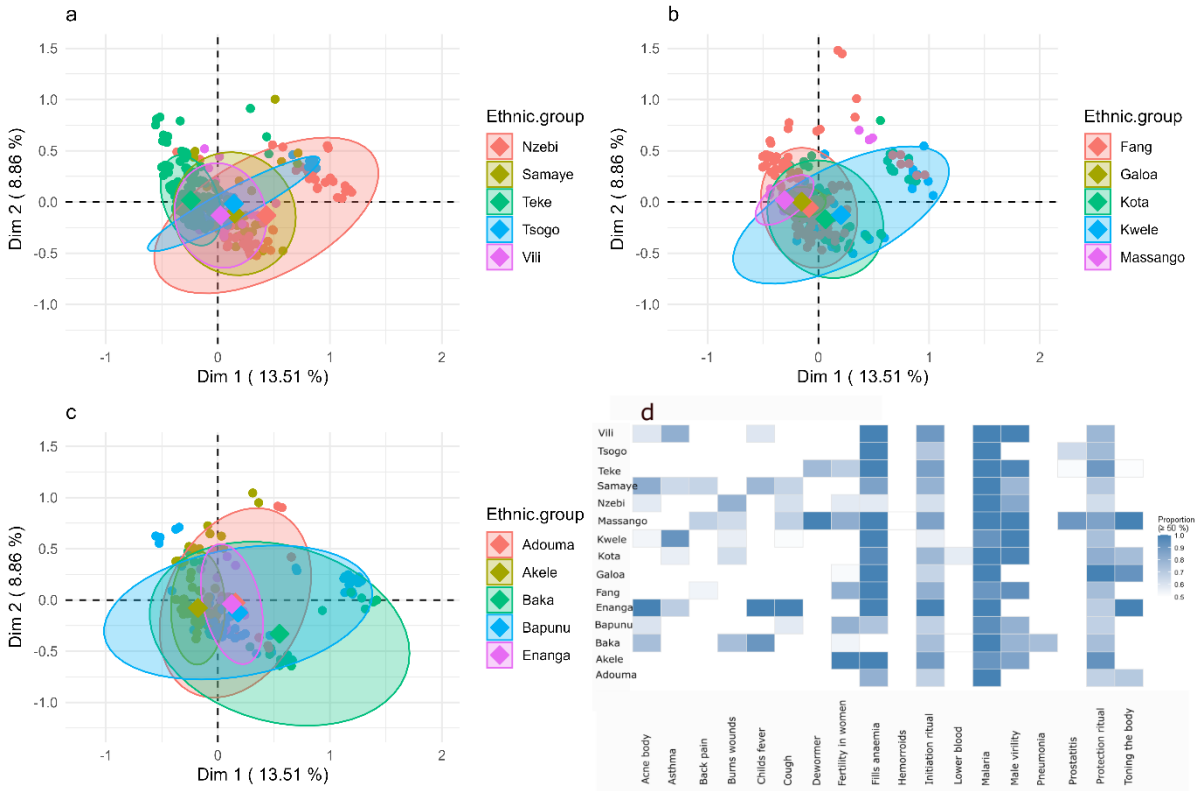

Figure 8. Multiple Correspondence Analysis (MCA) and heatmap illustrating ethnobotanical usage patterns among 15 ethnolinguistic groups in Gabon. MCA plots display confidence ellipses (95%) for each ethnic group based on usage patterns of Dialium polyanthum: a) MCA of **Adouma**, **Akele**, **Baka**, **Bapunu**, and **Enanga**; b) MCA of **Fang**, **Galoa**, **Kota**, **Kwele**, and **Massango**; c) MCA of **Nzebi**, **Samaye**, **Teke**, **Tsogo**, and **Vili**. Each plot reveals distinct groupings linked to specific medicinal, ritualistic, or practical uses. d) Heatmap highlighting specific ethnobotanical practices, showing the proportion (≥ 50%) of respondents reporting particular plant uses within each ethnic group. Darker shades indicate a higher prevalence of the associated use, underscoring culturally significant applications.

A heatmap analysis (Figure 8.d) further identified specific ethnobotanical usages significantly associated with particular ethnic groups. While some practices exhibited marked group specificity, others most notably remedies for malaria and anemia were widely shared across groups. In contrast, initiation rituals were notably frequent among **Akele** and **Enanga**. **Massango**, **Tsogo**, and **Vili** groups distinctly utilized treatments for dewormer, anemia, and male virility, respectively.

Discussion

Sociocultural factors influencing ethnobotanical use

The analysis of ethnobotanical knowledge across sociocultural variables in Gabon reveals a clear stratification influenced by age, gender, education, perceived efficacy, and family status. Age emerged as a particularly significant factor, with adults and elders identified as the primary custodians and practitioners of traditional plant knowledge. Their active roles in subsistence agriculture, healing practices, and forest resource collection provide both the setting and the experience necessary for the accumulation and transmission of this knowledge. In contrast, the under-representation of youth may reflect a generational shift shaped by urban migration, changes in lifestyle, and limited exposure to traditional practices due to formal education and reduced contact with elders.

Gender also plays a pivotal role in shaping ethnobotanical expertise. While men were slightly over-represented among respondents, likely due to their involvement in external collection and forest-based activities, numerous studies have emphasized the depth of women's ethnobotanical knowledge, particularly in domains tied to household health, childcare, and food preparation (N'Zue 2014, Raponda-Walker & Sillans 1961, Van Andel et al. 2012). Elder women, in particular, often

serve as silent reservoirs of plant knowledge, passed down through intergenerational oral traditions. These gendered roles suggest complementary, context-specific knowledge systems that co-exist within households and communities.

Educational attainment further illustrates the dynamics of traditional knowledge retention. Individuals with little or no formal education were found to possess more extensive ethnobotanical knowledge, a trend consistent with prior research in Central Africa (Lescure & Boulet 1985, Raponda-Walker & Sillans 1961). This can be attributed to the oral and experiential modes of transmission that characterize traditional knowledge systems, where learning occurs through observation and direct interaction with the environment. Conversely, respondents with higher education, particularly those living in urban areas, often have less exposure to these practices, as formal schooling typically prioritizes scientific paradigms over local ecological knowledge (Voeks 2007).

In light of these findings, targeted strategies are needed to safeguard this knowledge base. The incorporation of ethnobotanical content into school curricula, through community gardens, intergenerational learning programs, or participatory education, could engage younger and more formally educated individuals, ensuring continuity and cultural relevance in a rapidly changing social context.

The reasons cited for using medicinal plants further underscore the interplay between perceived effectiveness and socioeconomic accessibility. Most respondents reported efficacy as the primary motivation, echoing previous studies in Gabon and beyond (Lescure & Boulet 1985, Raponda-Walker & Sillans 1961). The appeal of low-cost remedies also reflects broader structural limitations in access to biomedical healthcare, especially in rural or underserved areas. These two drivers, efficacy and affordability, reinforce the pragmatic and deeply rooted nature of traditional medicine.

Interestingly, a substantial number of respondents did not explicitly articulate their rationale for plant use. This may reflect a form of "non-reflective traditional knowledge (Zent & Zent 2012), where medicinal plant use is so embedded in daily routines and cultural norms that it becomes habitual and unquestioned. Such practices often persist through tacit reinforcement rather than formal reasoning, particularly in tightly knit communities where oral transmission remains strong.

Family status adds another layer of complexity to the knowledge landscape. The predominance of married and widowed individuals among knowledgeable respondents suggests a link between domestic responsibility and ethnobotanical engagement. Widows, frequently older women, are widely recognized in Gabonese rural settings as key figures in household healthcare, often serving as primary caregivers and traditional healers (Raponda-Walker & Sillans 1961). Their lived experience and reliance on plant-based remedies for family well-being likely contribute to their deeper understanding of medicinal flora. In contrast, single and divorced individuals, who may be less involved in care-giving or less integrated into traditional family structures, appear less engaged in such practices, potentially reflecting shifts in knowledge transmission pathways.

Together, these findings point to the urgent need for integrative and context-sensitive strategies that not only document but also revitalize and transmit traditional knowledge across generations, genders, and educational backgrounds. Such efforts are crucial for ensuring the survival of Gabon's rich ethnobotanical heritage in the face of sociocultural and ecological transformations.

Traditional use of Omvong species

The findings of this ethnobotanical survey underscore the prominent role of Omvong in the local pharmacopoeia of Gabonese communities, consistent with patterns documented in various sub-Saharan African contexts. Similar ethnomedicinal uses have been reported for related Dialium species, such as *D. guineense* Wild, widely utilized in Nigeria and Côte d'Ivoire for treating malaria and febrile conditions, and *D. dinklagei* Harms, known in Gabon for its antimalarial properties (Oluwole-Banjo 2019, Tuo *et al*. 2015, Valentin *et al*. 2020). This cross-regional convergence suggests shared ethnopharmacological knowledge systems likely shaped by similar ecological settings and historical cultural interactions (Fred-Jaiyesimi *et al.* 2021, Kouassi & Yao 2017).

Phytochemical studies have further validated the therapeutic relevance of *Dialium* species, notably highlighting the presence of phenolic compounds, flavonoids, and tannins, classes of secondary metabolites known for their antioxidant, anti-inflammatory, and antimicrobial properties (Abu *et al.* 2019, Bui *et al.* 2019, Nkanu *et al.* 2016). *Dialium indum* Linné, for example, has exhibited significant antioxidant activity linked to its rich phenolic content (Ijoma *et al.* 2016, Sukeaw & Jannu 2021). Such bioactive constituents provide a biochemical rationale for the traditional usage of these species in treating febrile

and parasitic diseases like malaria (Valentin *et al.* 2020). The emphasis on malaria, typhoid, anemia, and infertility observed in our study likely reflects reliance on traditional remedies in contexts where biomedical healthcare access remains limited or intermittent (WHO 2023).

Nevertheless, certain ethnomedicinal claims, particularly those related to male virility or general tonic effects, remain anecdotal and require rigorous pharmacological validation. Additionally, the absence of standardized preparation methods and dosage specifications raises safety concerns and limits reproducibility for formal therapeutic integration. Furthermore, comprehensive toxicological assessments remain scarce, posing a significant barrier to safely incorporating Dialium-based remedies into institutionalized healthcare systems.

This study demonstrated significant variability in the ethnobotanical applications of Omvong among ethnolinguistic groups in Gabon. Multiple Correspondence Analysis (MCA) highlighted how cultural and ecological contexts significantly influenced plant usage patterns, with clear distinctions between medicinal, ritualistic, and practical applications. Clustering patterns, such as those observed between Adouma and Akele, and Fang and Kota groups, suggest shared historical or ecological factors shaping similar medicinal practices. Conversely, the distinctive profiles of groups like Baka and Vili indicate specialized knowledge, possibly reflecting unique ecological interactions or cultural traditions.

The heatmap analysis reinforced these findings by revealing specific uses strongly associated with particular ethnic groups, highlighting culturally embedded practices significantly influencing local medicinal traditions. These insights stress the importance of ethnobotanical knowledge in biodiversity conservation and sustainable resource management. Future research should focus on isolating and characterizing bioactive compounds underlying these traditional uses and verifying their pharmacological efficacy through rigorous in vitro and in vivo studies. Such endeavors are critical for translating traditional ethnobotanical knowledge into evidence-based, culturally respectful, and ecologically sustainable healthcare practices.

Conclusion

This study provides a comprehensive ethnobotanical assessment of Omvong (*Dialium*) tree species in Gabon, highlighting their multifaceted role in traditional health systems across diverse ethnolinguistic groups. Through field surveys involving over a thousand informants and multi-site sampling, we documented a rich repertoire of therapeutic applications, with particular emphasis on treatments for febrile conditions, reproductive disorders, and general health concerns. These uses are not only widespread but also culturally embedded, as reflected in the high frequency of citations and consistency with practices reported in other regions of sub-Saharan Africa.

The strong statistical association between ethnic affiliation and reported plant uses confirms that traditional medicinal knowledge is not uniformly distributed, but rather shaped by complex sociocultural, historical, and ecological factors. Age, gender, and education further influence knowledge retention and transmission, with older and less formally educated individuals emerging as key custodians of plant-based knowledge.

Despite the depth of traditional uses, the validation of certain claimed effects, particularly those relating to virility, tonic uses or malaria remains limited by a lack of standardized formulations and toxicological data. Nevertheless, the convergence of ethnobotanical knowledge and preliminary phytochemical evidence (from other *Dialium* species) suggests a promising pharmacological potential that warrants further exploration.

Taken together, these findings underscore the urgency of preserving and valuing local plant knowledge, particularly in light of generational shifts and environmental change. Future interdisciplinary research should focus on isolating and characterizing active compounds, evaluating their biological activities, and promoting culturally appropriate strategies for knowledge transmission. Such efforts are crucial not only for advancing scientific understanding but also for supporting sustainable, community-centred health practices rooted in Gabonese biodiversity and tradition.

Declarations

List of abbreviations: FSC-Forest Stewardship Council; FRMi-Forest Ressources Management Engeneer; ATIBT-International Tropical Timber Technical Association; UNESCO-United Nations Educational, Scientific and Cultural Organization; MCA-Multiple Correspondance Analysis; WHO-World Health organization; EHPVal-Essence à Haut Potentiel de Valorisation;

PPECF-Programme de Promotion de l'Exploitation Certifiée des Forêts; FPIC-Prior to any data or sample collection, Free, Prior, and Informed Consent

Ethics approval and consent to participate: This study was carried out with only participants who gave their full consent to provide their traditional knowledge for the research. All participants offered informed consent before the interview. prior to any data or sample collection, Free, Prior, and Informed Consent (FPIC) was obtained from each community, including all tribal leaders across the 15 ethnic groups surveyed. Accordingly, each informant accepted the request and orally approved their consent before the interview. Therefore, informed consent was orally obtained from all individual informants included in the study.

Consent for publication: All participants gave oral approvement prior informed consent when provided with the questionnaire form to gather ethnomedicinal knowledge.

Availability of data and materials: Data is available from the first author.

Competing interest: The authors declare that they have no competing interests.

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Author contributions:

JLD: conceptualization; GBB: survey, data collection, literature review, writing, original draft preparation; RD: Methodology; YB: Formal analysis; AR: Read and greed; AS: Supervisor; JLD: funding acquisition.

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