Ethnobotany and intra-cultural diversity in the uses of *Tephrosia vogelii* (Fabaceae) in Centre Benin (West Africa)

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Research

Abstract

Background: Rural dwellers harbor tremendous ancestral uses of local plant species, of which *Tephrosia vogelii*. This study aims to assess the use of diversity and the local perception of the temporal change of *T. vogelii* across the Fon ethnic group in central Benin.

Methods: Ethnobotanical surveys were undertaken across three communes and six villages chosen based on species distribution and geographical distance between the villages. A total of 213 informants, including traditional healers, farmers, hunters, and herbalists, were randomly questioned using semi-structured interviews. The ethnobotanical indices, such as citation frequencies of use reports, use categories, preparation modes, and index value of organs, were calculated. The chi-square test was performed to assess whether the citations differed significantly between the communes prospected.

Results: A total of 17 use reports were reported, ranging into six use categories, of which the medicinal (63.23%) uses represented the main category. Its use as firewood (20.26%) was the most cited use report and was followed by malaria treatment (17.65%) and abscess (11.11%). The index value of organs (IVO) highlights the leaves (41.65%) and leafy stem (16.2%) as the most important plant parts used. The decoction (50.2%) was reported as the main form of preparation of remedies.

Conclusions: The Fon communities in central Benin locally use *T. vogelii* as a multipurpose plant species but report a decline in the species temporal abundance. As such, further research is needed for its sustainability and possible valorization.

Keywords: *Tephrosia vogelii*, ethnobotanical uses, native plant, traditional knowledge, Benin.

Background

Rural communities across African regions harbor a wide knowledge of ancestral practices and traditional uses of native plant species. They usually rely on these resources to meet their daily needs, such as food, fodder, firewood, cork, and herbal remedies for curing various affections (Sa *et al.* 2017). These uses come from ancestral practices and were built based on people's interaction with natural resources of the surrounding environment (Haq *et al.* 2021). As such, according to their use categories, many plants have gained importance for cultural, religious, educational, economic, and industrial applications (Pereira *et al.* 2005; O'Neill *et al.* 2017).

Across the sub-Saharan region, and particularly in Benin, rural populations use plant resources for a wide range of purposes depending on sociocultural factors such as ethnicity, sex, age, profession, educational level, or religion (Sop *et al.* 2012). In such a context, a given plant may gain more importance instead of other plants, making that plant more useful than others (Sinadouwirou *et al.* 2022). While the local practices in plant uses are traditionally transmitted orally from one generation to the next through family members, they are not always formally documented (Asase *et al.* 2005). However, prior research unequivocally confirms that indigenous communities possess pertinent ethnobotanical applications and ecological understanding of native plants. Unfortunately, this knowledge and these practices disappear progressively due to the lack of interest of the young people in traditional use systems (Kadiri *et al.* 2015). In such a context, ethnobiological studies have been widely proven as a prominent tool to document local traditional uses of plant species, to develop sustainable management strategies, and to set up efficient healthcare systems (Haq *et al.* 2021).

In Benin, *Tephrosia vogelii* Hook.f. (Fabaceae family), commonly known as fish-poison bean or Vogel's Tephrosia, belongs to the important multipurpose plant resources (Adomou *et al.* 2012). It is a perennial shrub or small tree that typically grows to about 2 to 3 meters in height, with dense yellow or ferruginous pubescence and striking red or purple flowers. In Benin, it is commonly found in grasslands and cultivated areas across the phytogeographical districts of Littoral and Ouémé (Akoègninou *et al.* 2006). According to (Belmain *et al.* 2012; Akpo *et al.* 2016; Mkindi *et al.* 2019), *T. vogelii* is involved in a wide range uses, except the use in food system due to its toxicity.

However, *T. vogelii* faces threats caused by habitat degradation, urbanization, extensive agriculture, and overharvesting of its seeds. Therefore, this study focuses on the uses of *T. vogelii* to document the traditional practices related to its uses and management across the Fon, an ethnic group whose ethnobotanical knowledge is well known to encompass a wide range of plant species and their specific applications within their culture (Agoyi *et al.* 2014; Agbodjento *et al.* 2020; Houénon *et al.* 2021). More specifically, this ethnobotanical study aims to i) assess the use patterns (folk names, use reports, and categories of uses) of *T. vogelii* within the Fon communities in Centre Benin, ii) document the plant parts sought and the preparation forms of *T. vogelii*'s plant-based recipes, and iii) assess the local population's perception of the temporal changes in *T. vogelii*'s local abundance.

Materials and Methods

Study area

The surveys have been undertaken in the center of Benin across the municipalities of Zakpota, Zogbodomey, and Zangnanado, located respectively at 6°40'N, 2°26'E, 7°00'N, 2°07'E, and 6°50'N, 2°25'E (Fig. 1). These communes were chosen based on the geographical distribution of the target species (Akoègninou *et al.* 2006). Six villages were prospected, including Zonmon, Dovi Doga, and Don Tan in Zangnanado commune; Za Hla and Alahé villages in Zakpota commune; and Domègo village in Zogbodomey commune. Villages in each commune were chosen based on their geographical distance and the Fon ethnic group's dominance (Anbessa *et al.* 2024; Awoke *et al.* 2024). The geographical distance was prioritized to avoid similarly close information from populations.

The study area is within the Sudano-Guinean zone (SG), which is characterized by a semi-arid tropical climate and broadly dominated by a diverse vegetation, ranging from bush savannas to gallery forests along watercourses (Adomou *et al.* 2007). Agriculture is the main livelihood activity for the local populations, who cultivate crops such as maize, rice, and cassava. The major ethnic groups in this area are the Fon, Adja, and Goun (INSAE 2016), who maintain a strong connection with nature through agricultural practices and the collection of plants. However, this plant resource is increasingly threatened by deforestation, intensive agriculture, growing urbanization, and climate change (Neuenschwander *et al.* 2011).

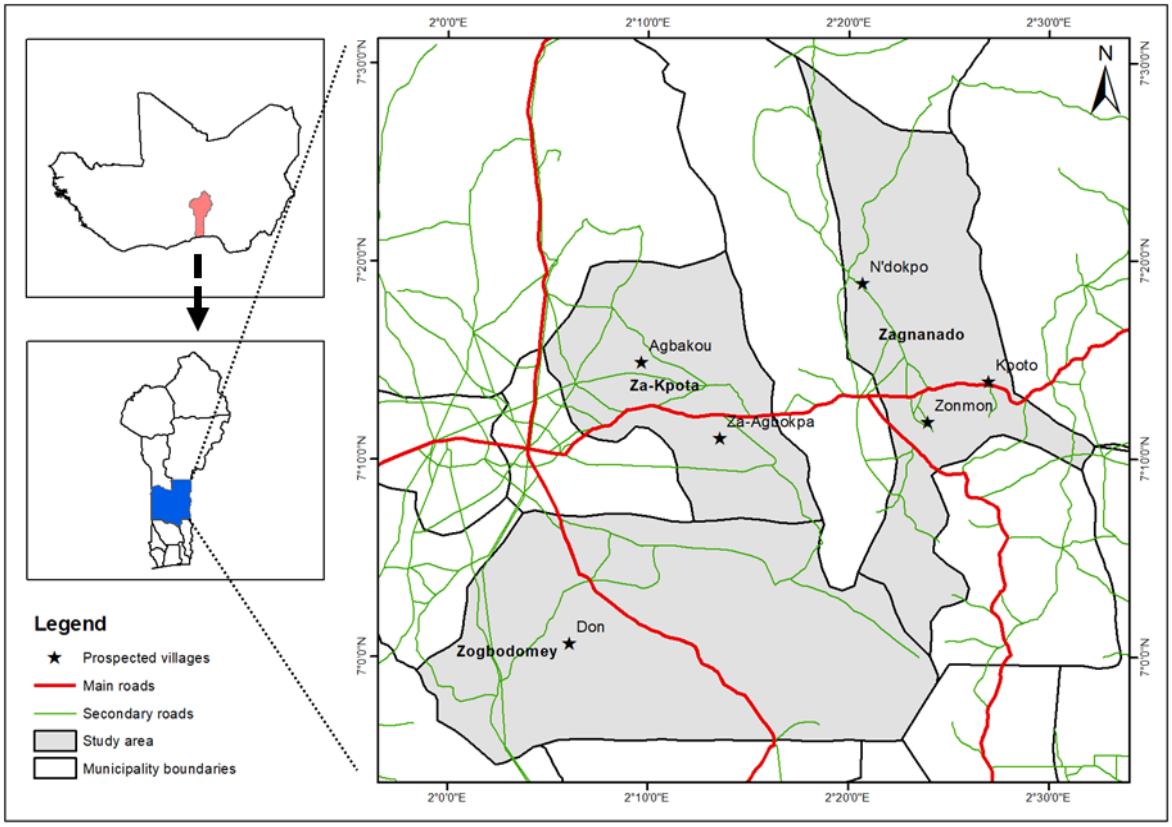

Figure 1. Biogeographical map showing the study area, showing the communes and vilages prospected

Sampling and data Collection

The villages surveyed were selected based on an exploratory survey and the geographical distribution of the species using Akoègninou *et al.* (2006) and the GBIF portal (''Global Biodiversity Information Facility''). The Fon ethnic group was chosen based on its dominance in this area and its prominent historical ethnobotanical knowledge and cultural practices of using plants for various purposes (Agoyi *et al.* 2014; Agbodjento *et al.* 2020; Houénon *et al.* 2021).

Prior, a rapid exploratory survey of 30 informants per commune was conducted to determine the sample size using the formula of Dagnelie (1998)

$$N = \frac{U^2_{1-\alpha/2} \times p\,(1-p)}{d^2}$$

where N is the size of the global sample; U1-α/2 is the value of the normal random variable for a probability value a = 0.05; U1-α/2 = 1.96; p is the proportion of informants who know and use at least one of the two species; and d is the marginal error fixed at 0.08.

The sample size defined for a commune was distributed among villages of this commune. A total of 213 informants were then interviewed (Table 1), including 71.24% men and 28.75% women, of which 66.01% were traditional healers, followed by farmers (16.94%), hunters (10.86%), and herbalists (6.19%).

Informants were selected using the random lottery method according to Tadesse *et al.* (2025). Before conducting every interview, the research objectives and procedures were clearly explained to the informants in the local language, and consent was verbally obtained. Ethnobotanical surveys were conducted using open- and close-ended semi-structured questionnaires through individual interviews and focus groups (Kala & Mathur 2002). We also used dried specimens (herbarium) and photographs as materials for species recognition by informants following Favi *et al.* (2022). Information included the use reports, plant parts sought, modes of preparation, and the informants' perception of the temporal change in this species abundance (increase, decrease, or stable). In group discussions, key informants were selected with the help

of knowledgeable persons in each village Mir *et al.* (2022). To avoid non-genuine information, special care was taken (Quinlan 2005), and responses were cross-checked through informal methods for confirmation (Mir *et al.* 2022). The code of ethics of the International Society of Ethnobiology was followed (ISE 2006), as adapted by (Favi *et al.* 2022b).

Table 1. Socioeconomic traits of the informants across the municipalities prospected

Traits		Zakpota	Zogbodomey	Zangnanado	Total
Number of informants		71	83	59	213
Women (28.75%)	<30 Yrs	16.31	14.97	9.11	13.46
	30<i<60 years	8.56	13.37	13.67	11.87
	>60 Yrs	0.9	2.36	7	3.42
Men (71.24%)	≤30 Yrs	6.52	17.37	12	11.96
	30<i≤60 years	47	43.16	37.89	42.68
	>60 Yrs	20.71	8.76	20.33	16.60
Education	No education	55.75	57.96	70.33	61.35
	Primary	31.41	26.58	23.54	27.18
	Secondary	11.76	15.46	3.67	10.30
	University	1.08	0	2.44	1.17
Profession	Traditional healers	67.75	57.96	72.31	66.01
	Farmers	17.41	21.58	11.84	16.94
	Hunters	11.06	14.65	6.86	10.86
	Herbalists	3.77	5.81	8.99	6.19

Data Analysis

Informant 'use reports were previously grouped into use categories (handicraft, fuel, medicinal, religious, fishing, hunting, and bio-repellents) following Hoffman & Gallaher (2007). Some categories, such as medicinal uses, were then ranged into subcategories corresponding to various body systems to which the affection is linked (Heinrich *et al.* 1998; Faruque *et al.* 2018); affections that could not be linked to a given system (non-specific affections) were considered as general health care. The ethnobotanical indicators, such as the citation frequencies for use reports, use categories, plant parts used, preparation modes, and perception of the temporal change in this species abundance (increase, decrease, stable), were calculated (Favi *et al.* 2022b).

The citation frequency of a given use was determined by dividing the total number of citations of a reported use by the total number of citations of all uses.

For plant parts reported for each use report, the index value of organ (IVO) was calculated following the formula (Balima *et al.* 2018):

$$IVO = \sum Nui\ x1/Ntu$$

Nui: the number of use patterns of each organ quoted by informants i, and Ntu: the total number of uses of all organs quoted by the informants N.

Then, the chi-square test (X^2) was used to test whether the frequency of citation of a given criterion differed significantly between the communes prospected. The results were designed through table or circular, chord, and alluvial diagrams given to informants' sexes, ages, and communes, using RAWGraphs following Mauri *et al.* (2017).

Results

Use reports and categories, and use values

In this study, *T. vogelii* was reported in seven (17) use reports, of which firewood (20.26%), malaria treatment (17.65%), and abscess (11.11%) were the main use reports cited by informants (Fig. 2). In contrast, madness (onset), wound, and use as arrow poison were the least mentioned uses, with 0.65% each. These use reports ranged into categories that showed that

T. vogelii was mainly used in two categories, such as plant-based medicine (62.09%) and fuel (20.26%). Indeed, informants reported using the entire plant to start or "refresh" kitchen fire.

Moreover, the frequency of citation of these uses varied within the municipalities prospected. Thus, in Zangnanado, the main use reports emphasized the global trend with firewood uses (18.33%) and malaria and abscess treatments with 13.33% each. Malaria treatment (24.39%), firewood uses (17.07%), and diarrhea treatment (14.63%) were the main uses reported in Zakpota, while informants in Zogbodomey reported the following main uses: firewood (25%), malaria (17.31%), and abortion, and diarrhea received 9.62% each. Within the municipalities investigated, Zangnanado was the commune with the highest citation frequency (39.22%) and was followed by Zogbodomey (33.39%) and Zakpota (26.80%). In addition, as presented by Figure 4, findings revealed that the men provided the highest number of use reports, especially those within the 30- and 60-year-old class (class age 2).

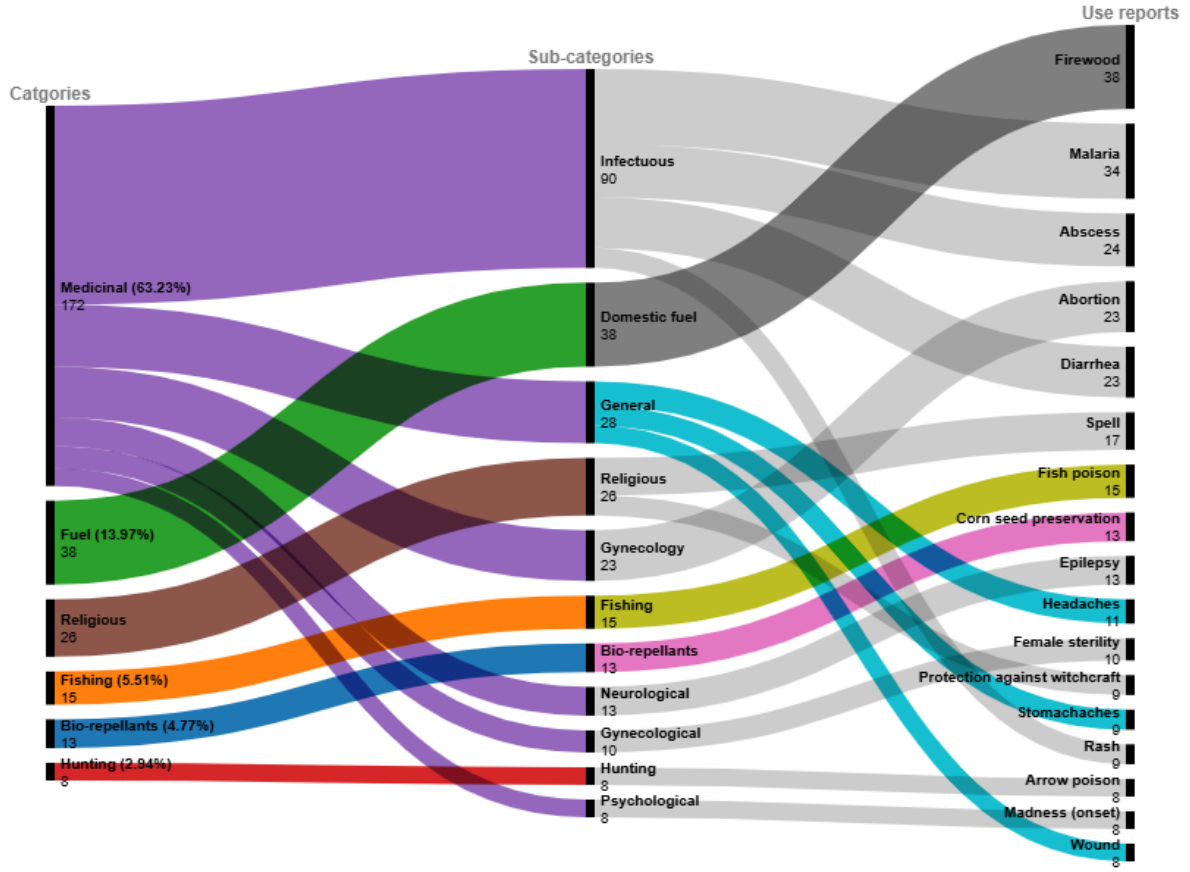

Figure 2. Alluvial diagram showing the use frequencies of the use reports and category of uses

Plant parts used, preparation, and administration modes

All plant parts were reported in *T. vogelii,* as shown in Fig. 5. As far as the utilization of plant parts for herbal remedy preparation is concerned, the index value of organs (IVO) revealed that the leaves (37.65%) were the most commonly used plant part, followed by the leafy stem (16.2%), whole plant (11.47%), stem bark (10.33%), seeds (9.91%), fruits (7.26%), roots (4.82%), and stem (2.36%). These plant parts varied significantly across the communes prospected (X-squared = 27.869, df = 14, p-value = 0.01481).

Regarding the form of preparation of remedies based on plant parts of *T. vogelii*, the study results show that decoction (50.2%) was the most frequent preparation form. It was followed by trituration (14.91%), poultice (11.43%), powder (11%), calcination (7.53%), and soaking (4.93%) (Fig. 6). However, the chi-square test performed revealed that the preparation modes of remedies did not vary significantly across the communes prospected (X-squared = 12.491, df = 10, p-value = 0.2535).

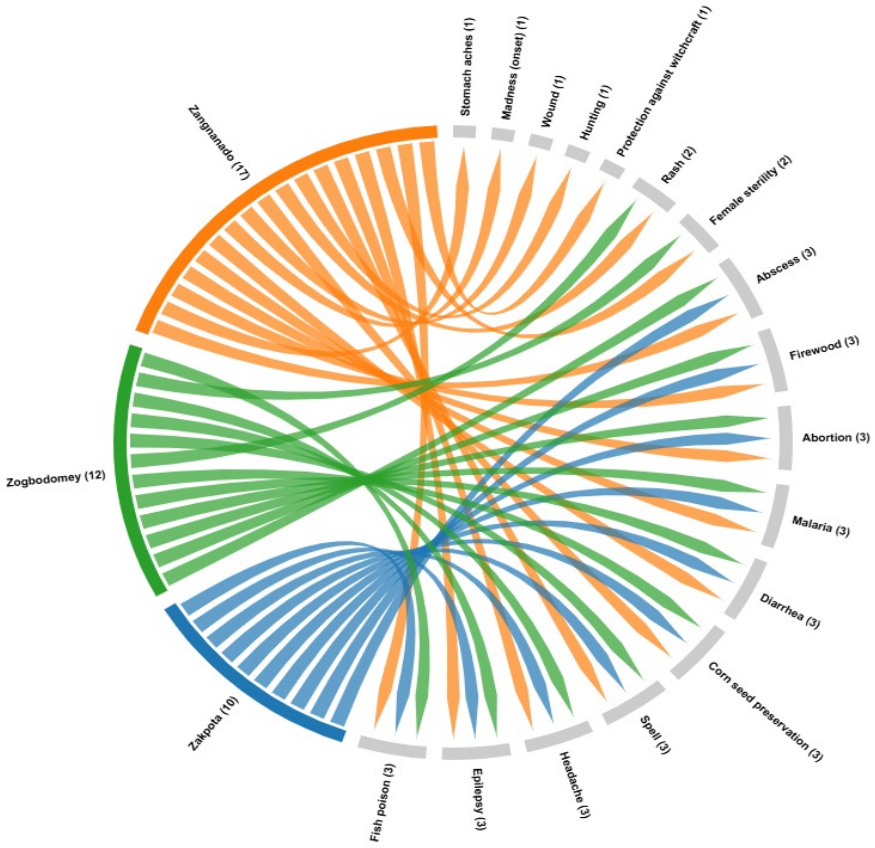

Figure 3. Chord diagram showing uses reports across the three surveyed communes. The frequencies of use reports are into brackets.

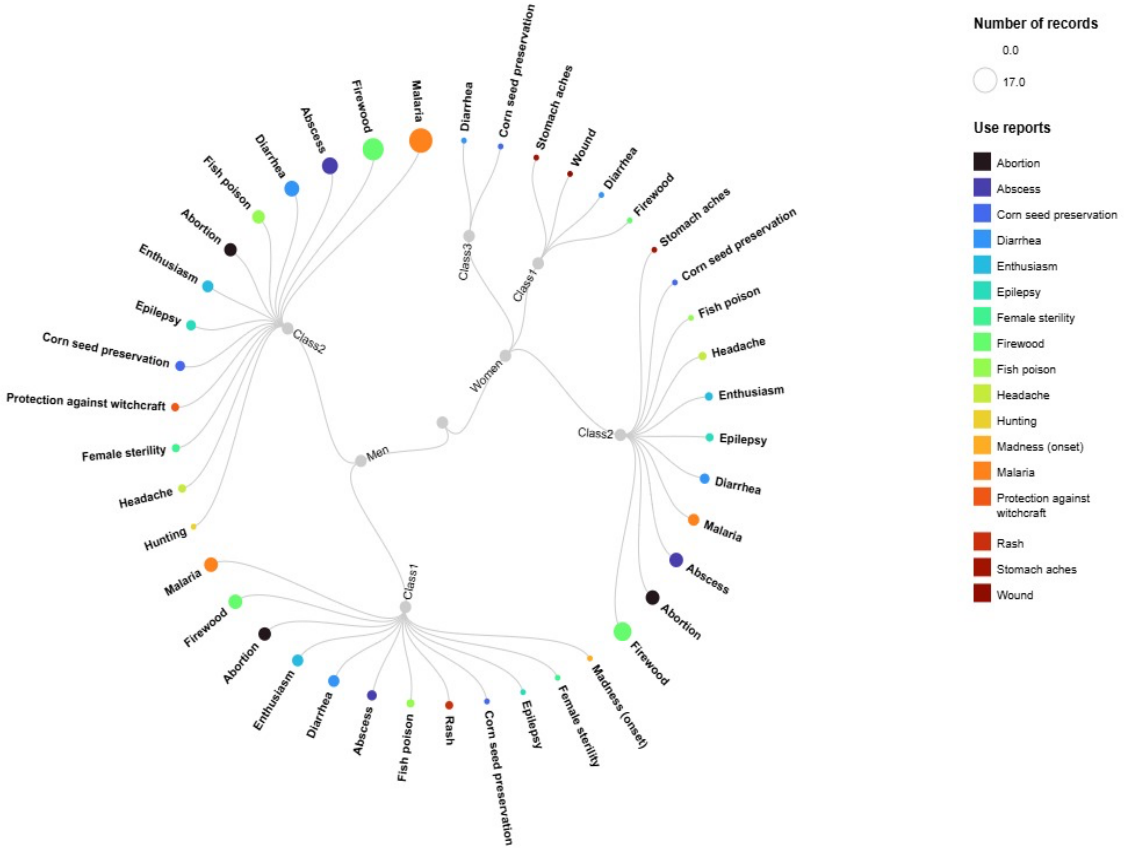

Figure 4. Circular dendrogram showing the repartition of uses reports according to sexes and age classes of informants.

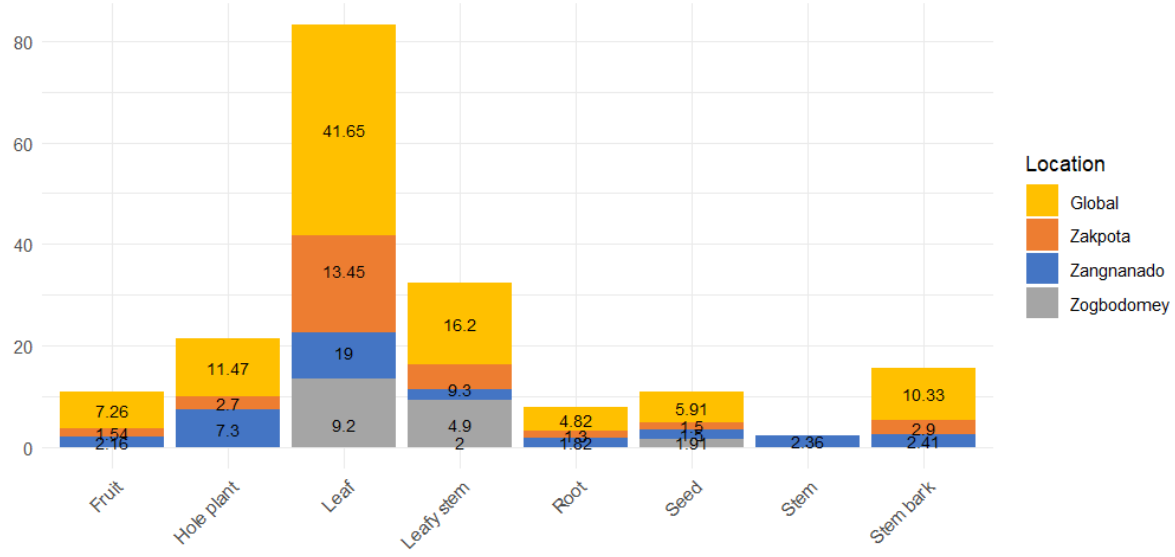

Figure 5. The index value of organs (IVO) in remedies

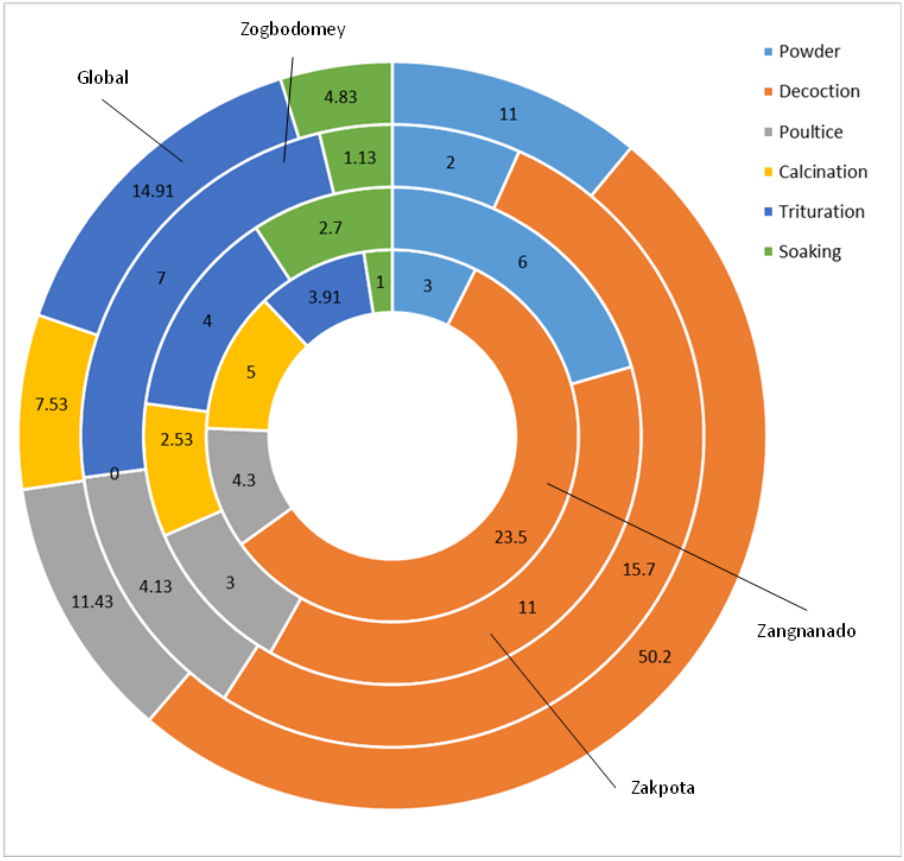

Figure 6. Frequencies of preparation modes of plant parts in remedies.

Informants' perceptions of temporal changes in species local abundance

Overall, the majority of informants (69.67%) reported that the population of *T. vogelii* has decreased locally (Table 2). This trend was also observed in the three municipalities prospected, where 62.71%, 70.42%, and 75.90% of informants reported a decline in the species abundance in Zangnanado, Zakpota, and Zogbodomey, respectively. However, the temporal change in this local abundance was broadly considered to be stable by 24.75% of informants, while 5.56% of them reported that this trend was rather increased. Globally, the trend of this species abundance, as perceived by informants, varied significantly across communes prospected ($p < 0.05$).

Table 2. Perceptions of temporal changes in species local abundance across the communes

Temporal change	Zangnanado	Zakpota	Zogbodomey	Global
Decrease	62.71	70.42	75.90	69.67
Increase	11.86	0	4.819	5.561
Stable	25.42	29.57	19.27	24.75
X^2 test	X-squared = 16.226, df = 6, p-value = 0.01259			

Discussion

Traditional uses, organs and preparation modes of remedies

This ethnobotanical study conducted in the center Benin formally recorded the uses of *T. vogelii* across the Fon ethnic group. Informants interviewed were composed of women and men, with a clear predominance of males, and mainly represented by people of under 30 years old. This result is in line by previous findings which supported that the socio-cultural factors, such as age, gender, occupation, and education level, could drive the traditional knowledge of plant species (Sop *et al.* 2012). Moreover, contrary to previous findings which supported a lack of interest of the younger generation toward traditional treatment systems, findings obtained here reported people with under 30 years olds as most informants in this study (Kadiri *et al.* 2015).

In this study, informants practice various profession and traditional healers (66.01%) was the main profession recorded, followed by farmers (16.94%). These informants have mainly not received any formal education. *T. vogelii* was reported into 17 use reports, proving that the species is well known and named across Fon ethnic group in Centre Benin. This is in line with the assertion that plants are given folk names when people know and/or use the given plant (Hidayati *et al.* 2022), supporting its cultural importance (Favi *et al.* 2022b). The use reports recorded emphasize previous results which documented a wide range of uses *T. vogelii* across its geographical distribution areas in Benin and elsewhere (Ogendo *et al.* 2004; Koona & Dorn 2005; Akoègninou *et al.* 2006; Belmain *et al.* 2012). The main uses of *T. vogelii* are the medicinal uses to solve about fourteen (14) human health issues. Among these affections, infectious affections such as malaria, abscess and diarrhea were mostly mentioned. Indeed, this hold several secondary metabolites including flavonoids, sesquiterpenes, steroids, isoflavonoids, saponins, rotenoids, and fatty acids (Mlozi *et al.* 2020; Yulvia *et al.* 2024), which possess potent biological and pharmacological activities, such as antibacterial (Kusumaningtyas *et al.*), antioxidative, anti-inflammatory, antimicrobial (Chen *et al.* 2014; Samuel *et al.* 2019).

However, this species was also reported in abortion supporting its toxicity (Dzenda *et al.* 2007; Dougnon *et al.* 2016) and uses as poison in fishing (Akoègninou *et al.* 2006). Early studies revealed several chemical compounds in *T. vogelii* organs, of which rotenoids, including deguelin, tephrosin, and rotenone (with deguelin being the most abundant) (Zhang *et al.* 2020). This could support the uses of all plant parts of *T. vogelii* as recorded in this study. At least, the decoction, trituration and poultice were the frequent preparation modes in *T. vogelii*. Concerning the plant parts reported by informants, leaves revealed the highest frequency of citation supporting findings of several authors (Mekonnen *et al.* 2022). This wide uses of the leaves supports various hypothesis such as the abundance and ease of collection (Mekonnen *et al.* 2022), the richness in bioactive compounds, with many medicinal properties (Remesh *et al.* 2023), the traditional processing through various methods like crushing, boiling, or drying for use in traditional remedies (Parvez & Yadav 2010), or the usual uses of leaves in diverse ways, the versatility (Savvides *et al.* 2023). Furthermore, about 50% of preparation methods of *T. vogelii* plants were based on decoction, following by trituration (14.91%) and poultice (11.43%). This is in line with findings reporting decoction and oral administration as the most prevalent method of preparation, and route of administration, respectively (Ghafouri *et al.* 2025). The predominance of this mode preparation could be due to the perceived high effectiveness in most affection treatments or because aqueous extracts are often less toxic than preparations with other extraction methods.

Decline of species availability and implication for conservation

As reported by informants, the local abundance of *T. vogelii* has decrease. In fact, expansion of agricultural land, natural habitat fragmentation, unsustainable and uncontrolled harvesting practices increasingly the induce a decline of local abundance of several multipuropose plant resources and threat there long-term availability (Viana *et al.* 2022). However, this decline is not only linked to *T. vogelii*, but to a global observation of the general loss of natural habitats and advanced forest degradation, leading to biodiversity loss or the scarcity of certain species in their natural habitat. Several authors in the past have reported this decline in the populations of certain species, as is the case with Detarium spp. (Houénon *et al.* 2021), Cochlospermum spp. (Favi *et al.* 2022b), Strychnos spp. (Djidohokpin *et al.* 2025) and more. Sometimes, local populations consider conservation actions unnecessary since they think that species regenerate naturally in the wild (Favi *et*

al. 2022a). In this context, it is crucial and urgent to rethink local practices in collecting and managing plant resources and to establish sustainable management strategies for wild populations of these resources. According to Favi *et al.* (2022a), rural populations should be sensitized with their potent role in resource conservation and reducing pressure on natural vegetation for effective plant conservation.

Future outlook

Beyond the results of this study, which reveal the uses of *T. vogelii* in traditional medicine, the species is also used in post-harvest conservation. This use, although rarely reported, confirms the species' potential as a biopesticide. This use had previously been reported by other authors, such as Ogendo *et al.* (2004), and Kerebba *et al.* (2019). As reported by Stevenson *et al.* (2012), *T. vogelii* is widely used as a pesticidal plant and provides interesting nutrients for the soil. As such, it would be useful to investigate the effectiveness of extracts from the species in the field treatment of crops with a view to developing natural biological formulas for pest control. Indeed, biopesticides protect crops from a large spectrum of pests and diseases, inducing specific action against pathogens and considerably reducing the risks and impacts on human and environmental health (Mawcha *et al.* 2024). It is made of plant-based natural substances and secondary metabolites, some bioactive compounds with antiparasitic, bactericidal, fungicidal, viricidal, and insecticidal properties, making it a valuable alternative to inorganic pesticides (Khursheed *et al.* 2022). They become ecological pest management tools in sustainable agriculture. Previous studies supported the effectiveness of *T. vogelii* in controlling many hard-to-kill field insects, including some fruit worms, cucumber beetles, leafhoppers, squash bugs, thrips, scales, flea beetles, and harlequin bugs (Ogendo *et al.* 2004; Koona & Dorn 2005; Kerebba *et al.* 2019; Zhang *et al.* 2020). According to (Koona & Dorn (2005), people use the dried leaves of *T. vogelii* to protect stored legume seeds from damage by the bruchids.

In this study, the use of leaves in corn seed conservation proves the existence of traditional knowledge and practices and the species potential in pest control. As such, further investigations on the effectiveness of extracts in pest control appear imperative. Findings of this study could strengthen insight on the useful knowledge of suitable doses for effective results and precautions to set up, including safe procedures for extraction, appropriate labeling of the extracted products, methods for storage, and safe methods for field applications at convenient times (Zhang et al. 2020).

Conclusion

Findings in this study reported the local uses of *T. vogelii* across Fon ethnic groups in central Benin. The traditional uses were about 17 use reports, ranging into six categories of uses, such as medicine, fishing, hunting, fuel, religious, and bio-repellant. The use reports included the treatment of various diseases, of which malaria, abscess, diarrhea, female sterility, etc. It was also reported as firewood, fishing poison, arrow poison, and in corn seed conservation. These uses offer several avenues for future research to better justify traditional knowledge, such as the use of extracts from the species in biological control as crop pests. However, the decline in the species' populations as reported by informants does not bode well for its long-term availability. To this end, further research must be conducted to document the threats to the species with a view to establishing a sustainable management strategy for *T. vogelii* in Benin and throughout its range.

Declarations

List of abbreviations: INSAE - Institut national de la statistique et de l'analyse économique; GBIF - Global Biodiversity Information Facility; ISE - International Society of Ethnobiology; IVO - Index value of organ.

Ethics approval and consent to participate: The development of the study followed the ethical and legal guidelines for the development of research on traditional knowledge. All informants involved provided their prior informed consent before the interviews.

Consent for publication: Not applicable

Availability of data and materials: Inquiries regarding data may be directed to the primary author.

Competing interests: The authors declare no competing interests.

Funding: No funding was received for this research.

Author contributions: L.D. conceptualized and designed the overall strategy of the study under supervision of D.C.C. L.D. conducted fieldwork data collection. G.A.F. and L.D. performed data analysis and drafted the initial manuscript. All authors participated in reading, revising, reviewing, and approving the final draft of the manuscript.

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