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Ethnobotanical survey on threatened medicinal plants in Togo

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Local communities heavily rely on the use of plants for disease treatment, notwithstanding modern medicine's progress. However, climate change and anthropic actions exacerbate threat to these medicinal plant's survival. This study aims to list Threatened Medicinal Plants (TMP) in the Guinean Zone of Togo and to access community's traditional knowledge about them. For this purpose, 31 localities were investigated and ethno-medicinal data was collected through semi-structured methods, including individual interviews and focus groups. A total, of 124 TMP were recorded, belonging to 118 genera and 47 families. The top five plant taxa were Khaya senegalensis (49.4%), Sarcocephalus latifolius (35.5%), Zanthoxylum zanthoxyloides (26.1%), Flueggea virosa (19.3%) and Caesalpinia bonduc (19.0%). The plant parts and mode of preparation most used were respectively leaves (64.8%) and decoction (76.6%). The high Informant Consensus Factor (IFC) (0.79) calculated shows strong agreement on TMP usage according to the disease categories identified. TMP such as K. grandifoliola, K. senegalensis, A. africana, G. afzelii, V. paradoxa, P. erinaceus and M. excelsa are vulnerable worldwide according to IUCN criteria. Safeguarding these TMP through their domestication and culture will help to safeguarding TMP and the traditional knowledge about them.

Keywords: threatened medicinal plant, ethnobotany, conservation, Togo

INTRODUCTION

Plant genetic resources provide a multitude services for all human-being across the world (Thiombiano et al., 2022). They are still used in numerous fields, and their medicinal use is highly valued (Sofowora, 2010; Chukwuma et al., 2015). Despite the progress of modern medicine (Motto et al., 2021), plant drugs are gaining in popularity among populations (Gadikou et al., 2022), especially in these post Covid-19 times (Haidara et al., 2020), because plant drugs are considered to be less toxic and milder than pharmaceutical product (Briki, 2019; Delhami et al., 2022). As result, 70–95% African people use plants for the treatment of primary symptoms. The plants knowledge (Atakpama et al., 2021), the trust and the medicinal efficacy of plant recipes (Kpoyizoun et al., 2019), and the populations impoverishment (Ouro-Djeri et al., 2022) explain this high increase in plant use (Agbodan, 2023). These reasons have increased anthropic action on medicinal resources, leading to the scarcity of some medicinal phytogenetic resources (Ouro-Djeri et al., 2022). In addition, climate change (Elith et al., 2011; Cain and Douzet, 2022) combined with ecosystem fragility (Adjossou et al., 2022) hampers the chances of survival and perpetuation of

medicinal plant species, which are a cultural legacy for various populations (Salako et al., 2021; Favi et al., 2022; Xu et al., 2022). Plants that were once highly prized for treating diseases are seeing their habitat reduced and threatened (Gadikou et al., 2022). There is a need to survey scarce and threatened medicinal plants and their related local knowledge for their conservation to next generations. This study contributes to the conservation of threatened medicinal plants (TMP) with their local knowledge. To the best author's knowledge, the available information on TMP in the Guinean zone is far from exhaustive. Although previous ethnobotanical surveys of medicinal plants have been conducted in the study area (Agody, 2007; Gnondoli et al., 2015; Holaly et al., 2015; Kpodar et al., 2015; Agbodeka et al., 2016; Kpodar et al., 2016; Agbodeka et al., 2017; Gbekley et al., 2017; Effoe et al., 2020; Atakpama et al., 2021; Gadikou et al., 2022; Ouro-Djeri et al., 2022), few investigations have focused on TMP. Consequently, this work would provide a useful update to a database for the preservation and promotion of ancestral TMP knowledge. Knowledge about diversity and local knowledge of TMP will allow for giving a priority on their conservation. This study aims to (i) list threatened medicinal plants in the Guinean zone of Togo, and (ii) inventory the medicinal uses of these TMP.

MATERIAL ET METHODS

Study area

The choice of the Guinean zone is based on its abundant plant diversity and the pressures from agricultural and urban expansion on the local ecosystem. The study area can be divided into three ecological zones (Ern, 1979). The plains zone situated in the northeast is characterized by savannas interwoven with dry forests dominated by Anogeissus leiocarpus. These savannas exhibit diverse flora, with Combretaceae and Andropogonae being the prominent species. Amid these savannas, are pockets of semi-deciduous forests and gallery forests featuring primary species like Cynometra megalophylla, Parinari congensis, and Pterocarpus santalinoides. The mountainous zone (ecological zone IV) in the northwest consists of semi-deciduous humid forests (Akpagana, 1989). Species found here include Hidelgardia barteri, Khaya grandifoliola, Milicia excelsa, Morus mesozygia, Parkia filicoidea, Musanga cecropioides, Triplochiton scleroxylon, and Pterocarpus midbraedii. These forests are interspersed with savannas containing species such as Lophira lanceolata, Pterocarpus erinaceus, Hymenocardia acida, Crossopteryx febrifuga, Faurea speciosa, and Vitex doniana. This region also harbors 110 locally threatened species and 16 globally vulnerable species, as per the IUCN criteria, highlighting its ecological significance (Adjossou, 2009).

The coastal plain (ecological zone V) to the south showcases a diverse landscape including croplands, fallow areas, thickets, bushes, and grassy savannas, along with sacred and community forests (Folega et al., 2023). Mangroves, flooded meadows, and savannas also thrive in the extreme southeast. This study holds particular importance in mitigating human-induced impacts on these ecosystems, reinforcing the conservation of threatened medicinal plants (TMP), promoting sustainable management practices, and safeguarding the valuable indigenous knowledge pertaining to TMP.

Ethnobotanical survey and data collection

The localities to be investigated were chosen on a stratified sampling basis (Akpavi et al., 2007). Strata selected were ecological zones (Ern, 1979) and the spread of ethnocultural groups (Gayibor, 1997) (Figure 1). An explorative survey was carried out to evaluate the understanding of the questionnaire and to determine the size of sample to be survey.

The sample was determined by Dagnelie's formula (Dagnelie, 1998) , where N is the sample size to be determined; p is the proportion (relative frequency) of respondents with knowledge about TMP; U1-α/2 is the standard value of confidence level (interval); and d is the margin of error set at 5% for this study. This formula provides a theoretical sample of person to be surveyed. It has been used by

several authors to determine the size of the surveyed sampling (Agbodan et al., 2020; Awo et al., 2020; Bi et al., 2020). Thus, several householders were surveyed in each locality with the goal to obtain a maximum and redundancy in information on TMP and their related local knowledge. Given the specificity of the information searched, adults (30-60 years) and older people (> 60 years) were favored. In each locality, resource people were selected with the help of local leaders. After explanation of the objectives, the local leaders and agricultural managers assembled people who fulfilled the criteria of the investigation. This approach has the advantage to build a mutual climate of trust and enables the collection of reliable and accurate information on a highly sensitive topic of medicinal plant. The ethics code was carefully followed, and an oral agreement “agreeing to be interviewed” from the community authorities and each interviewee, in accordance with the principles of the ethics ISE code was received. So, 352 interviewees from 31 localities and 10 cultural groups were surveyed from April to September 2022 throughout the study area. The Ewe, Adja, and Kabyè communities were investigated more, because of their widespread geographic distribution (Gayibor, 1997). Data were collected through semi structured individual and focus group (Akpavi et al., 2013). The questions are focused on medicinal plants, which were used in the past but no longer exists in the area, local knowledge related to these medicinal plants, plant organs, preparation, administration method, and diseases treated.

Classification of medicinal uses

The various diseases and symptoms were grouped into categories defined by the International Classification of Primary Care, Second Edition (Jamoulle et al., 2000). This classification has been used in several research related to medicinal plants (Gumisiriza et al., 2019; Lee et al., 2019; Miara et al., 2019; Anywar et al., 2020). These are general and unspecified diseases (A), blood and immunological system diseases (B), digestive system diseases (D), cardiovascular diseases (K), osteoarticular diseases (L), neurological diseases (N), psychological diseases (P), pregnancy and childbirth diseases (W), respiratory diseases (R), skin diseases (S), endocrine metabolism diseases (T), female genital system diseases (X), and male genital system diseases (Y).

Statut IUCN et statut local des TMP

The TMP identified was compared to the IUCN Red List (List, 2015) and local red lists (Radji, 2008; Adjossou, 2009; Atsri et al., 2018). The red list allows us to know the risk of extinction of species, and to monitor changes in the status of species (Kaky & Gilbert, 2019). The classes defined are Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC). According to the latest categorization, species considered threatened include those that are critically endangered, endangered and vulnerable. The R software, via rredlist package, was used to establish the status of TMP identified (Whitney, 2022).

Data Analysis

The collected data are inputted and encoded in the Excel for analysis. The Ethnobotany package of Rstudio software was used to generate basic quantitative indices in ethnobotany (Table 1). These are the reported uses (UR), the index of cultural importance (IC), and the consensus factor index (CFI).

RESULTS AND DISCUSSION

Respondents’ profile

The largest numbers of respondents were native people (84.4%), given the specific nature of the topic (Table 2). The sex ratio was 0.87, indicating a nearly equal distribution of interviewees by gender. Adults and elderly people (over 35 years old) were the most investigated age groups. The

number of dependents (children) was low (0–5) in 42.0% of households investigated. The respondents were occasional users (77.0%), traditional practitioners (19.6%), and resellers (3.4%), and 40.1% of these categories were illiterate. The results indicate that a low level of education does not hamper the acquisition of medicinal plant practices. Our results support those of Kpodar et al., (2015, 2016) in Togo. The number of threatened medicinal plants did not vary significantly according to respondent age, education level or household size. However, a significant difference at the 5% threshold was observed for the variables gender, type of respondent and distance of the locality from the nearest hospital (Table 1). Results are similar to those of work of Kébenzikato et al., (2015) in Togo, on the influence of socio-economic parameters on local knowledge about Adansonia digitata.

Medicinal plant diversity

Semi-structured interview helped to identify 124 TMP belonging to 118 genera and 47 families (Table 3). This rich diversity of TMP indicates a good knowledge of medicinal plants that are becoming rare, disappearing, or difficult to access (Gaur and Sharma, 2011), an area rich in highly anthropized ecosystems (Adjossou, 2009; Koda et al., 2019), a poor economic status of the residents, and an attachment to plants for the diseases treatment (Ouro-Djeri et al., 2022). Fabaceae (21 species), Euphorbiaceae (12 species), Apocynaceae (7 species), Compositae (5 species), and Rutaceae (5 species) are the most abundant botanical families identified (Figure 2). More than half-botanical families are represented by one or two species. The most frequently cited TMP are Khaya senegalensis (49.4%), Sarcocephalus latifolius (35.5%), Zanthoxylum zanthoxyloides (26.1%), Flueggea virosa (19.3%), Caesalpinia bonduc (19.0%), Bridelia ferruginea (16.19%), Acanthospermum hispidum (15.63%), Uvaria chamae (14.8%), Morinda lucida (13.7%), and Alstonia boonei (12.2%). Our results reinforce those of Gadikou et al., (2022) working on vulnerable medicinal plants in the maritime region of Togo. Seventy-eight (78) species are similar between the two studies. Seven (07) TMP are involved in the treatment of more than five (05) diseases. These plants, qualified as versatile, offer a wide range of recipes for the treatment of diseases. It is about A. hispidum, A. floribunda, C. bonduc, Jatropha curcas, K. senegalensis, M. lucida, and Vitex doniana. According to Schulz et al., (2001), for a given therapeutic indication, the traditherapist can cite several plants to hide the one containing the active ingredient. Sanon et al. (2003) showed significant inhibitory activity of A. hispidum (IC 50 =5.02 µg/mL) on Plasmodium falciparum isolates from children between 4 and 10 years old in Burkina Faso. In addition, Ram et al (Ram et al., 2004) proved the efficacy of A. hispidum (5000 µg/mL) against Pseudomonas aeruginosa and Candida albicans. These results can explain the folk utilization of A. hispidum in malaria and sinusitis treatment.

Alchornea floribunda inhibit Bacillus cereus, Enterococcus faecalis, Escherichia coli, which are responsible of gastrointestinal disease, and, Klebsiella pneumonia and Moraxella catarrhalis, responsible of respiratory disease (Noundou et al., 2014). These results confirm the traditional use of A. floribunda for respiratory and gastrointestinal (diarrhea) disease collected. Afolabi and Abejide (2020) reported in vitro activity of Alstonia bonei leaf extract against P. falciparum. The biological properties presented by plant extracts give credit to their indigenous uses. However, twelve plants have not been studied to show the safety and toxicity of TMP. It’s about A. hispidum, A. floribunda, A. albida, C. bonduc, C. viscosa, D. mespiliformis, J. curcas, L. taraxacifolia, M. lucida, N. latifolia, P. foetida, and X. aethiopica.

Launaea taraxacifolia has antimalarial, antiviral against the measles virus, antiarthritic, anti-inflammatory and bactericidal activities (Bello et al., 2018; Owolabi et al., 2020). Milicia excelsa is anticonvulsant, antiamnesic, antipsychotic, antihypoxic activities (Adebayo et al., 2019; Akinpelu et al., 2020). These pharmacological proprieties can explain traditional uses in malaria and female sterility treatment.

Securidaca longipedunculata has antiparasitic, antibacterial, antifungal, antiplasmodial, antiinflammatory, anticonvulsant, histopathologic activities (Alitonou et al., 2012; Mongalo et al.,

2015). These proprieties can explain traditional uses against snakebite, sinusitis and head wounds. However, there is a need to study the toxicity of these plants to ensure safe and effective use in populations.

IUCN Statut vs. local Statut of TMP

Different conservation statuses of TMP were determined (Figure 3). These include vulnerable species (VU) with 2.21% and are represented by species such as K. grandifoliola, K. senegalensis, A. africana, G. afzelii, and V. paradoxa. Threatened species (EN) with 0.74% are represented by P. erinaceus, while M. excelsa is the representative of the near-threatened species (NT) with 0.74%. Nearly 87 plant species are not evaluated (NE) by the IUCN. These results corroborate work which reports that, the IUCN Red List, although providing threat levels at the global level, has limitations because only 5.5% of plant species are assessed (List, 2015; Heywood, 2017). Thus, the threat status of plants varies more at local level than the international level, and several species may be threatened at the local level but not be evaluated at international level. In addition, the level of threat may differ by locality, region, or even continent. Among the 124 TMP identified, twenty-five (25) are classified as vulnerable according to the GBIF-Togo, the national herbarium, and the Togolese flora developed by Radji (2008). It's about A. africana, A. adianthifolia, A. floribunda, A. nobilis, A. vogelii, B. aethiopum, C. edulis, C. pentandra, D. senegalensis, D. mespiliformis, E. angolense, G. afzelii, G. kola, H. floribunda, K. anthotheca, K. grandifoliola, K. senegalensis, M. altissima, M. lutea, M. excelsa, P. excelsa, P. erinaceus, P. santalinoides, T. scleroxylon and V. paradoxa.

This study is in line with the one conducted by Adjossou (2009) in the forest zone (ecological zone IV) of Togo. Thus, 23 TMP were cited as threatened in the forest present in ecological zone IV of Togo. These are A. digitata, A. africana, A. adianthifolia, A. floribunda, A. nobilis, A. vogelii, B. aethiopum, C. edulis, C. pentandra, D. senegalense, D. mespiliformis, G. afzelii, G. kola, H. floribunda, K. senegalensis, M. lutea, M. excelsa, P. excelsa, P. erinaceus, P. santalinoides, T. scleroxylon, V. paradoxa and X. aethiopica. In comparison with the red list of Benin (Neuenschwander et al., 2011), twenty-one (21) TMP are classified as vulnerable. This study has the merit of identifying 35 other TMP (not cited in previous work in Togo) which becoming threatened in study area.

Plant parts and medicinal recipe preparation methods

The interviewees use different plant parts, alone or in combination, for the preparation of medicinal recipes. In this study, eleven (11) plant parts were identified (Figure 2): leaves (64.8%) remained the most commonly used, followed by roots (37.5%), bark (22.7%), and stem (14.8%). These results are similar to those obtained by Ouattara (2006) in Côte d'Ivoire and Olivier et al. (2012) in Burkina Faso.Leaves are the most used for the preparation of medicinal recipes, as they are more accessible (Mounkaila et al., 2017) and are a safe identification factor for users (Asase et al., 2005). Also, leaves, thanks to the photosynthesis phenomenon, remain the primary production site of secondary metabolites. Depending on the nature of the disease, a specific mode of extraction is used. The surveys identified seven (07) methods of preparing medicinal recipes (Figure 3). Of these, the three most commonly used methods of preparation were decoction (76.6%), maceration (35.2%), and roasting (17.2%). These results are similar to those found by Gnagne et al. (2017) in Côte d'Ivoire. Indeed, these different techniques of extraction of active principles from plant organs explain the use of a plant in the treatment of several pathologies or symptoms (N'guessan et al., 2009). Decoction remains the most used extraction method in the world because it allows, on the one hand, complete extraction of active principles (especially tannins) from the plant organs (Etame-Loe et al., 2018), and on the other hand, because it mitigates or cancels the toxic effect of some medicinal recipes (Salhi et al., 2019; Koman et al., 2021). However, it should be noted that respondents have difficulties in putting differences between "decoction" and "infusion".

Informant Consensus Factor

The high consensus factor index (above 0.79) demonstrates strong agreement on the TMP used in each category of disease (Table 4). These results are similar to those obtained by Gumisiriza et al. (2019) and Anywar et al., (2020) in Uganda. This index reflects good knowledge of PMTs due to cultural mixing during inter-ethnic marriages (Atakpama et al., 2015) or fine environmental control. Skin diseases (S), those related to the immunological system (B), and those of a general and non-specific nature (A) are treated, respectively, by 62, 58, and 45 TMP. However, dermatitis, wounds, and malaria constitute important scourges in rural environments. The scarcity of these TMP makes it difficult to find a cure for these diseases, especially in poor families

CONCLUSION

In the Guinean zone of Togo, there is a rich diversity (124) of medicinal plants that are threatened with extinction. This phytodiversity is essential for the local populations because the are used in the treatment of general and non-specific ailments, with general illnesses taking the lead. The plant parts and mode of preparation most used were leaves (64.8%) and decoction (76.6%), respectively. The pharmacological tests confirm the validity of medicinal recipes based on these TMP. This list remains threatened due to the increasing pressure on the collection of plant parts. However, a judicious use of herbal remedies is necessary to prevent resistance and public health issues. It is essential to promote domestication efforts to carry out their conservation.FundingThis study was funded by Rufford Foundation, England (N°34986-1, 2022) and IDEA Wild (USA, 2022) to the first author.

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