**A Comprehensive Review of the Diversity and Socioeconomic Uses of Non-Timber Forest Products in Togo**

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ABSTRACT

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| **Non-timber forest products (NTFPs) hold significant potential for sustainable ecosystem management, climate resilience, and food security, particularly when effectively integrated into development strategies. This study synthesizes existing literature and field observations to assess the diversity and uses of NTFPs in Togo. A total of 851 species (plants, animals, fungi, and bacteria) were documented, with dominant uses in food (51.24%) and medicine (29.40%). These NTFPs represent over 10% of Togo’s known biodiversity and are classified into 565 genera and 213 families. The study identifies priority taxonomic groups such as Fabaceae and Moraceae among plants, and highlights key vertebrate and invertebrate resources. The findings provide a valuable baseline for future research, conservation, and livelihood-enhancing policies, and underscore the need for integrated strategies to ensure the sustainable use of these vital natural resources.** |

*Keywords: Non-timber forest products, biodiversity, utilization, sustainable development, Togo*

1. INTRODUCTION

According to the most recent *State of Food Security and Nutrition in the World Report* (FAO et al., 2023)**,** between 691 million and 783 million people experienced hunger in 2022, with Africa and Asia being the most affected continents. In sub-Saharan Africa, over one-third of the population faces challenges related to both the quantity and quality of food (Kennedy, 2003). The diversity of food crops in tropical regions offers potential solutions to these issues of undernutrition (FAO/INFOODS, 2014, 2018; Johns, 2003). However, a significant portion of these resources remains underutilized (Padulosi and Hoeschle-Zeledon, 2004).

In Togo, many minor food plants, once widely consumed and valued, are gradually being abandoned (Akpavi, 2010). This trend threatens plant genetic resources critical for human nutrition with extinction (Magha, 2004). Agrodiversity loss is further exacerbated by climate change, which disrupts agricultural stability by altering growing conditions (Balaka and Yovo, 2023; Lagacé, 2015; Seguin, 2010). Projections suggest that global agricultural production could decrease by 2%, while food demand may increase by 14% by 2050 (Porter et al., 2014). The poorest countries, particularly vulnerable to natural disasters, will likely experience the steepest declines in agricultural yields (Pelling et al., 2004).

Given the challenges posed by climate change, adopting short- and medium-term strategies is crucial to meet the growing food demands of the global population. The promotion of neglected and underutilized crops, including primitive cultivars of major crops and their wild relatives, offers a promising approach. These species, with their resistance to abiotic and biotic stresses, can strengthen ecosystem resilience and adaptability to climate change while addressing nutritional and socio-economic challenges. This strategy can support vulnerable populations, mitigate poverty, and enhance food and nutritional security.

In tropical regions, many edible wild species continue to be harvested through traditional cultural practices. In Africa, wild forest products provide livelihoods for nearly 60 million people (Kouakou et al., 2017), with more than two-thirds of sub-Saharan Africa's population depending on forest resources for sustenance (Mawunu et al., 2016). Due to poverty and food insecurity, household dependence on forest resources has grown in developing countries (Padakale et al., 2015).

Non-timber forest products (NTFPs) are of significant socio-economic and environmental value, contributing to poverty reduction and food security for various African ethnic groups (Loubelo, 2012; Aleza et al., 2018; Badjaré et al., 2018). NTFPs encompass biological resources other than timber, originating from forests, trees outside forests, and other woodlands. These include products used for food, medicine, cosmetics, craftsmanship, cultural purposes, and trade (Chitale et al., 2018; Pandey et al., 2016). Despite international interest, NTFPs remain largely neglected, with limited data on their socio-economic importance, ecological impacts, and contributions to national GDPs. Unlike timber and agricultural products, most African countries lack monitoring and evaluation systems for NTFPs and their socio-economic roles.

To maximize the benefits of NTFPs, it is essential to inventory their diversity and assess their socio-economic relevance. Recent years have seen an increase in ethnobotanical, ethnofungal, ethnozoological, and commodity chain studies on NTFPs in Togo. These studies include research on wild vegetables (Batawila et al., 2005a, 2005b), spontaneous fruit trees (Atato et al., 2010), snails (Ekoué and Kuevi-Akue, 2002), insects (Badanaro, 2015), fungi (Kamou et al., 2015, 2017), medicinal plants (Karou et al., 2011; Tchacondo et al., 2012; Radji et Kokou, 2013; Gbekley et al., 2015; Koudouvo et al., 2017; Agody et al., 2019) and cosmetic plants (Pereki et al., 2012). However, these studies often present fragmented data. Regional studies, such as those in Kara (Dourma et al., 2018) and Savanes (Kpeglo et al., 2024), do not provide sufficient information for national-level extrapolation. To address these gaps, this study was initiated to compile and analyze bibliographic data on the diversity and uses of NTFPs across Togo, aiming to support their valorization.

2. methodology

A comprehensive review of scientific knowledge on NTFPs was conducted by consulting various sources, including scientific articles, dissertations, theses, books, and reports published between 1969 and 2024. These materials were accessed through bibliographic searches using keywords related to NTFPs in Togo across databases such as Google Scholar, Bielefeld Academic Search Engine (BASE), and ScienceDirect. After a rigorous selection process, 57 relevant publications were identified, analyzed, and classified into three primary themes: (1) NTFP diversity in Togo, (2) parts of NTFPs used, and (3) applications of NTFPs. The literature review was supplemented by physical document reviews in university libraries in Togo and field observations. Field observations were carried out in several rural markets across the Togolese territory. The selection of survey sites was guided by the results of the literature review, allowing for a targeted approach based on existing knowledge related to the use and sale of NTFPs.

3. results

**3.1 Diversity of PFNL au Togo**

**3.1.1 Diversity of NTFPs of Bacterial Origin**

The literature review identified a single bacterial species, *Arthrospira platensis* Gomont, belonging to the family Microcoleaceae and the genus Arthrospira, recognized as a NTFP in Togo (**Supplementary Table S1**).

**3.1.2 Diversity of NTFPs of Fungal Origin**

The literature review identified 35 species of NTFPs of fungal origin (**Supplementary Table S2**, Table 1). Among these, the Ascomycotina are represented by a single species, *Daldinia eschscholtzii* (Ehrenb.) Rehm, belonging to the family Hypoxylariaceae. The Basidiomycotina encompass 12 families and 14 genera. Seven of these families are monospecific, while the Pleurotaceae and Tricholomataceae families each include two species. The Cantharellaceae and Lyophylaceae are represented by four species each. The most diverse families are the Amanitaceae (6 species) and Russulaceae (9 species).

**Table 1: Summary of NTFP fungal diversity in Togo**

|  |  |  |  |
| --- | --- | --- | --- |
| Fungal groups | Families | Genera | Species |
| Ascomycotina | 1 | 1 | 1 |
| Basidiomycotina | 12 | 14 | 34 |
| Total | 13 | 15 | 35 |

**3.1.3 Diversity of Plant-Based NTFPs**

The review also revealed significant diversity among NTFPs of plant origin, totaling 441 species (**Supplementary Table S3**, Table 2), distributed across 99 families and 314 genera. Among these, *Nephrolepis biserrata* (Sw.) Schott from the family Dryopteridaceae is the only pteridophyte species documented as an NTFP in Togo (Table 1). The angiosperms, predominantly dicotyledons, are complemented by a notable presence of monocotyledons from 10 families.

Among the monocotyledons, four families are monospecific. The most represented families include Commelinaceae (2 species), Dracaenaceae (2 species), Dioscoraceae (2 species), Arecaceae (six species), Zingiberaceae (4 species), and Poaceae (10 species). Dicotyledons are distributed across 88 families, with 36 being monospecific. Fifteen families contain two species each, while the most represented families include Combretaceae (20 species), Apocynaceae (21 species), Moraceae (22 species), and Fabaceae (47 species), making these the dominant families of plant-based NTFPs in Togo.

**Table 2: Summary of botanical diversity of NTFPs surveyed in Togo**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Botanical groups | | Families | Genera | Species |
| Pteridophytes | | 1 | 1 | 1 |
| Angiosperms | Monocotyledons | 10 | 23 | 30 |
| Dicotyledons | 88 | 289 | 410 |
| Total | | 99 | 314 | 441 |

**3.1.4 Diversity of Animal-Based NTFPs**

The inventory identified 374 animal species used as NTFPs, representing 100 families and 235 genera (**Supplementary Table S4**, Table 3). The invertebrate NTFPs include crustaceans, insects, and mollusks (snails). Crustaceans are represented by a single species, while insects span 14 families. Among these, 8 families are monospecific, 3 families include two species, 1 family includes three species, and one family includes 4 species. The most represented insect families are Acrididae (8 species) and Scarabaeidae (13 species). Mollusks are represented solely by the Achatinidae family, with 4 species.

The vertebrates demonstrate considerable diversity, comprising 203 mammal species, 32 bird species, 11 reptile species, and 83 fish species (**Table S4**). Fishes are distributed across 24 families, including 13 monospecific families. Three families are represented by 2 species each, one by 3 species, two by seven species, and 3 by 8 species. The most represented fish families are Mormyridae (9 species) and Cyprinidae (14 species).

Reptiles include members of the families Pythonidae, Varanidae, Testudinidae, and Crocodylidae, totaling four families. The Pythonidae and Varanidae each have 2 species, the Crocodylidae 3 species, and the Testudinidae 4 species.

Birds are classified into 18 families, 15 of which are monospecific. Families with more than one species include Musophagidae (2 species), Ardeidae (3 species), and Psittacidae (6 species).

Mammals exhibit notable diversity, including rodents (rats and mice), squirrels, aulacodes, bats, antelopes, gazelles, hippopotamuses, warthogs, elephants, felines, mongooses, primates, porcupines, pangolins, African civets, hyraxes, otters, zorillas, hedgehogs, hinds, pigs, and tenrecs. Among the 38 families listed, 14 are monospecific. Four families are represented by 2 species, and 4 others by 4 species. Two families have 5 species each, and 2 families contain 16 species. Additionally, 5 families are represented by 3 species, and 3 families by 7 species. The most diverse families are Bovidae (26 species) and Muridae (27 species).

**Table 3: Summary of NTFP zoological diversity in Togo**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Zoological groups | | Families | Genera | Species |
| Arthropods | Crustaceans | 1 | 1 | 1 |
| Insects | 14 | 31 | 40 |
| Molluscs | | 1 | 2 | 4 |
| Fishes | | 24 | 48 | 83 |
| Reptiles | | 4 | 5 | 11 |
| Birds | | 18 | 29 | 32 |
| Mammals | | 38 | 114 | 203 |
| Total | | 100 | 235 | 374 |

**3.2 Proportions of NTFPs in Togo's Biodiversity**

The proportions of the different groups of NTFPs in relation to Togo's biodiversity were calculated using data from Tables 1, 2, and 3, as well as the Convention on Biological Diversity (CBD, 2018). NTFPs account for 11.06% of plant diversity, 4.11% of fungal diversity, 9.10% of animal diversity, and 10.30% of Togo’s overall flora and fauna.

**Table 4:** Percentage of NTFPs of different origins relative to total biodiversity in Togo

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Bacteria | Mushrooms | Plants | Animals | Total |
| NTFP in Togo | 1 | 35 | 441 | 374 | 851 |
| Biodiversity (CBD, 2018) | 815 | 170 | 4002 | 4019 | 8191 |
| Percentage (%) | 0.12 | 4.11 | 11.02 | 9.30 | 10.39 |

**3.3 Used Parts of NTFPs**

The available literature on the parts used in non-timber forest products (NTFPs) predominantly focuses on plant products and mushrooms, with limited information on animal-derived parts. Regarding mushrooms, the cap and stem are generally the primary parts utilized. For plant NTFPs (Figure 1), several plant parts or even the whole plant are used. Whole plants are employed with a frequency of 8.93%. Leaves are the most commonly used plant parts (36.90%), followed by fruits (17.86%), roots (15.03%), stems (12.20%), seeds (5.95%), flowers (1.64%), underground parts (tubers and rhizomes) (1.19%), and gums or resins (0.30%).

**Figure 1: Frequency of citing use of NTFP plant parts**

**3.4 Uses of NTFPs in Togo**

NTFPs in Togo are utilized for a variety of purposes to meet diverse needs. Some NTFPs serve multiple functions, while others are specific to particular uses (Supplementary S1–S4). Seven primary categories of use have been identified (Figure 2). Food applications dominate, accounting for 51.24% of uses, followed by medicinal-related applications at 29.40%. Other uses include artisanal (5.24%), cosmetic (4.71%), forage (3.73%), body care (3.02%), and ritual (2.66%) purposes. More than 80% of the species are used in at least two domains, particularly for food and medicinal purposes.

**Figure 2: Frequency of citing uses of NTFPs**

The frequency of NTFPs used for medicinal purposes, categorized by biological kingdom, is illustrated in Figure 3. Plant-based NTFPs overwhelmingly account for medicinal applications (96.98%), compared to animal species (1.81%) and fungi (1.21%). Conversely, the diversity of animal species used for human consumption (60.49%) is significantly higher than that of plants (33.80%) and fungi (5.72%), as shown in Figure 4.

**Figure 3: Frequency of citing NTFP medicinal use according to species origin**

**Figure 4: Frequency of citing NTFP food use according to species origin**

4. discussion

**4.1 Diversity of PFNL au Togo**

The literature review reveals the significant diversity of NTFPs in Togo, with 851 species identified: 1 bacterial, 35 fungal, 441 plant, and 374 animal species. Collectively, NTFPs constitute 10.39% of Togo's documented biodiversity (Table 4).

**4.1.1 Diversity of NTFPs of Bacterial Origin**

Only 1 bacterial species, *Arthrospira platensis* Gomont, is documented as a food-based NTFP in Togo (Vicat et al., 2014). Although 815 bacterial species have been identified nationally, they are not reported as utilized for consumption or other purposes. The consumption of cyanobacteria is well documented and known on several continents, notably in Asia, South America and Africa since antiquity (Malaisse, 2004; Sguera, 2008). Among them is the *Arthrospira,* known as spirulina, includes species widely cultivated and consumed globally, particularly, *A. platensis* and *Arthrospira maxima* Setchell & N.L. Gardner (Sguera, 2008).

**4.1.2 Diversity of NTFPs of Fungal Origin**

The 35 fungal species identified as NTFPs in Togo (Table 2) are primarily exploited for food and medicinal purposes, consistent with findings in southwestern Côte d'Ivoire (Pitta Badjo et al., 2021). Despite the documentation of 170 fungal species in Togo (CBD, 2018), information on the consumption of fungi remains limited due to insufficient research on mycophagy in West Africa (Bâ et al., 2011).

**4.1.3 Diversity of Plant-Based NTFPs**

This review identified plant-based NTFPs as representing 11.02% of Togo's documented plant biodiversity (Table 4). While macroalgae are not reported as NTFPs in Togo, 28 species of macroalgae have been identified, including *Caulerpa racemosa* (sea grapes) and *Ulva lactuca* (sea lettuces) (Pangestuti et al., 2021) as well as various species of the Fucus genus (Barbosa et al., 2020), known for their consumption in other tropical countries. Additionally, only one fern species *Nephrolepis biserrata* (Sw.) Schott is cited for traditional medicinal use (Koudouvo et al., 2011; Agody et al., 2019), despite the identification of 134 pteridophyte species in Togo (Abotsi et al., 2018).

However, several species of pteridophytes listed in Togo are well recognized for their medicinal uses, notably species of the Selaginella genus (Selaginellaceae), which are exploited for ethnomedicinal purposes worldwide (Adnan et al., 2021), and Dicranopteris linearis (Burm.f.) Underw. (Gleicheniaceae), which is traditionally used in Malaysia to treat various skin conditions (Lai et al., 2021). However, several species of pteridophytes listed in Togo are well recognized for their medicinal uses, notably species of the Selaginella genus (Selaginellaceae), which are exploited for ethnomedicinal purposes worldwide (Adnan et al., 2021) and Dicranopteris linearis (Burm.f.) Underw. (Gleicheniaceae), which is traditionally used in Malaysia to treat various skin conditions (Lai et al., 2021).

The absence of detailed information on the medicinal or edible uses of these species in Togo does not imply they are unused; rather, it highlights a lack of ethnobotanical research. Many of these plants likely play integral roles in the daily lives of rural populations.

Angiosperms are well-represented, with 30 monocotyledonous and 410 dicotyledonous species. Widely utilized species by various populations in Togo include *Adansonia digitata,* *Annona senegalensis,* *Blighia sapida, Borassus aethiopum, Elaeis guineensis, Mangifera indica, Moringa oleifera, Tamarindus indica, Parkia biglobosa, Vitellaria paradoxa*. These species are also recognized as NTFPs in neighboring West African countries such as Côte d'Ivoire (Zanh et al., 2016) and Niger (Hama et al., 2019), as well as in central Africa, notably in Tchad (Madjigoto et al., 2016) and Republic of Congo (Loubelo, 2012).

The commonality of these species across regions is attributed to shared phytogeographical characteristics, which foster similarities in plant formations and ethnobotanical practices. Species selection is often influenced by local ecological conditions and the socio-economic importance of specific plants to rural communities. Among the most represented families, Fabaceae stands out with 47 species, valued for its protein-rich plants critical to human and animal nutrition.

**4.1.4 Diversity of Animal-Based NTFPs**

Non-timber forest products (NTFPs) of animal origin are derived from a wide range of taxa, including arthropods (myriapods, crustaceans, insects), mollusks, reptiles, amphibians, fishes, birds, and wild mammals. According to Badanaro (cited by Adzorgenu, 2024), several species of myriapods (millipedes) are used for both food and medicinal purposes by the Gourmatché ethnic group in northern Togo, where they are even sold in local markets under the vernacular name "goude." Similarly, the Bobo people of Burkina Faso consume millipedes belonging to the families Gomphodesmidae (*Tymbodesmus falcatus* (Karsch, 1881) and *Sphenodesmus sheribongensis* (Schiotz, 1966)) and Spirostreptidae (Enghoff et al.,2014). The shared consumption of millipedes by the Gourmatché of Togo and the Bobo of Burkina Faso underscores cultural links between these geographically adjacent ethnic groups.

Crustaceans from Togo's continental aquatic ecosystems, although abundant, remain poorly documented in scientific literature, with only one species (*Gecarcinus sp*) mentioned. Crustaceans (crabs and crayfishes) are widely consumed in Togo, but their taxonomy remains largely unexplored.

Insects represent a significant category of consumed NTFPs. Commonly consumed species include Orthoptera such as locusts, grasshoppers, and crickets (notably *Brachytrupes membranaceus* (Drury) of the Gryllidae family); Coleoptera larvae and adults (e.g., *Rhynchophorus phoenicis* (Fabricius, 1801) and *Oryctes monoceros* (Olivier));

Isoptera (termites, including queens and adults of the genus *Macrotermes*); Lepidoptera caterpillars (particularly Saturnidae); and Hymenoptera larvae and eggs (*Apis mellifera* (Linnaeus) and Formicidae). The black soldier fly (*Hermetia illucens*), extensively used in global animal feed, has also been documented in Togo (Attivi et al., 2022; Mlaga et al., 2022). Les insectes consommés sont diversifiés. A total of 39 insect species consumed in Togo have been identified (Badanaro, 2015; Tchibozo et al., 2016), representing 7.44% of the 524 edible insect species documented across Africa (Ramos-Elorduy, 2005).

Mollusks, particularly giant snails of the genera *Achatina* and *Archachatina*, are widely consumed in Togo. Additionally, species of the genus *Limicolaria*, consumed in neighboring Benin (Adamou et al., 2018), are likely consumed in Togo but remain undocumented due to the shared culinary traditions between the two countries.

Amphibians, although known to be consumed in Togo, have not been documented in the scientific literature as NTFPs. This gap may stem from the absence of ethnozoological studies on amphibians in the country. Segniagbeto et al. (2006) inventoried 60 amphibian species in Togo, including various Ptychadena frogs consumed in Chad (Seignobos, 2014), *Amnirana galamensis* (Duméril & Bibron, 1841) used medicinally in Burkina Faso (Mohneke et al., 2011), and *Hoplobatrachus occipitalis* (Günther, 1858) consumed in Benin (Codjo et al., 2022).

Reptiles consumed in Togo include snakes (*Python regius* Shaw, 1802), crocodiles (*Crocodylus niloticus* Laurenti, 1768), monitor lizards (*Varanus niloticus* (Linnaeus, 1766)), and tortoises (*Kinixys nogueyi* (Lataste, 1886)). However, as Ombeni (2014) notes, reptiles generally provide limited food resources to forest populations due to widespread fear of their appearance, movement, and venomous reputation.

Birds represent another diverse group, with 31 species identified as NTFPs in Togo. However, this number is modest compared to the 44 bird species documented for traditional medicine by the Gouro people of Côte d’Ivoire (Koue Bi et al., 2017). Commonly consumed species in Togo include birds of prey (*Aquila rapax* (Temminck), *Gyps bengalensis* (Gmelin)), storks (*Ephippiorhynchus senegalensis* (Shaw), *Leptoptilos crumeniferus* (Lesson)), secretary birds (*Sagittarius serpentarius* (Miller)), touracos (*Tauraco persa* (Linnaeus)), owls (*Otus scops* (Linnaeus)), parrots (*Agapornis pullaria* (Linnaeus), *Psittacula krameria* (Scopoli)) for craft and wild guinea fowl (*Agelastes meleagrides* (Bonaparte)), partridges (*Ptilopachus petrosus* (Gmelin) and *Francolinus bicalcaratus* (Linnaeus)), and wild ducks. Many small bird species consumed by children in rural areas remain undocumented due to limited studies.

Mammals are the most diverse group of animal NTFPs in Togo, with 203 species identified. These include rodents (*Mus haussa* (Thomas & Hinton)), aulacodes (*Anomalurus beecrofti* Fraser), squirrels (*Thryonomys swinderianus* Temminck), hares (*Lepus aegyptius* Desmarest), monkeys (*Papio anubis* (Lesson), *Thryonomys swinderianus* (Temminck)), antelopes or gazelles (*Alcelaphus buselaphus* (Pallas), *Sylvicapra grimmia* (Gray)), hippopotamuses (*Hippopotamus amphibius* Linnaeus), warthogs (*Potamochoerus porcus*), elephants (*Loxodonta africana* (Blumenbach)), and felines (*Panthera pardus* (Linnaeus), *Felis sylvestris* Desmarest). These mammals play an essential role in improving food security for rural populations. However, many mammalian species consumed for food and other uses remain undocumented.

The biodiversity of spontaneous flora and fauna in Togo remains poorly documented, especially among lesser-studied taxonomic groups. Ethnobiological studies are scarce, and the identification of species is often complicated by the use of shared vernacular names for multiple species with similar uses. This underscores the need for more comprehensive research to achieve a fuller understanding of Togo’s biodiversity and the range of NTFPs available.

**4.3 Utilized Parts of NTFPs**

The utilization of NTFPs involves various parts of plant and animal species or, in some cases, the entire organism, depending on the resource type. For mushrooms, the cap and stem are the most commonly harvested parts in Togo, as in other parts of the world (Zanh et al., 2016). This harvesting approach allows mushrooms to regenerate through their underground structure, the mycelium, via asexual reproduction.

Research into the components of NTFPs utilized often focuses on plants, with Autochthonous populations exploiting either specific parts or the whole plant, depending on the species. A review of the literature shows that leaves are the most frequently used plant parts, representing 37.48% of samples. This prevalence is likely due to their abundance and ease of harvesting. When fruits (17.31%) and seeds (5.58%) are included, these renewable plant organs account for 60.37% of the total parts harvested. The preference for renewable organs such as leaves, fruits, and seeds over non-renewable vital organs, such as roots (16.17%), stems (13.59%), flowers (1.72%), and entire plants (6.72%), contributes to the preservation of biodiversity. Harvesting renewable organs helps maintain plant populations.

However, non-renewable organs still constitute 44.01% of the harvested plant parts, posing a significant threat to NTFP biodiversity. Studies in Togo (Batawila et al., 2007; Koudouvo, Denou, et al., 2017) have documented the detrimental effects of anthropogenic pressures associated with harvesting these vital organs.

Limited literature is available regarding the animal parts utilized as NTFPs, but certain trends can be identified. The capture of live animals is relatively rare and mainly involves vertebrates, including mammals and reptiles kept as pets, and birds. Most live-captured birds are used for craft purposes (e.g. birds of prey, storks, messenger snakes, touracos, owls, parrots). Some bird species, like wild guinea fowl, wild ducks, and partridges, are also valued for their meat and are poached in their natural habitats. Other animal by-products, including eggs, bird nests, honey, royal jelly, and beeswax, are also utilized. In most cases, animals are slaughtered before their parts of interest - such as bones, skins, ivory, snail shells, or turtle shells - are removed for various purposes, including consumption or medicinal use, further endangering biodiversity.

**4.4 Uses of NTFPs in Togo**

Togo's rich biodiversity includes species with diverse applications, spanning medicinal (51.24%), food (29.40%), artisanal (5.24%), cosmetic (4.71%), forage (3.73%), body care (3.02%), and ritual (2.66%) uses. Approximately 80% of species are used for medicinal and nutritional purposes, underscoring the essential role of NTFPs in healthcare and human nutrition.

Among medicinally utilized species, plants account for 96.98%, compared to 1.81% for animals. Scarce ethnographic data on the medicinal uses of animals, with exceptions such as dytiscus employed to treat nasal hemorrhage (Badanaro et al., 2024), suggest that this area remains under-researched in Togo. Nevertheless, animal organs are often observed for sale in local markets like the Lomé fetish market.

Globally, animals or their parts are also used for medicinal purposes. In Côte d'Ivoire, for example, 44 bird species are integral to traditional medicine (Koue Bi et al., 2017). In Burkina Faso, millipedes are utilized by the Bobo people to treat malaria (Enghoff et al., 2014), and in India, various bedbug species are employed in disease treatment (Chakravorty et al., 2011). Similarly, in Siribinha, Brazil, marine and estuarine resources are used in folk medicine (Costa-Neto et Marques, 2000). Animal by-products such as hair, skins, horns, shells, and feathers also feature prominently in traditional pharmacopoeia (Loubelo, 2012).

Mushrooms constitute another critical NTFP in the daily lives of Togolese people, serving both as a food source and for medicinal purposes.

Plant-based NTFPs significantly contribute to diets, with 51.24% of the species surveyed in Togo used for food. These plants are consumed in various forms, including vegetables, fruits, tubers, spices, and beverages. Leaves of species such as *Adansonia digitata, Ocimum gratissimum, Talinum triangulare, Vernonia amygdalina, and Vitex doniana* are particularly common as vegetables (Batawila et al., 2007). Additionally, spontaneous fruit plants, such as *Adansonia digitata* Linnaeus, *Blighia sapida* Konig, *Cola nitida* (Vent.) Schott & Endl., *Detarium senegalense* J. F. Gmel, *Dialium guineense* Wild, *Garcinia kola* Heckel, *Irvingia gabonensis* (Aubry-Lecomte ex O’Rorke) Bail, *Monodora myristica* (Gaertn.) Dunal, *Parkia biglobasa* (Jacq.) Benh, *Spondias mombin,* Linnaeus, *Tamarindus indica* Linnaeus, *Vitellaria paradoxa* C. F. Gaertner, *Vitex doniana* Sweet, *Xylopia aethiopica* (Dunal) A. Rich, are marketed, providing income for local populations (Atato et al., 2010). Tubers like *Ipomoea batatas* (L.)*, Ipomoea mauritiana* Jacq., *Tacca leontopetaloides* (L.) Kuntze are consumed, particularly during the lean season.

Other plant-based products, such as wines from *Raphia sudanica A*. Chev. and *Elaeis guineensis*, play cultural roles, with the latter's distilled form ("Sodabi") being a popular alcohol (Tagba et al., 2018). NTFPs also serve as packaging materials, food colorants, and raw materials for handicrafts, tools, and construction. Animals provide materials such as leather, fur, and horns, while some skins (e.g., crocodile and python) are sought after in the luxury goods industry.

NTFPs contribute significantly to the well-being of the Togolese people by providing marketable goods and sources of financial income. They play an essential role in various household activities. For example, they are used as packaging materials for food products in Togo and the Democratic Republic of Congo, where 38 plant species have been inventoried for this purpose (Lassa et al., 2022). However, this specific use was not mentioned in the literature we reviewed.

NTFPs also serve as food colorants, such as *Bixa orellana* and *Tectona grandis* L.f., and as materials for making brooms, rakes, and fans (*Elaeis guineensis, Borassus aethiopum*), as well as ropes (*Ancylobotrys amoena, Landolphia owariensis* P. Beauv., *Secamone afzelii* (Schult.) K. Schum).

They are integral to crafts, being used as building materials for human dwellings - such as frameworks (*Bambusa vulgaris* Schrad. & J.C. Weendl.) and roofing - and for animal shelters (*Parkia biglobosa (Jacq.) R. Br. & G. Don, Raphia sudanica A.* Chev).

In basketry, they are crafted into hats, tablecloths, baskets, cages, and mats (*Borassus aethiopum, Raphia sudanica A.* Chev). In furniture-making, they are utilized for beds, chairs, armchairs, and tables. They are also employed in sculpture, the production of tam-tams, mortars, and canoes, as well as in making natural jewelry, such as ivory tips. Additionally, gourds (*Crescentia cujete* Linnaeus) are used as utensils, and plant resins like *Afraegle paniculata* (Schum. Thonn.) serve as glue.

NTFPs also support agricultural and hunting activities, such as making farming tools (e.g., hoes) and hunting bows. Animal-derived materials, including leather, fur, hair, and horns, are widely used in handicrafts. The tanned skins of mammals (e.g., antelopes, buffaloes) and reptiles (e.g., monitor lizards, pythons) are crafted into trophies, traditional decorations, bowstrings, and ceremonial drums. Crocodile and python skins have long been prized by the luxury leather goods industry for manufacturing items like bags, belts, shoes, and wallets.

In traditional practices, animal skins are used by priests in Kabye country for ceremonial attire, while bird feathers are occasionally used to adorn hair (Feathercraft) during various ceremonies.

Certain plants (leaves and roots) and resins such as *Canarium schweinfurthii*, provide resins used as incense in socio-cultural rites. Several NTFP species are also widely employed as fodder for livestock, including *Lannea acida* A. Rich, *Lannea microcarpa* Engl. & K. Krausse, *Annona senegalensis* Pers, *Sterculia kunthiana* Cham, *Ceiba pentandra* (L.) Gaertn, *Isoberlinia doka* Craib & Stapt, and *Senna siamea* (Lam.) H. S. Irwin & Barneby (Pandey et al., 2016; Badjaré et al., 2018; Shrestha et al., 2019).

NTFPs also find use in personal care. For example, *Terminalia laxiflora* Engl. & Diels is used as a toothbrush, *Blighia sapida* K.D. Köning fruits serve as soap, and *Luffa aegyptiaca* Mill fruits as sponges. Shea butter (*Vitellaria paradoxa* C.F. Gaertner), *Prosopis africana* (Guill. & Perr.) Taub., *Pentadesma butyracea* Sabine, and *Blighia sapida* K.D. Köning are valued in cosmetics for their anti-aging and hair-softening properties (Pereki et al., 2012). Bee honey is similarly prized in cosmetics, while *Lawsonia inermis* Linnaeus (henna leaves) are used in tattooing, and *Indigofera tinctoria* Linnaeus is used for textile dyeing.

4. Conclusion

This study highlights the exceptional diversity of NTFPs, reflecting the biological richness of Togo's ecosystems. A total of 851 species, encompassing 565 genera and 213 families, were identified from the literature. Despite the significant diversity of NTFPs in Togo, few systematic studies have been conducted on their comprehensive inventory and utilization. The biological diversity of these resources holds considerable socio-economic importance in addressing food insecurity and poverty in Togo. For impoverished households often excluded from market participation due to low purchasing power, nature provides vital resources through gathering and hunting activities.

The multifaceted uses of NTFPs (as medicine, food, cultural tools, crafts, and cosmetics) enhance access to healthcare and nutrition while contributing to poverty alleviation. This diversity underscores the potential of NTFPs as a significant opportunity for sustainable development.

The findings of this study underscore the necessity of implementing measures to safeguard the diversity of NTFPs and enhance their sustainable utilization. The results contribute to a deeper understanding of the socio-economic and ecological significance of NTFPs, providing a foundation for their effective planning and management. Such efforts are critical for the conservation and sustainable, integrated management of NTFP-rich ecosystems, particularly in the context of climate change.

Promoting income-generating activities based on NTFPs should be a key component of strategies to improve food security and reduce rural poverty. Furthermore, investments are needed in NTFP conservation, production, extension services, and value-addition initiatives to ensure their long-term viability and maximize their socio-economic benefits. Furthermore, future research could further explore the challenges related to the commercialization of NTFPs, as well as the policy implications of their integration into sustainable development strategies.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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