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# Comparative Analysis of Naming Criteria for Wild Edible Mushrooms across Linguistic Families in Benin

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## Abstract

Traditional taxonomic sorting of samples into recognizable taxonomic units, such as morphospecies or morphotypes, is commonly relied upon in conservation biology and ethnobiological studies. However, understanding the criteria used for traditional nomenclature of fungi, particularly wild edible mushrooms across linguistic groups, remains limited, leading to frequent errors in species recognition. This study seeks to assess how linguistic affiliations influence the local naming of useful wild mushrooms, and is the first of its kind in Benin. In order to understand how local people recognize, classify and name mushrooms that develop in or close to their villages, 2234 respondents from five socio-linguistic groups across three geographical areas were interviewed. Structured and semi-structured interviews were conducted to gather data on the local naming criteria for edible wild mushrooms. Citation scores were recorded for both nomenclature criteria and species, considering variables such as linguistic groups, age, and language. Twenty-two nomenclature criteria were used by local people to name edible wild species. Strong similarity in classification and naming of species was shown in 97% of the languages, while 3% showed differing classification criteria. The Gur, Atlantic, and Mande linguistic groups demonstrated more comprehensive traditional taxonomic and nomenclatural knowledge, sharing six common criteria: texture, taste, size, kingdom (Fungi), form, and substrate. Overall, local populations possess extensive knowledge regarding the diversity of wild edible mushrooms in their environment.

**Keywords**

Ethnomycology, Naming Criteria, Linguistic Groups, Edible Mushrooms, Benin

## 1. Introduction

Local knowledge is orally transmitted from generation to generation within communities and is regarded as an inheritance either from a family, a specific social group within a village, or a particular region [1]-[3]. This local knowledge is closely linked to languages, which serve as a vessel for cultural values and traditional wisdom [4]-[6]. To unravel the connections between local knowledge, language, cultural values, beliefs, practices, and the environment, one must understand the relationship between human culture and nature at the local level [7]. Sociolinguistic identity, along with cultural context and its dynamic evolution over time, thus serves as the primary driver of local knowledge [8].

In Benin, languages are classified according to their typological characteristics into three linguistic families or phyla: the Niger-Congo family with twenty languages; the Nilo-Saharan family with two languages; and the Afro-Asiatic family with one language. These families are further divided into five linguistic groups: Kwa, Gur or Voltaic, Atlantic, Benue-Congo, and Mande within the Niger-Congo family; Songhai within the Nilo-Saharan family; and the Afro-Asiatic family, whose linguistic group name remains undefined [9]-[15]. Each linguistic group is further subdivided into dialectal continua. The use and mastery of languages within a community strengthen social cohesion, as individuals at various stages of their development acquire new knowledge and are exposed to different cultural dimensions. Learning a foreign language broadens people's understanding of communication, exposing them to cultures different from their own, without neglecting the scientific observations that can be gathered through this socio-cultural openness [16]. Local populations living around forests rich in useful wild resources often speak different languages based on their origins and have developed over time the ability to identify and name these resources [17]. To distinguish between useful and toxic wild species, linguistic groups in Benin employ detailed demarcation criteria. Traditional taxonomy is rooted in cultural knowledge, relying on vernacular naming systems, the primary tool for communication and the preservation of indigenous knowledge across generations.

In Benin, as in other tropical African countries, traditional mycological knowledge is orally passed from generation to generation, and the stability of local nomenclature for wild edible mushrooms over time has long been a topic of interest [18] [19]. Several ethnomycological studies have examined local nomenclature systems to improve sustainable management perspectives for locally useful wild mushrooms [20]-[22]. Because wild edible mushrooms have been used for generations, local populations living near forests possess extensive knowledge of local

nomenclature, based on demarcation criteria such as color, shape, size, and smell [22]-[25]. In addition to considerations of traditional taxonomy, previous studies highlighted the age, gender, formal education, poverty level, and occupation, as influencing the local mycological knowledge [2] [22] [26]-[29]. Moreover, knowledge sources are generally regarded as secondary determinants of the level of local knowledge [30]. However, despite extensive research, few studies have focused on the similarities or differences in criteria used for naming edible mushrooms across linguistic groups. At the same time, languages disappear in the context of the erosion of local knowledge, disrupting the relationship between people and nature. Sociolinguistic identity is crucial in preserving local knowledge within communities [2] and helps to explain the shared knowledge that distinguishes one individual or group from another dynamic entity.

The objectives of this study are: (i) to assess and compare criteria used by diverse linguistic groups to name wild edible mushrooms in Benin, and (ii) to identify the main factors influencing the ability of individual persons to recognize mushroom species.

## 2. Methodology

### 2.1. Study Area

This study was carried out in Benin, West Africa, in three areas, namely the Tchaourou-Touï-Kilibo (FR-TTK), the Ouémé Supérieur-N'Dali (FR-OSN), and the Trois Rivières forest reserves (FR-TR). Figure 1 presents the three study areas with the selected villages.

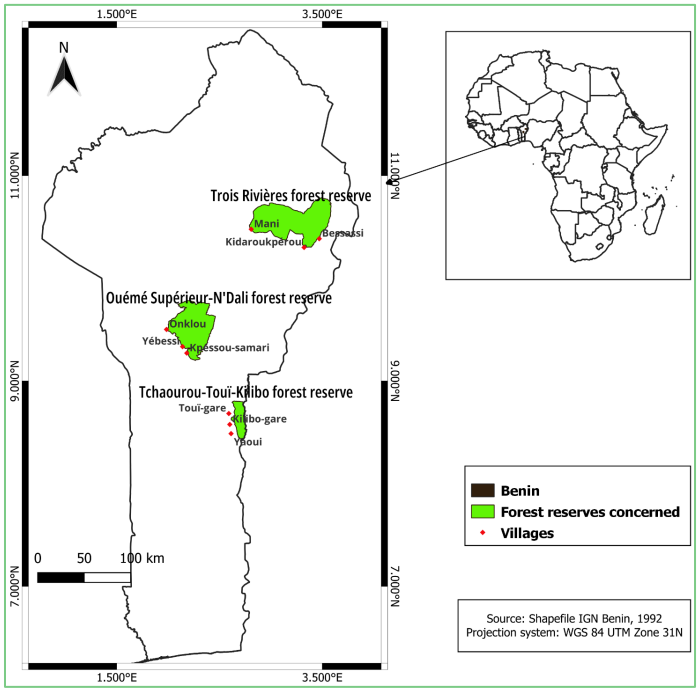



Figure 1. Map of Benin showing the three forest reserves investigated in this study.

## 2.2. Villages' Selection

To select the target villages, we conducted a rapid preliminary survey in 14 villages bordering the three targeted forests (Tchaourou-Touï-Kilibo, Ouémé Supérieur-N'Dali and Trois Rivières). The selection of the 14 villages was based on three criteria: (1) the diversity of ethnic groups in the village, (2) the distance of the villages to the forest reserve, and (3) the level of mushroom consumption. A total of 30 respondents were the selected opportunistically in each of the 14 villages. Point scores were calculated for each village and we selected the three villages with the highest score for each forest reserve, totaling nine target villages. Those villages are: (i) Touï-gare, Kilibo-gare and Yaoui (for FR-TTK); (ii) Onklou, Kpéssou-samari and Yébessi (for FR-OSN) and (iii) Bessassi, Kidaroukpérou and Mani (for the FR-TR).

## 2.3. Population Sampling

A stratified sampling method was applied across the nine target villages using their population size from the fourth national population census data [31]. The sample size in each village is obtained using the following formula as presented by [32]. A total number of 2,234 respondents were interviewed distributed as follows in the nine target villages (**Table 1**).

**Table 1.** Number of respondents per target village in each forest reserve.

| Forest reserve | Village | Population size | Number of respondents |
|---|---|---|---|
| Tchaourou-Touï-Kilibo forest reserve | Touï-gare | 4614 | 354 |
| | Kilibo-gare | 1196 | 92 |
| | Yaoui | 3823 | 292 |
| Ouémé Supérieur-N'Dali forest reserve | Onklou | 5631 | 342 |
| | Kpéssou-samari | 5724 | 204 |
| | Yébessi | 9474 | 208 |
| Trois Rivières forest reserve | Bessassi | 3171 | 220 |
| | Kidaroukpérou | 5341 | 372 |
| | Mani | 2144 | 150 |
| Total | | | 2234 |

We set the threshold at a minimum of three nomenclature criteria in order to eliminate minority linguistic groups. Finally, after applying this restriction, a total of thirteen languages was considered: booyǎ, baatɔnum, sɔla, lɔkpa, yom, dit-ammari, aja, fɔn, waama, fulfulde, cabɛ, gando and biali.

## 2.4. Collection of Wild Mushrooms in Forests

Fresh specimens of wild mushrooms were collected early in the morning in the target forests. The sampled specimens were compared with professional illustrations of

wild edible mushrooms taken from various field guides for scientific identification [17] [28] [33] [34]. The preliminary identification based on field guides was cross-checked through microscopic examination of the specimens by a light microscope.

A total of 187 fresh wild species (Click here on the Appendix 1), both edible and non-edible, were collected, labeled, and dried at 40˚C. Scientific names were checked in Index Fungorum. All samples were then deposited at the mycological herbarium of the University of Parakou [35].

### 2.5. Structured and Semi-Structured Surveys

Structured and semi-structured interviews were conducted in nine villages (Touïgare, Kilibo-gare, Yaoui, Onklou, Kpéssou-samari, Yebessi, Bessassi, Kidaroukpérou and Mani) using samples of edible mushrooms collected close to the village the same day. For each fungal species, respondents were asked to provide the name and the meaning of the species' name in their local language. With the respondent's consent, an audio recorder was used during the interviews to capture the exact pronunciation of the local names, with three repetitions of name pronunciations. Then, with the help of educated speakers of each language, the correct spelling reflecting the pronunciations of the names was determined in order to transcribe the species' name according to the International Phonetic Alphabet. The number of citations of naming criteria was grouped by linguistic groups [12] [15] to facilitate intra- and inter-linguistic comparisons. The number of species citations as well as the number of citations of associated naming criteria were highlighted. In order to identify the factors associated with the ability to recognize wild edible mushrooms, socio-linguistic characteristics of respondents were collected.

## 3. Data Analyses

In order to assess the diversity of nomenclature criteria, Shannon's diversity index and Piélou's J index of fairness were calculated on the one hand by ethnic group and on the other hand for all ethnic groups with the Biodiversity R package [36]. To better assess the cross-ethnic diversity of nomenclature criteria, the Morisita-Horn similarity index was calculated using the CommEcol package [37]. All analyses were performed using R.4.1.1 software [38]. Poisson regression was used to assess the variation of fungi recognition ability in the population.

## 4. Results

### 4.1. Gender Disparity within the Studied Population

In the context of interviews conducted in nine villages in Benin with 2234 respondents, 1117 individuals were able to provide vernacular names for species of edible mushrooms and their corresponding meanings based on specific criteria of the fungi. The results indicate a balanced distribution between men and women,

with a slight female predominance. Men account for 44% of the total sample, aged between 10 and 58 years, while women make up 56% of participants, aged between 10 and 60 years (Figure 2).

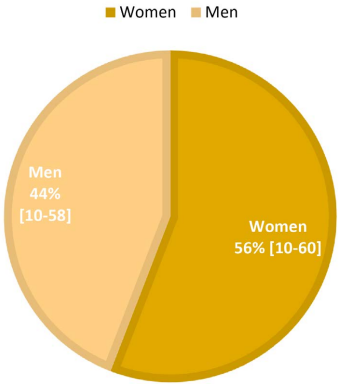



**Figure 2.** Gender distribution and age range of the study population.

## 4.2. Diversity of Local Nomenclature Criteria in the Naming of Edible Mushrooms

A total of 22 nomenclature criteria (Table 2) were recorded from a total of 13 languages. The highest number of naming criteria (11) is recorded among the booyǎ, while the lowest number (3 criteria) is recorded among the aja people (Table 3). The diversity of criteria for all languages taken together is very large (Shannon-Weiner: 1.92 and J of Piélou: 0.62). Similarly, J de Piélou equitability index shows that from one individual to another and within each language, the same naming criteria are cited. A high diversity value (1.91) is recorded for booyǎ, while a low value (1) is recorded for aja. Based on these values, the diversity of criteria is lower among individuals within each language compared to across all languages.

**Table 2.** List of nomenclature criteria used by local people to name wild edible mushrooms (in 13 different languages).

| N° | Criteria |
|---|---|
| **1** | Texture |
| **2** | Taste |
| **3** | Size |
| **4** | Kingdom (Fungi) |
| **5** | Form |
| **6** | Collecting site or substrate |
| **7** | Color |
| **8** | Spirituality aspect |
| **9** | Tufted growth |

Continued

| | |
|---|---|
| **10** | Prestige |
| **11** | Water content of the species |
| **12** | Ability to cover oneself |
| **13** | Consumption by animals |
| **14** | Fat content |
| **15** | Milk present or not |
| **16** | Natural mushroom regrowth |
| **17** | Scarcity |
| **18** | Teeth whitening/cleaning function |
| **19** | Sticky appearance |
| **20** | Cooking time |
| **21** | Endemism |
| **22** | Community consumption |

Legend. Kingdom (Fungi): name referring to the fungal kingdom.

Table 3. Diversity of nomenclature criteria as highlighted by the Shannon index and Piélou Equitability.

| | Number of criteria used by languages to name wild edible mushrooms | Shannon-Weiner diversity index | J de Piélou equitability of citations between nomenclature criteria by languages and for the entire study |
|---|---|---|---|
| **aja** | 3 | 1 | 0.91 |
| **baatɔnum** | 12 | 2.1 | 0.85 |
| **biali** | 9 | 1.77 | 0.81 |
| **booyǎ** | 14 | 1.91 | 0.72 |
| **fɔn** | 4 | 1.01 | 0.73 |
| **gando** | 10 | 1.78 | 0.77 |
| **ləkpa** | 8 | 1.27 | 0.61 |
| **cabɛ** | 7 | 1.75 | 0.9 |
| **ditammari** | 9 | 1.64 | 0.75 |
| **fulfulde** | 8 | 1.5 | 0.72 |
| **sɔla** | 5 | 1.09 | 0.68 |
| **waama** | 7 | 1.24 | 0.64 |
| **yom** | 11 | 1.77 | 0.74 |
| **All** | 22 | 1.92 | 0.9 |

## 4.3. Number of Criteria Shared by Linguistic Groups

A total of five linguistic groups belonging to the Niger-Congo language family

have been considered (Table 4). These linguistic groups are grouped into four dialectal continua, which in turn are grouped into languages. All linguistic groups commonly cite four naming criteria, that are: collecting site or substrate, texture, size and kingdom (Fungi) (Table 4).

Table 4. Number of citations of shared naming criteria by all linguistic groups within the Niger-Congo language.

| Linguistic phylum/ Linguistic family | Linguistic group | Dialect continuum | Language | Naming criteria followed by the number of corresponding mushroom species | Shared criteria |
|---|---|---|---|---|---|
| Niger-Congo | Kwa | gbe | fɔn, aja | Substrate (36), Texture (9), Kingdom (7), Size (5) | Substrate, Texture, Size and Kingdom |
| | Gur or Voltaic | oti-volta-oriental | biali, ditammari, waama, ləkpa, yom and sɔla | Substrat (257), Texture (90), Size (48), Form (48), Kingdom (39), Taste (20), Color (17), Milk present or not (13), Tufted growth (12), Water content of the species (8), Scarcity (4), Prestige (3) | |
| | | central | baatɔnum | | |
| | Atlantic | | fulfulde, gando | Substrat (57), Kingdom (29), Taste (16), Texture (13), Size (9), Prestige (9), Color (4), Form (3), Tufted growth (9), Milk present or not (2), Natural mushroom regrowth (1) | |
| | Benoue-Congo | ede | cabɛ | Form (7), Taste (7), Substrat (6), Size (5), Texture (3), Kingdom (1), Color (1) | |
| | Mande | | booyǎ́ | Texture (132), Taste (74), Kingdom (48), Texture (41), Prestige (20), Size (11), Form (11) | |

### 4.4. Number of Criteria Shared within Each Linguistic Group

The largest number of shared criteria (8) is recorded within the Atlantic linguistic group. The eight criteria are texture, taste, size, kingdom (Fungi), form, collecting site or substrate, prestige and the present/absence of milk (Click here on the Appendix 2). The Gur or Voltaic group is next with five shared criteria among the languages biali, ditammari, waama, ləkpa, yom, sɔla and baatɔnum. These criteria are texture, size, kingdom (Fungi), form, and collecting site or substrate (Click here on the Appendix 3). The fewest criteria (4) were shared by fɔn and aja languages (Kwa), namely texture, taste, kingdom (Fungi), and collecting site or substrate (Click here on the Appendix 4).

### 4.5. Nomenclatural Patterns for the Top Ten Most Cited Species

In total, 66 edible mushroom species were documented across the three regions, amounting to a total of 1117 citations. Figure 3 presents mushrooms most cited by the majority of linguistic groups. The ten most cited species and the number of citations per taxonomic criterion recorded for all linguistic group are presented in Table 5. *Lentinus squarrosulus* (122), *Candolleomyces*

*tuberculatus* (110), and *Volvopluteus earlei* (87) received the highest numbers of citations. The local names of the top 10 mushroom most cited by the majority of linguistic groups are presented in Table 6. The complete list of all species that were cited with their recorded local names is provided in the appendix (Click here on the Appendix 5).

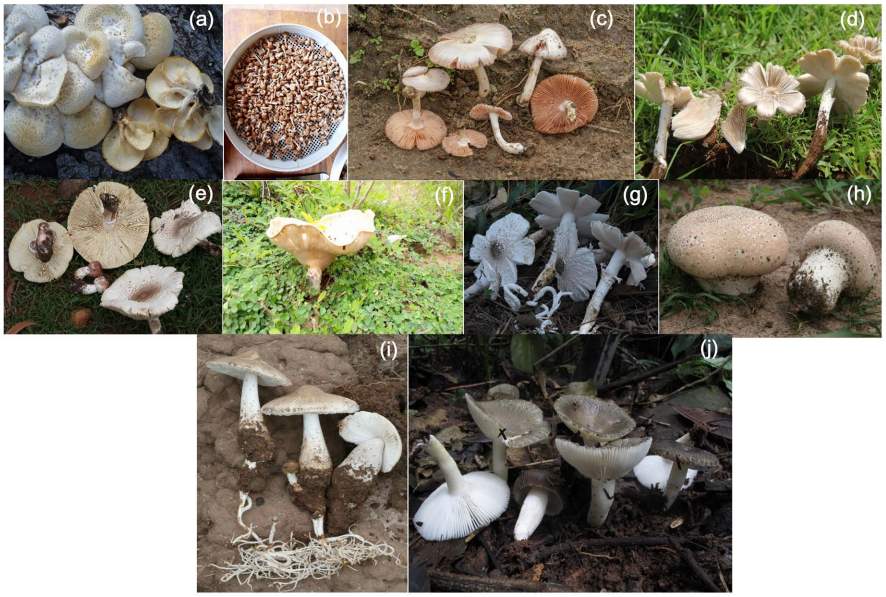



**Figure 3.** Mushrooms most cited by the majority of linguistic groups. (a) *Lentinus squarrosulus*; (b) *Candolleomyces tuberculatus*; (c) *Volvopluteus earlei*; (d) *Termitomyces reticulatus*; (e) *Chlorophyllum palaeotropicum*; (f) *Lentinus tuber-regium*; (g) *Termitomyces schimperi*; (h) *Calvatia gardneri*; (i) *Termitomyces robustus*; (j) *Russula cellulata*. Photos by Yorou NS.

**Table 5.** Number of citations of shared naming criteria by all linguistic groups within the Niger-Congo language.

| N° | Species | Number of species citation | Citation frequency and criteria used to name the species | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Lentinus squarrosulus* | 122 | Texture 74 | Taste 28 | Taste 7 | Kingdom 6 | Size 3 | Form 3 | Water content of the species 2 | Tufted growth 1 | Prestige 1 | |
| 2 | *Candolleomyces tuberculatus* | 110 | Taste 39 | Size 38 | Taste 13 | Kingdom 10 | Tufted growth 7 | Form 5 | Texture 2 | Prestige 2 | Water content of the species 1 | |
| 3 | *Volvopluteus earlei* | 87 | Taste 52 | Kingdom 15 | Texture 4 | Taste 4 | Form 3 | Color 3 | Prestige 3 | Water content of the species 2 | Size 1 | Scarcity 1 |

**Continued**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | *Termitomyces reticulatus* | 62 | Taste 46 | Size 6 | Taste 3 | Form 3 | Prestige 3 | Texture 2 | Kingdom 2 | |
| 5 | *Chlorophyllum palaeotropicum* | 59 | Taste 44 | Kingdom 7 | Texture 2 | Taste 2 | Form 2 | Color 2 | Prestige 2 | Tufted growth 1 |
| 6 | *Lentinus tuber-regium* | 40 | Texture 25 | Taste 9 | Taste 2 | Kingdom 2 | Size 1 | Form 1 | Color 1 | |
| 7 | *Termitomyces schimperi* | 39 | Taste 26 | Size 4 | Texture0 4 | Kingdom 3 | Tufted growth 2 | Texture 1 | | |
| 8 | *Calvatia gardneri* | 38 | Taste 17 | Kingdom 7 | Form 7 | Texture 4 | Size 2 | Color 2 | Scarcity 1 | |
| 9 | *Termitomyces robustus* | 36 | Taste 29 | Color 2 | Form 2 | Taste 1 | Size 1 | Tufted growth 1 | Prestige 1 | |
| 10 | *Russula cellulata* | 32 | Taste 23 | Kingdom 3 | Color 2 | Prestige 2 | Texture 1 | Form 1 | | |

The local names of the top 10 most cited mushroom species by the majority of linguistic groups that cited at least five criteria, are presented in Table 6 below.

Table 6. Locale names of the top 10 species most cited by the majority of linguistic groups, citing a minimum of five criteria.

| | Mushroom species | Major linguistic groups | Number of criteria | Local names | Language | Criteria |
|---|---|---|---|---|---|---|
| 1 | *Lentinus squarrosulus* | Gur or Voltaic (8) | 8 | Bala gəsandu = Hard mushroom | biali | Texture |
| | | | | Kpantako = Hard mushroom | waama | Texture |
| | | | | Tikɔ̃ɔ̃tãntãnti = Hard mushroom | ditammari | Texture |
| | | | | Tidabiti kɔ̃ɔ̃tɪ̀ = Wood mushroom | ditammari | Collecting site or substrate |
| | | | | Nyɛrtɛɛwajiʊ = Lazy doesn't eat | yom | Texture |
| | | | | Pɔɣ-kpmɛsəfuŋmii = Tender mushroom | yom | Texture |
| | | Mande | 7 | Kankpɔtɛ = Hard mushroom | ləkpa | Texture |
| | | | | Sɔmburugo = Waste of time | booyǎ | Texture |
| | | | | Konuyĩgye = Dry sticks in the teeth | booyǎ | Texture |
| 2 | *Candolleomyces tuberculatus* | Gur or Voltaic | 8 | Gɔmpim = petit champignon | yom | Size |
| | | | | Nkɔ́pí = Small mushroom | sɔla | Size |
| | | | | Sukunsɔye = Pounded yam mushroom | baatɔnum | Form |
| | | | | Suulu wontu = Vitellaria paradoxa mushroom | ləkpa | Collecting site or substrate |
| | | | | San pwom = Water mushroom | biali | Water content of the species |

**Continued**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Pɛmbimɛ̃ntansu = Small and thin | waama | Size |
| | | | | Ikũã wũãyì = Small mushroom | ditammari | Size |
| | | | | Munuanikũã = Dwarf mushroom | ditammari | Size |
| | | | | Sokasoweeji = Small mushroom | gando | Size |
| | | Atlantic | 7 | Gbatareeji = Isoberlinia doka mushroom | fulfulde | Collecting site or substrate |
| | | | | Sɔlɛgbɛ̀ = Hoe track mushroom | booyǎ | Collecting site or substrate |
| | | Mande | 6 | Tɔ̃kelena = Small mushroom | booyǎ | Size |
| | | | | Kpɔ̀kelena = Small fish | booyǎ | Size |
| 3 | *Volvopluteus earlei* | Gur or Voltaic | 10 | Awasa tɔɔ kɛkpɛsɪ = Furrow mushroom | ləkpa | Collecting site or substrate |
| | | | | Wesakoso = Elephant's knee | baatɔnum | Collecting site or substrate |
| | | | | Naaŋ kɛkpɛsɪ = Beef mushroom | ləkpa | Collecting site or substrate |
| | | | | Yapɛ̃nkũã̀ = Furrow mushroom | ditammari | Collecting site or substrate |
| | | | | Wí sandu = Field mushroom | biali | Collecting site or substrate |
| | | Mande | 5 | Solɛgbɛ = Hoe trace | booyǎ | Collecting site or substrate |
| 4 | *Termitomyces reticulatus* | Gur or Voltaic (5) | 5 | Sanp-woéi = White-colored mushroom | biali | Color |
| | | | | Tuupɛmbina = Termite mound mushroom | waama | Collecting site or substrate |
| | | | | Titukpɛ̃nkɔ̃ɔ̃tì = Termite mound mushroom | ditammari | Collecting site or substrate |
| 5 | *Chlorophyllum palaeotropicum* | Mande | 5 | Nam yaya = The ox tongue | booyǎ | Form |
| | | | | Zugbɔ̃tɔ̃ = Cow dung mushrooms | booyǎ | Collecting site or substrate |
| | | Gur or Voltaic | 5 | Nami sandu = Mushroom that grows on cow dung | biali | Collecting site or substrate |
| | | | | Nakimipɛmbina = Mushroom that grows on cow dung | waama | Collecting site or substrate |
| | | | | Inaaminkũã = Beef dung mushroom | ditammari | Collecting site or substrate |
| | | | | Ikũãwũã́ = Red mushroom | ditammari | Color |
| | | | | Kʊtʊ-kʊtʊjɛna = Similar to egg | yom | Form |

**Continued**

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | *Lentinus tuber-regium* | Gur or Voltaic | 7 | Tusandu = Termite mound mushroom | biali | Collecting site or substrate |
| | | | | Pɛmbimɛ̃ntansu = Small mushroom | waama | Size |
| | | | | Pɔɣ-kpɛmsəfu-ŋmii = Hard like skin of the elderly | yom | Texture |
| | | | | Tidabiti kó tikɔ̃ɔ̃tɛ̃ɛ̃tɪ̀ = Dead tree mushroom | ditammari | Collecting site or substrate |
| | | | | Anyímɛɛkɔpí = Peanut mushroom | sɔla | Color |
| 7 | *Termitomyces schimperi* | Mande | 6 | Dayɛ̀ = Mushroom of the family | booyɑ́ | Community consumption |
| | | | | Kuliziyɔ̃ = Grows at the foot of the shea tree | booyɑ́ | Collecting site or substrate |
| | | Atlantic | 5 | Gomiiji sokantedji = Regrowth when the hole is closed | gando | Natural mushroom regrowth |
| 8 | *Calvatia gardneri* | Gur or voltaic | 7 | Naʊ kɛkpɛka = look like navel of the ox | ləkpa | Form |
| | | | | Anyímɛɛkɔpí = Peanut mushroom | sɔla | Form |
| 9 | *Termitomyces robustus* | Gur or voltaic | 6 | Tuceitisandu = Large termite mushroom | biali | Collecting site or substrate |
| | | | | Tile kɛkpɛsɪ = Termite mushroom | ləkpa | Collecting site or substrate |
| | | | | Nɑɑ-bigɔmi = Cow dung mushroom | baatɔnum | Collecting site or substrate |
| 10 | *Russula cellulata* | Mande | 5 | Kyuliziyɔ̃ = Shea butter mushroom | booyɑ́ | Shea butter mushroom |

### 4.6. Comparison of Languages Regarding the Criteria Used to Name Wild Edible Mushrooms

More than 97% of the languages present a strong similarity regarding nomenclatural criteria (MH > 0.5) (Click here on the Appendix 6). The similarity of nomenclature criteria is high between all the languages except for baatonum and cabɛ. The first language is made up of ditammari, biali, waama, ləkpa, yom, sɔla, gando, aja, fulfulde, booyɑ́, and the second one is made up of baatɔnum and cabɛ (**Figure 4**). It emerges that the language kinship represented in this tree does not reflect their linguistic kinship.

### 4.7. Variability of Nomenclatural Criteria within Each Socio-Linguistic Language

The correspondence analysis with the two main factors explains more than 87% of the variance in the data (**Figure 5**). The prestige, scarcity, form, taste, size, growth habit and texture are most used criteria by Gur-related, while taste and prestige are used by Mande-related languages.

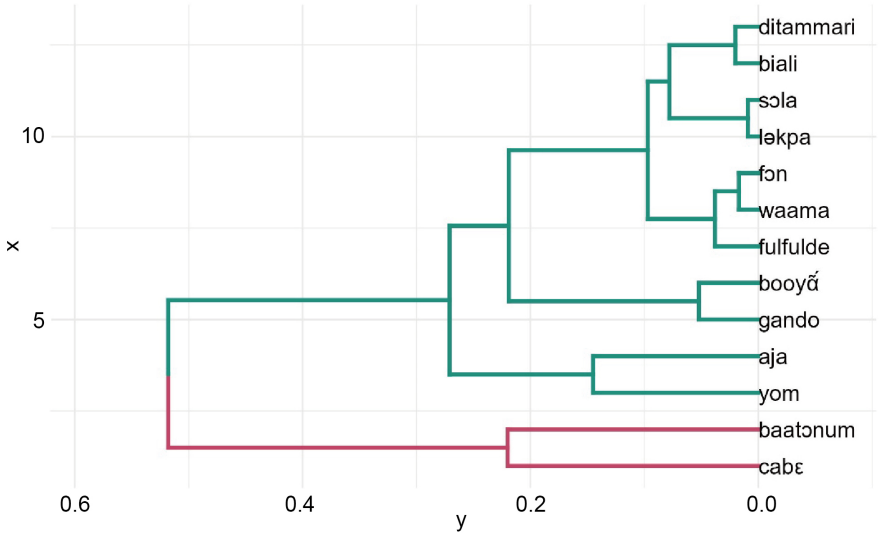



**Figure 4.** Similarity of languages regarding the criteria used to name mushroom species.

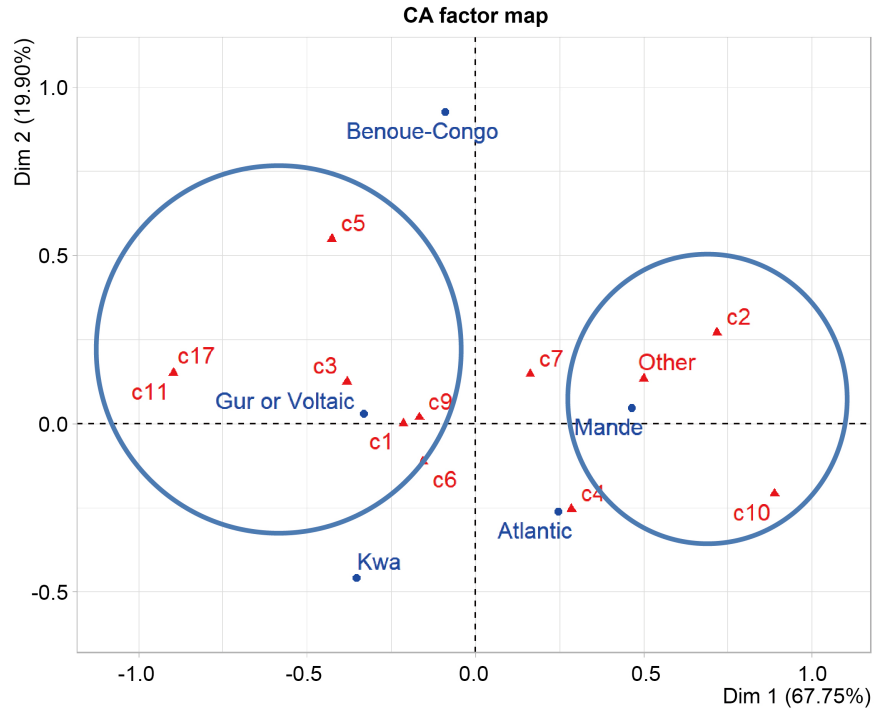
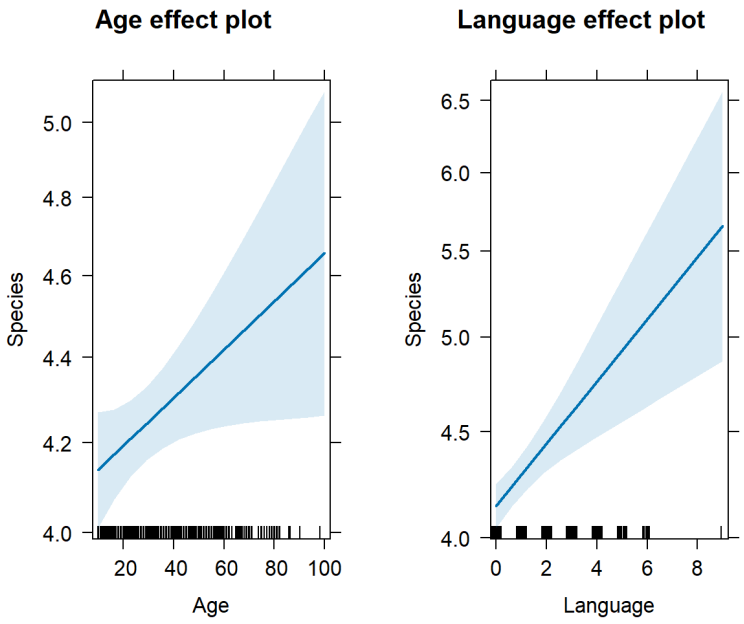



**Figure 5.** Principal Component Analysis (PCA) to show affinities between linguistic groups and the criteria used to name mushroom species.

## 4.8. Drivers of the Recognition Capacity of Wild Edible Mushrooms by Respondents

The age and the number of languages spoken by the respondents are the main drivers of ability to recognize mushrooms (Click here one the Appendix 7). The mushroom recognition ability of respondents increases with the age ($p < 0.035$) and the number of spoken languages ($p < 0.001$) (**Figure 6**).




(a) (b)

**Figure 6.** Relation between age (a), the number of spoken language (b) and the number of species recognized by the respondent.

## 5. Discussion

### 5.1. Diversity, Intra- and Inter-Linguistic Group Variability of Nomenclature Knowledge

The assessment of the diversity of nomenclature criteria for wild edible mushrooms in Benin within and outside of linguistic groups has revealed that 97% of the languages present a strong similarity in the use of nomenclatural criteria. This strong similarity of criteria is observed for Gur linguistic group composed of ditammari, biali, waama, ləkpa, yom, sɔla, gando, aja, fulfulde, booyǎ and is certainly linked to the similarity of their origins (Northern Benin) where their ancestors would have cohabited [38]-[40]. This cohabitation probably facilitated the transmission of similar criteria from generation to generation. Benin brings together a great diversity of languages [41] [42] where cohabitation facilitates the mixing of these and thus contributes to easily shared indigenous knowledge (IK) of mushrooms and therefore to changes in people's attitudes. Northern Benin is dominated by Gur linguistic groups that have a Niger-Congo Linguistic family phonetic root [12] [15] [38] [43]. It appears from these results that the same geographical environment reinforces the social links and therefore the easy sharing of local knowledge of useful wild mushrooms [22].

As mentioned above, it may have been possible that all those languages originated from a common ancestral one, from which minor languages evolved that conserved and transmitted the local nomenclatural system of the mushroom species. Gur or Voltaic, Mande and Atlantic are those linguistic groups that cite more edible mushrooms and use similar nomenclature criteria e.g.: texture, taste, size,

collecting site or substrate, kingdom (mushrooms) and shape of the fruit body in the local nomenclature system. These nomenclature criteria are mainly used to designate *Candolleomyces tuberculatus, Volvopluteus earlei* and *Lentinus squarrosulus* in local languages. This reflects the fact that belonging to various linguistic groups and therefore cultural families, in no way prevents the sharing of social values and indigenous knowledge, particularly if these different people live around forests within which they all have free access. This sharing could also be justified by the social ties that have existed for centuries between certain communities belonging to different linguistic groups, as in the case of the booyǎ and babɛ languages which originated in Nigeria [44]. Similar ancestral affinities are observed between the booyǎ and gando languages [45]. The Gando people derived from the Baatonu, either as prisoners of war [40], or by abandoned children due to so-called "malefic" births or "abnormal" dentition [45] [46], or by slaves working for the Baatonu. The use of nomenclature criteria is therefore primarily a function of the knowledge acquired by respondents from their ancestors, which is perpetuated through generational transmission, but also of shared cultural background and histories. In addition to such vertical knowledge transmission, the social networking during field works, social events in the villages will facilitate the horizontal sharing of nomenclatural knowledge.

In general, the local names of mushrooms are mostly composed of a single or sometimes several words. In cases where several words are involved, we have the epithet (descriptive part) which comes first and is followed by the vernacular term of the mushroom [28]. However, for cabɛ and nago languages [22], the epithete follows the generic name. In the Gur or Voltaic linguistic group, the species *Candolleomyces tuberculatus* is called "Gɔmpim = small mushroom" in yom and "Kɛkpɛkɛya = small mushroom" in Lɔkpa, based on the size criterion. Similarly, using the habitat criterion *C. tuberculatus* is called "Suulu wontu = mushroom from *Parkia biglobosa*" in lɔkpa and "Dɔbi-gʊŋa = mushroom from *Parkia biglobosa*" in yom. *Termitomyces schimperi* is called "Tusandu = termite mound mushroom" in biali language, "Tuupɛmbina = termite mound mushroom" and "Titúkɔ̃ɔ̃tì = termite mound mushroom" in waama refering to the the site of occurence. It is evident in this study that languages belonging to the same linguistic group apply similar criteria in the naming of species. The various forms of solidarity existing in the area would have also facilitated the transfer of knowledge between linguistic groups, such as participation in a happy or unhappy event highlighting mutual aid, affection and respect for values (of solidarity and family). This therefore helps to maintain and also cement the social bond deeply rooted in parenthood and personal networks [47] [48]. In democratic Republic of Congo, after about 80 years of sedentary lifestyle and cohabitation with the Ntomba ethnic groups, and almost 50 years of agricultural practice, the peoples belonging to the Batwa ethnic group have adopted practices and knowledge similar to those of their neighbors [49]. Popular taxonomic and local nomenclature therefore reinforces scientific taxonomy in that it can also explain the disagreements recorded between

the edibility-toxicity of species.

According to Cheikh Anta Diop [50], three factors contribute to the social identity of people, namely: the historical factor, the linguistic factor and the psychological factor [50]. The most relevant for this study is the linguistic factor that concerns the language and all the means of communication that the people use to translate their emotions, explain the world and interact with others. Language thus represents the trait of cultural identity par excellence. With a diversity of 855 local names for a total of 66 edible mushroom, there is no doubt that the integration of these species into the cultural system of the target linguistic groups, better explains their potential and various forms of valorization within rural populations.

### 5.2. Factors Affecting the Recognition and Naming Ability of Wild Edible Mushrooms

The belonging of the respondents to the same linguistic group, the number of languages spoken and the age of the respondents have been identified as the main drivers of species identification and naming in this study. Previous studies confirmed that the ethnicity, sex, age, and also the level of education, considerably determined the ethnomycological knowledge in rural communities [21]-[23] [26] [28] [51]. The influence of age in the ability to recognize mushrooms is linked to the experience acquired by the respondents during either their work in fields or during other activities in the forest (charcoal production for example). Then, by experience, local people have learnt the ecology of the species, and can recognize it through its ecological behavior. For example, during our investigations, local populations assigned specific names to ectomycorrhizal species whose partner tree is *Isoberlinia doka* (Fabaceae). This is also valid for *Candolleomyces tuberculatus* whose name refers to its occurrence on dead wood of *Parkia biglobosa*; *Termitomyces schimperi*, due to its habitat (termite mound), is called "Zɛ̀tona" in booyǎ, "Tusandu" in biali, and "Tuupɛmbina" in waama all referring to its occurrence on a termite mound.

## 6. Conclusion

The diversity of classification criteria testifies the richness of local knowledge in terms of traditional taxonomic. The origins of the peoples as well as their geocultural affiliation strongly influence the similarities and dissimilarities observed in terms of classification criteria. This goldmine of traditional taxonomic possessed by these indigenous peoples deserves to be valued at higher educational levels as it complements modern taxonomy. In addition, belonging to a linguistic family, number of languages spoken and age of a person, are factors that influence the preservation of knowledge in traditional taxonomic. With regard to the natural heritage possessed by the local populations on the sustainable development of knowledge in ethnomycology, it is becoming essential to include policymakers in the management of the natural resources of our forests, taking ethnomycology

into account in management plans. This therefore implies the need to cooperate with the people who hold this local knowledge in order to better protect them and give them the necessary respect.

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## Authors' Contributions

**Olyvia Gwladys Fadeyi, Nourou Soulemane Yorou and Meike Piepenbring**: conception of the study; **Olyvia Gwladys Fadeyi, Boris Armel Olou and Nourou Soulemane Yorou**: data acquisition; **Olyvia Fadeyi, Apollon Dossou Migan Tadagbé Hegbe**: data analyses; **Olyvia Gwladys Fadeyi:** First draft generation; All authors: editing and proof reading; **Meike Piepenbring and Nourou Soulemane Yorou**: Fund acquisition.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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