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Diversity of Medicinal Plants and Preliminary Parameterization of their Uses in Benin (Western Africa)

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Diversity of Medicinal Plants and Preliminary Parameterization of their Uses in Benin (Western Africa)

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Abstract

An investigation was conducted in Benin botanical gardens, endogenous therapeutic gardens and forests in order to assess diversity of medicinal plants and their endogenous, alimentary and medicinal importance. A preliminary parameterization to assess the importance range of these medicinal plants was performed. To that end, three indices were built such as National Identity Coefficient (NIC), National Utility Coefficient (NUC), and Alimentary Utility Index (AUI) per family. Relation between these indices and botanical families was assessed using factorial correspondence analysis. Ailments treated per family and percentage of organ solicited per family, were also assessed. As results, the medicinal plants observed globally belong to 15 botanical families. The NIC ranges from 0.31 to 1, and shows eight families that are mostly identified at national scale. The NUC ranges from 0.26 to 1, and indicates seven mostly useful families, i.e. Apocynaceae, Capparidaceae, Euphorbiaceae, Annonaceae, Meliaceae, Rutaceae and Sterculiaceae; but these are not belonged to the most identified families at the national scale. The AUI ranging from 6 to 50, pointed out eight families i.e. Capparidaceae, Annonaceae, Sterculiaceae, Mimosaceae, Bignoniaceae, Combretaceae, Ceasalpiniaceae and Bombacaceae; these are mostly used as food, with 50% highly solicited in treating more ailments. Polygaceae and Flacourtiaceae are the mostly threatened as 70% of their species roots are solicited for various uses. Further studied are needed to standardize these indices.

Key words: Medicinal Plants, Family, Parameterization

Introduction

Over 60 % of the world's population, 80 % in developing countries depends directly on plants for their medical purposes. Medicinal plants have been harvested from the wild since ancient times (Singh et al., 1979; Mshigeni, 1990; Balick and Cox, 1996; Sheldon et al., 1997; Dhillion and Ampornpan, 2000; Dhillion et al., 2002). Traditional medicine is still recognized as the primary health care system (Bannerman et al., 1983; Manandhar, 1994, 1998; Svarstad and Dhillion, 2000) in many rural communities because of its effectiveness, lack of modern medical alternatives, and cultural preferences (Plotkin and Famolare, 1992; Taylor et al., 1995; Balick et al., 1996; Tabuti et al., 2003). Many rural peoples possess traditional knowledge of medicinal plants (Manandhar, 1992; Comerford, 1996; Johnston and Colquhoun, 1996; Milliken and Albert, 1996; Joshi and Joshi, 2000). Such knowledge survives because it is transferred from one generation to another (Manandhar, 1989; Jain and Saklani, 1991; Tabuti et al., 2003). Some plant families are clearly more useful in certain use categories than others (Phillips and Gentry, 1993a,b; Moerman, 1996; Moerman et al., 1999; Byg et al., 2006). The same reasoning holds true for individual plant species (Prance et al., 1987; Byg et al., 2006). Determining the usefulness of plant families generally pertains to the domain of scientific researchers (Moerman, 1996; Treyvaud Amiguet et al., 2006; Bennett and Husby, 2008, Adou Yao et al., 2011), whereas local people are ideally placed to assess the usefulness of particular plant species for particular applications, as the latter can rely on empirical knowledge accumulated over several years to generations of practice. Since folk classification and perception vary for the use of medicinal plants and organs, methods are needed to assess importance of these resources for a sustainable management in each part of the world. The aim of this study was to assess diversity of medicinal plants and to parameterize the usefulness of plant family based on quantitative indices. Parameterization of usefulness of medicinal plants has been previously and diversely assessed. The relative importance of taxa for specific use categories is calculated with informant consensus factor (F_{ic}) formula (Trotter and Logan, 1986) also called "Informant Agreement Ratio" (IAR, Collins et al., 2006; Inta et al., 2008) or Fidelity level (FL) formula (Alexiades, 1996) or Relative Importance index (adapted from Bennett and Prance, 2000) or Informant indexing technique proposed by Phillips and Gentry (1993a) and Thomas et al. (2009) while the cultural importance of medicinal plants is calculated with Relative Frequency of Citation (RFC) formula (Tardio and Pardo-de Santayana, 2008) and cultural Importance index (CI) (Tardio and Pardo-de Santayana, 2008; Signorini et al., 2009). None of these formulas use the endogenous languages, the endogenous names and alimentary utility of medicinal plants. Since no research addressed the parameterization of medicinal plant use, based on endogenous languages, endogenous names, and alimentary utility of medicinal plants, this preliminary study will help in understanding the importance of plant family according to their endogenous usefulness.

Material and methods

Data collection

A total of 200 reports of three consecutive years (2005-2007) for the purposes of pharmaceutical research in Benin botanical gardens, endogenous therapeutic gardens and forests (Lama and Pobè) were used. The following information were gathered from the reports analyzed: species names, botanical families names, plant organs utilized per ailment per species and family, ailments treated per species per family, plant parts utilized as food per species per family, number of endogenous names and endogenous languages per species per family.

Data analysis

Some parameters were developed for measuring the use importance of medicinal plants. These were: National Identity Coefficient (NIC), National Utility Coefficient (NUC), and Alimentary Utility Index (AUI) per family. The following formulas were developed and used:

$$\text{NIC} = \frac{\text{Number of species per family}}{\text{Number of endogenous language named the species}}$$

NIC > 0.5: family less identified or less useful at the national scale

NIC < 0.5: family mostly use.

$$\text{NUC} = \frac{\text{Number of species per family}}{\text{Number of endogenous name}}$$

NUC < 0.5: family most identified or mostly used at the national scale.

NUC > 0.5: family less identified or fairly used at the national scale.

$$\text{AUI} = \frac{\text{Number of species used as food per family}}{\text{Number of species per family}} \times 100$$

0 % < AUI ≤ 30 %: family less used as food;

30 % < AUI ≤ 50 %: family mostly used as food.

The data were analyzed using the linear mixed model with SAS software (SAS Inc., 2003). Factorial correspondence analysis was performed in order to assess the relation between the botanical families and the defined parameters. Diversity in species composition per family and ailments treated per family were illustrated with diagram in order to detect the most diversified families and the family that are useful for treating more ailments. Percentage of organs utilized per family for treating ailment, were assessed and the threatened families were detected.

Results

Parameters for medicinal plants use importance

Table 1 shows average values of the parameters used to assess the medicinal plants use status in Benin. NIC ranges from 0.31 to 1. Values are low (NIC<0.35) with Caesalpiniaceae, Meliaceae and Flacourtiaceae and high (NIC > 0.75) with Apocynaceae, Rutaceae, Lytraceae, Mimosaceae and Capparidaceae. NUC ranges from 0.26 to 1. Lower values (<0.35) appeared with Meliaceae, Euphorbiaceae, Caesalpiniaceae and Flacourtiaceae while higher (>0.6) with Lytraceae, Mimosaceae and Capparidaceae, Bignoniaceae, Sterculiaceae and Combretaceae. AUI ranges from 6 (Apocynaceae) to 50 (Ceasalpiniaceae).

Useful of medicinal plants at national scale

Results of factorial correspondence analysis performed on parameters (AUI, NIC and NUC) and families showed that the first two axes were highly significant and explained the overall information related to parameters and families. AUI contributed mostly for axis 1 while NIC and NUC contributed mostly for axis 2. Combretaceae, Bignoniaceae, Capparidaceae, Mimosaceae, Rutaceae, Flacourtiaceae and Meliaceae also mostly contributed for axis 1 while Sterculiaceae, Lytraceae, Apocynaceae, Annonaceae, Bombacaceae, Euphorbiaceae, Polygaceae and Caesalpiniaceae mostly contributed for axis 2. Figure 1, we observed that Capparidaceae, Annonaceae, Sterculiaceae, Mimosaceae, Bignoniaceae, Combretaceae, Caesalpiniaceae and Bombacaceae were situated in the same side as alimentary utility indices and positively correlated to the axis 1. Thus, these families were the most used as food. The second axis showed that the most useful families at national scale (NUC) were Apocynaceae, Capparidaceae, Euphorbiaceae, Annonaceae, Meliaceae, Rutaceae, and Sterculiaceae since these families were positively correlated to this axis as the NUC, while Bombacaceae, Flacourtiaceae, Lytraceae, Polygaceae, Caesalpiniaceae, Bignoniaceae, Combretaceae and Mimosaceae were mostly identified at national scale (NIC) as they were negatively correlated to this axis like NIC.

Diversity and solicitation of botanical families for treating ailments

Diversity and ailments treated per family

Comparison of species composition and ailments treated per family (Fig. 2) highlighted the most diversified families and the solicitation of families in ailments treating. Apocynaceae and Mimosaceae were the most diversified families holding respectively 12 species while the less diversified were Flacourtiaceae and Lytraceae with only one species respectively. Annonaceae, Apocynaceae, Caesalpiniaceae, Bombacaceae and Capparidaceae treated more than 50 ailments. Apart from Flacourtiaceae which treated less than 10 ailments, the number of ailments treated with the other families range from 20 to 49.

Organs solicited for treating ailments per family

Table 2 shows diversity of organs solicited per family for treatments. Polygaceae (70 %) and Flacourtiaceae (70 %) roots are more useful for treating ailments while less families' roots for treating ailments were Lytraceae (10 %), Sterculiaceae (10 %) and Caesalpiniaceae (5 %). From barks, the most useful family was Fabaceae (40 %) while the less useful family was Combretaceae (0 %). Families from which leaves were more solicited for treating ailments were Lytraceae (50 %) and

Combretaceae (45 %) while the less solicited leaves families were Mimosaceae (5 %), Fabaceae (5 %) and Bignoniaceae (5 %). The most useful families' stems were Euphorbiaceae (30 %), Meliaceae (30 %), Bignoniaceae (30 %) and Lytraceae (30 %). The less useful families' stems were Annonaceae (5 %) and Fabaceae (5 %). The most useful families' fruits were Caesalpiniaceae (40 %), Annonaceae (30 %) and Bombacaceae (30 %) while the less useful families' fruits were Euphorbiaceae (<0.1 %), Polygaceae (<0.10 %), Flacourtiaceae (<0.1 %) and Lytraceae (<0.1 %).

Discussion

Useful of medicinal plants at national scale

The fact that each of the investigated botanical family and species has gotten a name from vernacular language of ethnic groups suggests that every plant species or family has attained a high degree of cultural significance in the study areas.

Using the National Identity Coefficient, Bombacaceae, Flacourtiaceae, Lytraceae, Polygaceae, Caesalpiniaceae, Bignoniaceae, Combretaceae and Mimosaceae families were the most identified at national scale. In these families, species were named in more endogenous languages. Thus, these families involved species used for large purposes in ailments treating for large local population since endogenous languages were speaking by local population.

Based on the National Utility Coefficient, we remarked that the most useful families at national scale were Apocynaceae, Capparidaceae, Euphorbiaceae, Annonaceae, Meliaceae, Rutaceae, and Sterculiaceae. In these families, one species may have more than one name in the same language; then these families were those mostly named in endogenous language. The fact that one species may have more than one name in the same language is due to its importance to this local population who uses to speak this language. Since these families were mostly named in endogenous language, they had more importance to local population who speaks the language in which they were mostly named.

Capparidaceae, Annonaceae, Sterculiaceae, Mimosaceae, Bignoniaceae, Combretaceae, Caesalpiniaceae and Bombacaceae were the most useful families as food based on Alimentary Utility Indices. This seems true because, these families involved species from which leaves and fruits are widely valorized as food in the whole country by local population.

Parameterization of family importance, allowed us to understand the variation in use of families and to detect the most important families. Assessing the useful of medicinal plants based on indices was also documented (Trotter and Logan, 1986; Phillips and Gentry, 1993a; Smith, 1993; Alexiades, 1996; Borgatti, 1996ab; Bennett and Prance, 2000; Collins *et al*., 2006; Inta et al., 2008; Signorini *et al*., 2009; Tardío and Pardo-de Santayana, 2008; Thomas *et al*., 2009).

Diversity and solicitation of botanical families for treating ailments

The number of species per family ranges from 1 (Flacourtiaceae and Lytraceae) to 12 (Apocynaceae). The difference in species composition of medicinal plant families may be linked with their usefulness in treating ailments. This is confirmed with the number of ailments treated per family. In fact, the number of ailments treated varied with the species composition of family. Family with more species treats more ailments except Lytraceae which treated 30 ailments with only one species.

As far as the organs solicited for treating ailments are concerned, the roots of Polygaceae (70 %) and Flacourtiaceae (70 %) were more used in treating ailments while Fabaceae' barks (40 %) were more useful. Lytraceae (50 %) and Combretaceae (45 %) leaves were more solicited while Euphorbiaceae (30 %), Meliaceae (30 %), Bignoniaceae (30 %) and Lytraceae (30 %) stems were more useful for treating ailments. The most useful families' fruits for treating ailments were Caesalpiniaceae (40 %), Annonaceae (30 %) and Bombacaceae

(30 %). It should be known that families from which species' root was mostly solicited were more threatened than the others. In fact, removal of roots could have significant detrimental effects on plant survival and regeneration (Dhillion and Amundsen, 2000). Thus, the most threatened families might be Polygaceae and Flacourtiaceae.

Conclusion

Parameterization of the usefulness of medicinal plants helped in understanding the variability in their using and the most useful families in Benin. Plant species and plant parts solicited for treating ailments vary according to plant family. Threatened families are those of which roots are more solicited.

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Table-1. Parameters for medicinal plants use in Benin

Parameters	Minimum value	Maximum value	Average value	Coefficient of Variation
National Identity Coefficient (NIC)	0.31	1	0.69 ± 0.31	44.93
National Utility Coefficient (NUC)	0.26	1	0.60 ± 0.28	46.67
Alimentary Utility Index (AUI)	6	50	29.75 ± 14.10	47.39

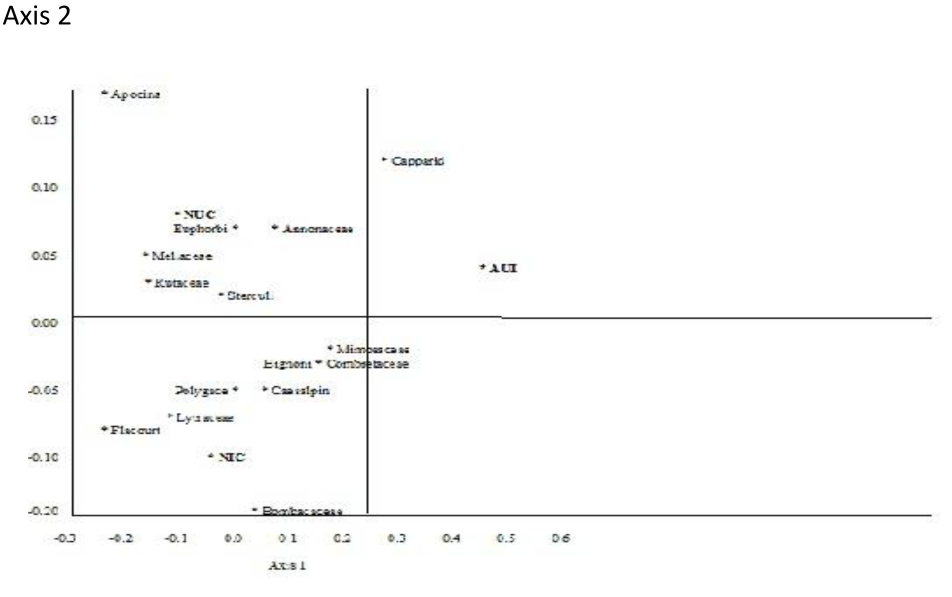

Figure 1: Factorial correspondence analysis on parameters and botanical families Legend: Apocina: Apocynaceae; Euphorbi: Euphorbiaceae; Sterculi: Sterculiaceae; Capparid: Capparidaceae; Bignoni: Bignoniaceae; Caesalpin: caesalpiniaceae; Polygace: Polygaceae; NUC: National Utility coefficient; NIC: National Identity coefficient; AUI: Alimentary Utility Index.

Table 2: Percentage of organs solicited per botanical family for treating ailments

Family	Roots (%)	Barks (%)	Leaves (%)	Stems (%)	Fruits (%)	Total (%)
Polygaceae	70	10	10	10	0	100
Flacourtiaceae	70	10	10	10	0	100
Rutaceae	35	15	25	10	15	100
Fabaceae	35	40	5	5	15	100
Apocynaceae	30	15	15	15	25	100
Euphorbiaceae	30	10	30	30	0	100
Combretaceae	30	0	45	10	15	100
Mimosaceae	25	25	5	20	25	100
Capparidaceae	25	15	25	20	15	100
Annonaceae	25	20	20	5	30	100
Bignoniaceae	25	30	5	30	10	100
Bombacaceae	20	25	10	15	30	100
Meliaceae	15	30	15	30	10	100
Sterculiaceae	10	25	15	25	25	100
Lytraceae	10	10	50	30	0	100
Caesalpiniaceae	5	30	10	15	40	100

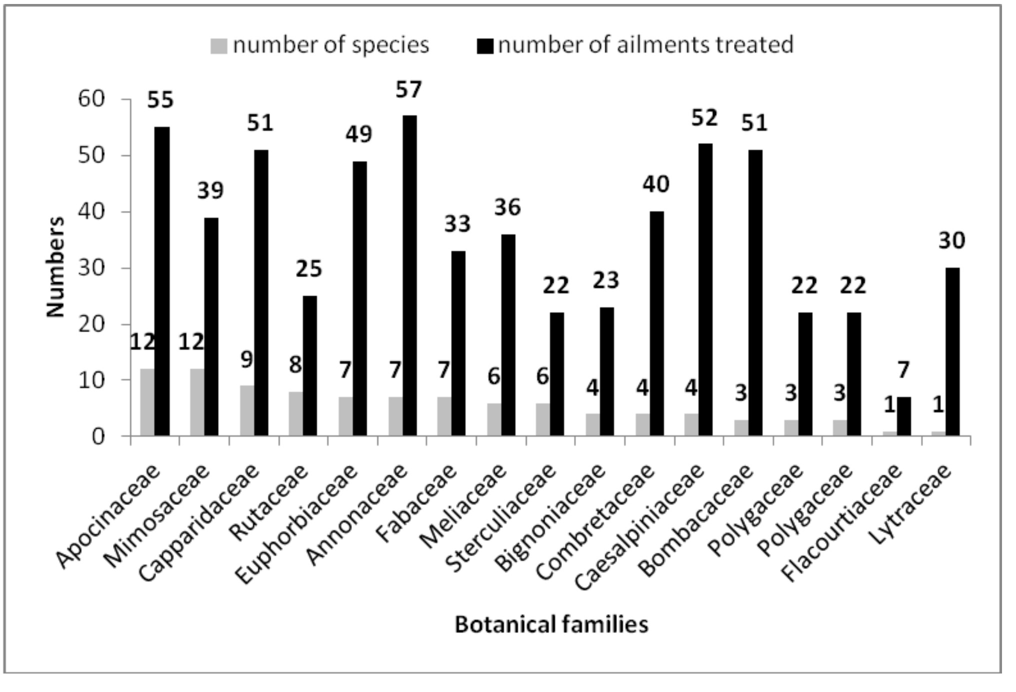

Figure 2: Botanical families' diversity and ailments treated per family

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