

Original Research Article

Melliferous plants threatened to disappearance in Togo

ABSTRACT

Pollinic analysis and apicol surveys conducted between 2009 and 2014 on honey sampled directly in beekeeping areas or ~~outlets has~~ outlets have permitted ~~to inventor~~ discovery of 330 melliferous species Including 9,70%, which are ~~threatened to disappearance~~ extinction in Togo. Compared with Togolese melliferous flora, these plants are about 0,25 %.

~~Grouped in~~ The 43 genres, ~~these of food plant species inventoried~~ which are food plants can be grouped into 24 families and most at risk are the Malvaceae, ~~the~~ Anacardiaceae, the Fabaceae and the Annonaceae.

~~These plants can be divided into two classes: wild plants and crop plants. Their bodies'~~ majority The routinely used parts of these plants are the fruits and leaves. In general, nectar plants are the most represented.

Keywords: Melliferous plants; threat; Togo.

1. INTRODUCTION

Melliferous plants are plants whose flowers provide nectar or pollen for honey production to bee colonies. Besides their role in honey production or provision of pollen, some have other uses. They serve as food plants. Apart from their contribution to biodiversity of the regions or areas where they occur, these plants are very important in nutrition, health and household food security [1].

They have many virtues in various fields that contribute to the proper development and sustainable environmental management. Unfortunately, many are threatened by environmental, economic, social and cultural challenges. Once valued their consumption, are neglected, underutilized and endangered [2].

The objective of this work is to identify the melliferous species that are endangered or threatened by different uses in Togo and evaluate them compared with all melliferous species which currently constitute melliferous flora of Togo.

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2. METHODOLOGICAL APPROACHES

2.1. Study zone

The study was performed in the five ecological zones of Togo (Fig. 1). Togo is bordered to the north by Burkina Faso, to the south by the Atlantic Ocean, to the east by Benin and to the west by Ghana. This country is located between 6 ° and 11 ° north latitude and between 0 ° and 2 ° East. It covers an area of approximately 56,600 km² with a population of 6,191,155 inhabitants. The Togo extends over a length of 600 km and a width varying from 45 km at the coast and 140 km at Bassar. It has a tropical climate which varies from south to north. It is determined by two main currents of air: the monsoon and the harmattan.

Mainly composed of over 80% rural, the Togolese population lives essentially of agriculture. Thus, to meet the food needs of a growing population, the different vegetation formations are continuously degraded and replaced with food or cash crops and plantations. This degradation results in major depletion of certain plant species, or even disappearance of the flora of Togo. Actually the flora of Togo is evaluated to 3501 species [37].

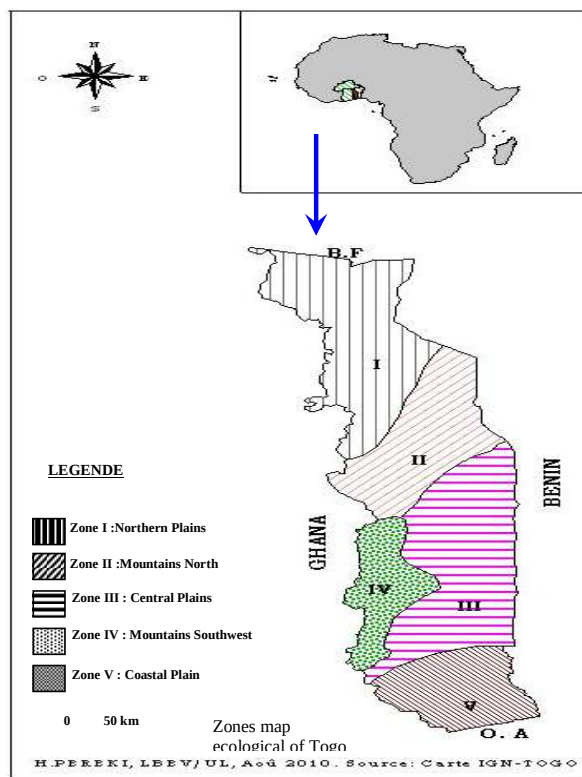


Fig. 1. Map of Ecological Zones of Togo
(source: Koudégan & al. (2014))

2.2. Pollinic analysis

Twenty millimeters of honey were collected and acetolysed [18] to remove macromolecules like sugars, proteins and waxes of pectocellulosic membranes, etc. For each sample of honey, about 20 microliters-micrograms of the pellet obtained after centrifugation at 3000 rpm ~~/min~~ ± 100 for 10 minutes with a centrifuge "juan c 3 12" was mounted between microscopic slide glasses and cover glasses for microscopic observation. The observations were performed using a light microscope biloculaire "Nikon Eclipse ci" to 400x and 1000x magnifications. Each preparation was then fully explored and the readings were progressively done on the horizontal lines of a periphery to another for inventory of all their palynological population. Determinations were made at the species level or genus or family in this study.

2.3. Ethnobotanical surveys

In all, 280 communities of Togo were surveyed. They include 38 cultural groups, some of which majority and everywhere in the country and other minority located in an area or even a single village [6]. The number of ethnocultural groups varies from one locality to another. Also, the samples within an ethnocultural group were based on the importance of the geographical distribution of that group in the country.

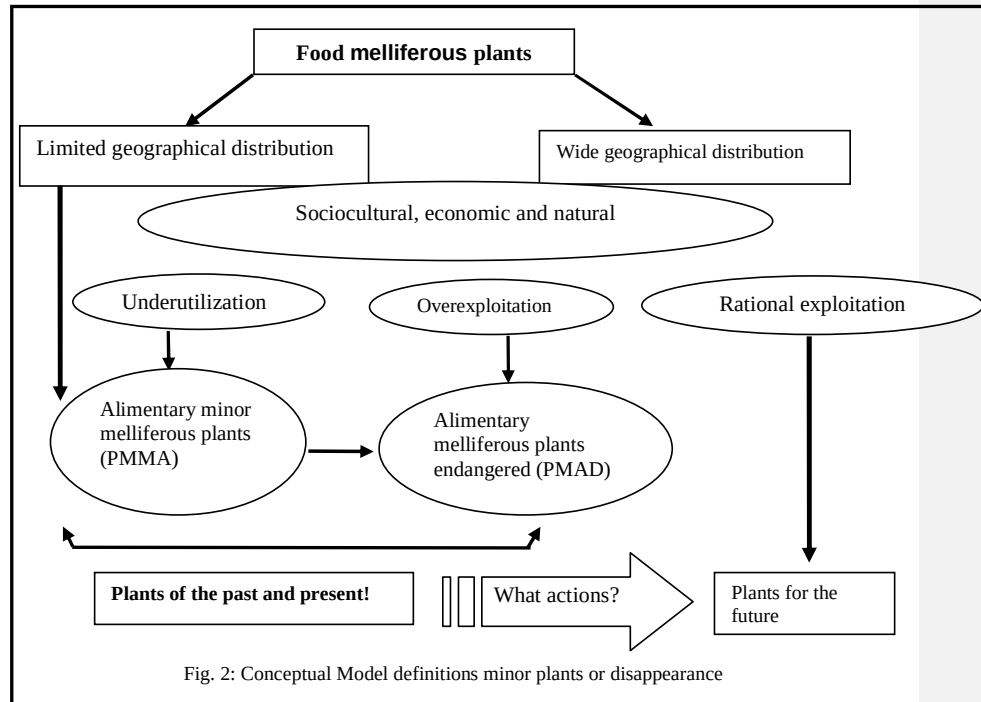
In these localities, the chosen people, often with the assistance of local authorities (Leaders of Village Development Committees and agricultural groups, the farmers of the Third Age , etc), are of all social strata: men, women, heads of households, young and old, rich and poor, farmers, agro-pastoralists and people engaged in an activity other than agriculture, etc. These respondents were in groups of 2-70 individuals with an average size of 11 people.

Data collection was carried out with the support of a multidisciplinary team at the Laboratory of Botany and Plant Ecology by ethnobotanical surveys. Semi-structured interviews coupled with direct observations at home, in the fields and market places were organized [9, 10]. The survey was conducted using an interview guide previously established and tested on a small sample.

Most species encountered were determined directly in the field. Those who are difficult to identify were sampled and placed in a herbarium for laboratory identification according to certain nomenclatures [8, 11, 12, 13, 14, 15, 16]. Photos of the plants have been taken in the field for the identification and illustration. Pretreatment of all species inventoried and appointed enabled the development of two major categories of species:

- Alimentary cultivated and minor spontaneous plants (wild) melliferous ; this category regroup alimentary plants that are rarely used or underutilized [2, 17] and food plants whose original geographical distribution is reduced;
- Alimentary plants spontaneous melliferous or cultivated endangered to disappearance .

In general, endangered melliferous food plants include minor and non-miners plants that are overexploited (Fig. 2).



(Source: extract of Akpavi S. & al. (2008))

3. RESULTS AND DISCUSSION

3.1. Results

In all, a total of 45 species were identified, which are grouped into 43 genera and 24 families.

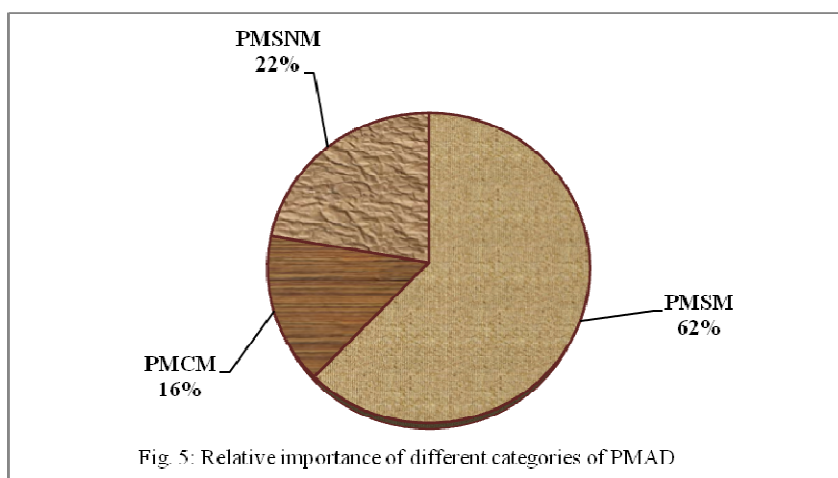
3.1.1. Distribution of alimentary melliferous species threatened according to categories of plants

Alimentary melliferous plants endangered consist of:

- Minor spontaneous melliferous plants "PMSM" (62 %) constituted by *Amaranthus spinosus* L., *Annona senegalensis* Pers., *Balanites aegyptica* (L.) Del., *Blighia sapida* C. König, *Bombax costatum* Pellegr. & Villet, *Borassus aethiopum* Mart., *Ceiba pentandra* (L.) Gaertn, *Cola millenii* K. Schum, *Dialium guineense* Willd., *Diospyros mespiliformis* Hochst. ex A. DC., *Ficus sycomorus* L., *Grewia carpinifolia* Juss., *Hexalobus monopetalus* (A. Rich.) Engl. & Diels, *Ipomoea mauritiana* Jacq., *Irvingia gabonensis* (Aubry- Lecomte ex O'Rorke) Baill., *Lannea acida* A. Rich.,

Nauclea latifolia Sm., *Parkia clappertoniana* Keay, *Paullinia pinnata* L., *Sclerocarya birrea* (A. Rich.) Hochst, *Spondias mombin* L., *Strychnos spinosa* Lam., *Talinum triangulare* (Jacq.) Willd., *Tamarindus indica* L., *Uvaria chamae* P. Beauv., *Vitellaria paradoxa* CF Gaertner *Ximenia americana* L. and *Zanthoxylum zanthoxylloides* (Lam.) Zepernick & Timler.

- Minor cultivated plants melliferous "PMCM" (16 %) formed to *Anacardium occidentale* L., *Carica papaya* L., *Corchorus olitorius* L., *Cyperus esculentus* L., *Elaeis guineensis* Jacq, *Psidium guajava* L. and *Solanum aethiopicum* L.
- Non minor spontaneous melliferous plants "PMSNM" (22 %) constituted by *Afraegle paniculata* (Schum. & Thonn) Engl, *Antiaris africana* Lesch, *Celosia argentea* L., *Commelina benghalensis* L., *Corchorus fascicularis* Lam, *Corchorus tridens* L., *Khaya senegalensis* (Desr.) A. Juss., *Mangifera indica* L., *Mitragyna inermis* (Willd.) Kuntze and *Sterculia tragacantha* Lindl.



3.1.2. Distribution of melliferous families according to their specific composition

Depending on their composition from threatened species, these families can be divided into four groups (Fig. 3a):

- The group of highly threatened families consisting of Malvaceae (33.33 %) and Anacardiaceae (20.83 % each);
- The group of moderately threatened families constituted by Fabaceae and Annonaceae (12.5 % each);
- The group of threatened families formed by Amaranthaceae, Arecaceae, Moraceae, Rubiaceae, Rutaceae and Sapindaceae (8.33 % each);

- The group of low risk families constituted by Caricaceae, Commelinaceae, Convolvulaceae, Cyperaceae, Droseraceae, Gentianaceae, Irvingiaceae, Meliaceae, Myrtaceae, Olacaceae, Portulacaceae, Sapotaceae, Solanaceae, Zygophyllaceae (4.16 % each).

Figure 3 below reflects the distribution of families according to the number of threatened species assessed as a percentage.

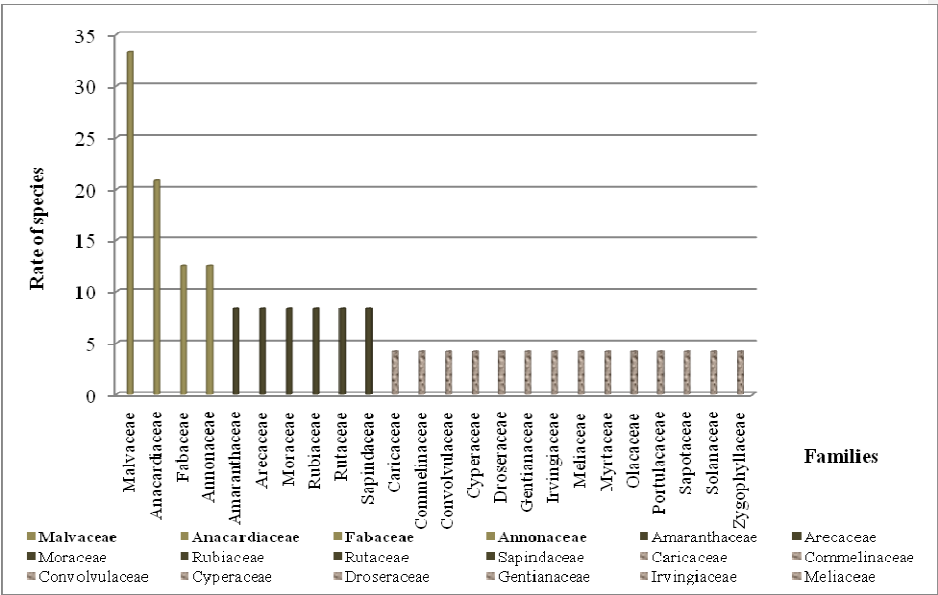
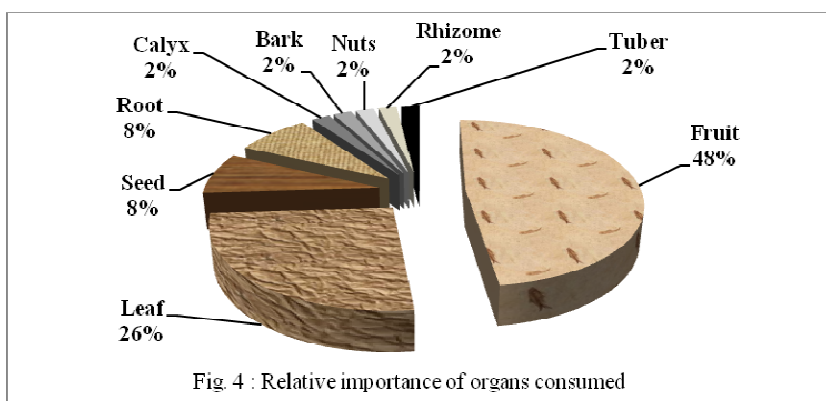


Fig. 3: Relative importance of melliferous families threatened

3.1.3. Distribution of alimentary melliferous plants threatened according to organ consumed

In terms of the various organs used, fruit plants are most dominant (47%); those moderately dominant consist plants whose leaves are consumed (27%) and those weakly dominant formed by seed plants, root plants, calyx plants, bark plants, nut plants, rhizome plants and tubers plants (8-3%).



3.1.4. Distribution of food melliferous species threatened according to nutrients foraged by bees

The different plants identified are differently foraged. Overall, the nectariferous plants are the most important, followed by nectariferous-polleniferous plants, ~~then after~~ and finally polleniferous plants (Figure 6).

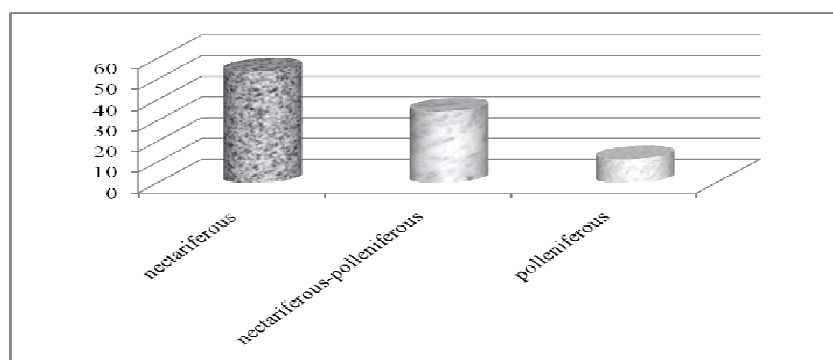


Fig. 6: Relative importance of nutrients PMAD foraged by bees

3.1.5. Causes of threats on the alimentary plants in Togo

Availability, consumption and sustainability of food melliferous plants are influenced by a combination of factors that work synergistically. These causes, which vary from one locality to another and from one ethnocultural group to another, include: the destruction of natural ecosystems by advanced of agricultural and urban fronts and uncontrolled bush fires, the soil and climatic conditions unsuitable, sociocultural considerations, the degradation of good

neighborly relations, the disruption of family structures, social discrimination against the use of plants to certain categories of people, the cultural shift schedule, changes in eating habits, competition from new varieties, the lure of the exotic, the specific characteristics of plants, reduction of agricultural land, the influence of rainfall and low crop yields .

All these different causes listed above can be divided into four main areas [3, 4, 5] as shown in Figure 7 below.

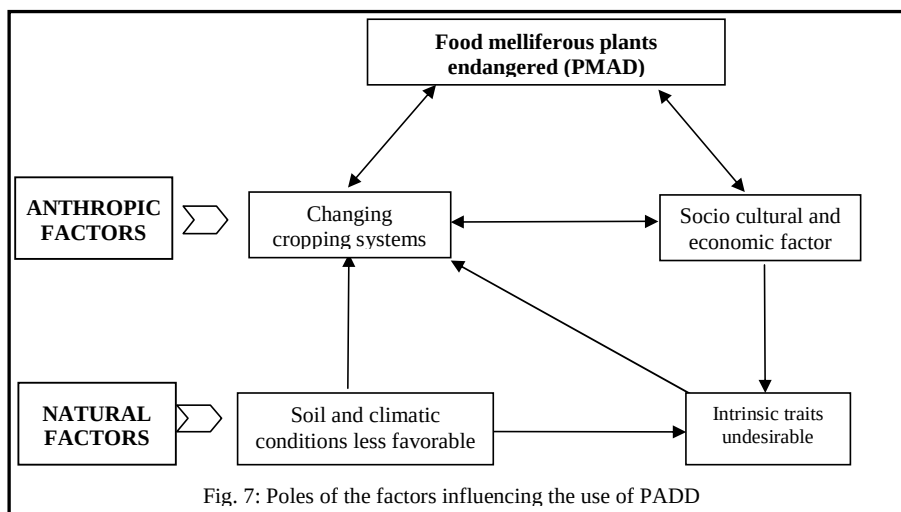


Fig. 7: Poles of the factors influencing the use of PADD

(Source: extract of Akpavi S. & al. (2008))

When the conditions of soil and climates are not conducive to certain cultures, they are abandoned and thus altering the structure of cropping systems. The changing of cropping systems can also be linked to socio-cultural and economic factors favoring or prohibiting the consumption of certain plants. Each of these centers is, in a different way, threats to the availability and consumption of plants.

This correlation between the factors influencing the availability, consummation and sustainability of PMAD is more related to the spatial distribution of ethnocultural groups than their size. Indeed, more a people is widespread, more it is in touch with all the natural, socio-traditional and economic conditions prevailing in all agro-climatic zones of the country. This remains true even if the number of people's representatives in these areas is not large size.

3.2. Discussion

The 45 melliferous species identified as endangered represent 24% of the national melliferous flora which currently covers about 9.43 % of the Togolese flora (3501 species), according the studies carried out [19, 20]. Taking into account all of endangered food plants inventoried [3] this number represent 32.85 %. What remains important not to overlook,

given the importance of these plants in the survival of living beings, or generally in the conservation and sustainable management of ecosystems.

The classification of these alimentary melliferous plants endangered (PMAD) in different categories (minor spontaneous plants and minor cultivated plants) is an important preliminary [study/data](#) in the management of local resources [21]. Cultivated melliferous plants identified in this study are all minor. Cultivated minor plants are those less cultivated and / or consumed in favor of other introduced species [3]. Similarly, other authors confirmed this assertion [2, 18, 22, 23] stating that as these plants become less and less available in food recipes populations. For melliferous species threatened [and](#) qualified as spontaneous minor, that represent 62 %, the work [3, 8, 24, 25] showed that these are plants that either have a low representation on the territory, or are less consumed and neglected, and therefore attract less the attention of consumers.

This study emphasizes that taking into account the organs consumed according to the number of species, the fruit are most at risk (48 %) followed by plant leaves (26 %). This confirms the results obtained by Akpavi, which reports that fruit and wild vegetables are an important part of the minor or endangered plants [3, 4, 5]. Another works have proved that the fruit and wild vegetables have strong implications in food recipes of West Africans population especially during food crises [26, 27, 28].

The majority of these threatened species include plants that bees need for honey production: nectariferous plants. Honey, being completely made with nectar, a sweet substance in the flowers, the disappearance of these species has a significant effect on the rate of production of this food; a very useful food for bees themselves and humans also. Moreover, this threat of extinction will have direct effects on plant and animal ecosystems. As bees are Hymenoptera which playing an important role in the multiplication of plants by the pollinating, so the disappearance of their nutrient supply sources (-nectar-, pollen-, resins, ...) cause their reduction or their total extinction. This means that the threat of extinction of these plants is in turn a threat of destruction of the whole environment; which is very worrying.

Moreover, the various causes related to threats of extinction food melliferous species above are of two kinds: natural and anthropic causes.

The natural order threats that affect the availability and consumption of food plants in Togo are related to environmental degradation, change in cropping systems, some intrinsic characteristics of plants and factors sociocultural and economic [3]. The phenomenon of degradation and human impacts of ecosystems leads to land saturation and a farmland mining [29]. Complementing this statement certain authors explain that the lack of agricultural land obligate farmers to intensify cropping systems and to operate some rigorous choice, thus excluding often the seeds of food crops to low commercial value [30, 31].

Another works showed that influences linked the marginalization and the loss of many food plants are also due to anthropic factors or contemporary social phenomena such as changes in eating habits, social disparities, individualized behavior, migration of populations and the dislocation of family structures [3, 32, 33]. The work of FAO indicates that changes in eating habits can lead to a complete disappearance of menus, a total or partial modification of components of menus [34]. These changes are a response to a multitude of internal and external factors in interaction, especially the food availability, culture and education, way of life, socioeconomic level and styles or dietary models [35, 36].

4. CONCLUSION

From this study, it appears that 45 species of melliferous and alimentary interest were targeted endangered in Togo. These species, which represent approximately 24 % of the national melliferous flora, correspond to 43 genres and belong to 24 families. These melliferous families were divided into four groups based according to their composition in endangered plants: the highly threatened families, families moderately threatened, endangered families and families low risk. Overall, the fruit plants are the most dominant plants followed the leaf plants. The majority of these plants are represented by the nectariferous plants.

In addition, food melliferous species identified were grouped into three categories: melliferous spontaneous minor plants, cultivated melliferous plants and non-minor spontaneous melliferous plants.

The causes which are the basis of the disappearance of food melliferous plants in Togo are generally in natural and human order and can be divided into four areas intrinsically linked: the conditions soil and climatic, changes in systems cropping, sociocultural and economic factors and intrinsic traits undesirable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Frisian E. A., Cherfas J., Eyzaguirre P. B. et Johns T. *Biodiversity for nutrition*. In Frison E., Omont H. et Padulosi S., 2000. *GFAR and International Cooperation on Commodity Chains*. Synthesis paper for presentation to the GFAR-2000 Conference, Dresden, Germany, May 21-23, 2000.
2. Padulosi & Hoeschle – Zeledon. Underutilized plant species: what are they? *LEISA Magazine*. 2004, 20 (1): 5-6.
3. S. Akpavi, K. Wala, K. Akpagana, K. Batawila, H. Dantsey-Barry, K. Amouzou, K. Kossi-Titrikou et I. Butaré. *Diversité des plantes alimentaires mineures et menacées de disparition au Togo*. JSIL/UL, XXII^e éd du 24-29 Octobre (Togo), p 66. CNRST/FRSIT, VII^e éd du 18-25 Novembre (Burkina Faso), p 57 ; 2006.
4. S. Akpavi, K. Wala, K. Batawila, K. A. Gbogbo, M. Kanda, H. Dantsey-Barry, K. Amouzou, K. Kossi-Titrikou, I. Butaré et K. Akpagana. *Distribution spatiale des plantes alimentaires menacées de disparition au Togo : un indicateur de l'ampleur de leurs menaces*. 18^e congrès de l'Association pour l'Etude Taxonomique de la végétation et de Flore d'Afrique Tropicale (AETFAT). Yaoundé, 24 Février au 02 Mars 2007, 165.
5. S. Akpavi, K. Wala, K. Batawila, K. A. Gbogbo, M. Kanda, H. Dantsey-Barry, K. Amouzou, K. Kossi-Titrikou, I. Butaré et K. Akpagana. Intrinsic characteristics of food plants in Togo: threat factors. International Symposium. "Underutilized plant species for food, nutrition, income and sustainable development". Ngurdoto Mountain Lodge, Arusha, Tanzania, 2-8 March, Book of abstracts. 2008, 110.
6. Gayibor N. L. *Histoire des Togolais, des origines à 1884*. Presses UB, Lomé, vol. 1. 1997, 13-68.

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Use of et al instead of et
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7. Ern H. Die Vegetation Togos : Gliederrung, Gefährdung, Erhaltung. *Willdenowia*. 1979, 9 : 295-312.
8. Brunel J. F., Hiekpo P. et Scholz. H. *Flore analytique du Togo : Phanérogames*. GTZ, Eschorn. 1984, 751.
9. Twamasi P. A. *Social research in rural communities*. 2nd ed., Ghana Universities Press, Accra. 2001, 168.
10. Tom Kumekpor K. B. *research methods and techniques of social research*. SonLife Press and Services, Accra. 2002, 304.
11. Hutchinson J. & Dalziel J. M. *Flora of West Tropical Africa*. 2nd ed., revised by Keay R. W. J. and Hepper F. N., Crown Agents for Oversea Governments and Administrations, 3 vols. 1954-1972.
12. Aubréville A. *La flore du Gabon : Famille des Sapotacées*. MNHN éd., Paris, France, vol. 1. 1961, 162.
13. Berhaut J. *Flore illustrée du Sénégal. Dicotylédones, Tome VI, Linacées à Nymphaéacées*. Ministère du Développement Rural et de Hydraulique, Dakar. 1979, 635.
14. Arbonnier M. *Arbres, arbustes et lianes des zones des sèches de l'Afrique de l'ouest*. CIRAD-MNHN, 2^e éd. 2002, 573.
15. Akoègninou A. Van der Burg W. J., Van der Maesen L. J. G., Adjakidjè V., Essou J. P., Sinsin B. et Yédomonhan H. *Recherches sur les forêts denses humides du Togo*. Th. Doct., Univ. Bordeaux III. 2006, 195.
16. Angiosperm Phylogeny Group (APG II). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society. With 1 figure*. 2003, 141: 399-436.
17. Eyzaguirre P. B., Padulosi S. et Hodgkin T. IPGRI's strategy for Neglected and Under-utilized Species and the Human Dimension of Agrobiodiversity. In Padulosi S. (Ed.) *Priority-setting for Under-utilized and Neglected Plant Species of the Mediterranean Region*, IPGRI, Alepo (Syria). 1999.
18. Erdtman G. *The acetolysis method*. A revised description. In. Svesk. Bot. Tidskv. 1960, 54 (4), 561-564.
19. Koudégnan C., Etorh T., Guelly K., Batawill K., Akpagana K. *Inventaire des taxons polliniques des miels de la Zone Guinéenne du Togo : cas des zones écofloristiques IV et V*. European Scientific Journal; November edition vol. 8, No.26 ISSN: 1857 – 7881 (Print) e – ISSN 1857 – 7431. 2012, 14 (37–50).
20. Comlan M. Koudégnan, Thérèse Etorh, Kudzo Guelly, Siendou Coulibaly. *Pollens of Melliferous Plants of Ecologic Zones IV and V of Togo*. British Journal of Applied Science & Technology. 2013, 4(3): 540-557; 17. (540-557).
21. Ambé G. A. Les fruits sauvages comestibles des savanes guinéennes de Côte d'Ivoire : état de la connaissance par une population locale, les Malinké. *Biotechnol. Agron. Soc. Environ*. 2001, 5 (1) : 43-58.
22. Padulosi S. Criteria for priority setting in initiatives dealing with underutilized crops in Europe. In Gass T., Frese L., Begemann F. et Lipman E. (Ed.) *Implementation of the Global Plan of Action in Europe – Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture*. Proceedings of the European Symposium, Braunschweig, Germany. 1999, 236-247.
23. Padulosi S., Hodgkin T., Williams J. T. et Haq N. Under-utilized crops: Trends, challenges and opportunities in the 21st century. In Engels J. M. M., (Ed.), *Managing plant genetic resources*, London and Rome, CABI-IPGRI. 2002, 21-40.
24. IPGRI. *Diversity for well-being. Making the most of agricultural biodiversity, IPGRI's new strategic directions*. IPGRI, Rome. 2004, 46.
25. Padulosi S. Hunger and poverty : the role of biodiversity. In Bala Ravi S., Hoeschle-Zeledon I., M. S. Swaminathan M. S. et Frison E. (Ed.) *Report of an International*

- Consultation on The Role of Biodiversity in Achieving the UN Millennium Development Goal of Freedom from Hunger and Poverty. Chennai, India. 2006.
26. Norman J. C., *tropical vegetable crops*. Devon Ed., Great Britain. 1992, 114.
27. Millogo-Rasolidimby J. *L'homme, le climat et les ressources alimentaires végétales en période de crises de subsistance au cours du 20^è siècle au Burkina Faso*. Th. Doct. Etat, Univ. Ouagadougou, Burkina Faso. 2001, 211.
28. Zoro Bi I. A., Koffi K. K. et Djè Y. Caractérisation botanique et agronomique de trois espèces de cucurbités consommées en sauce en Afrique de l'Ouest : *Citrullus sp.*, *Cucumeropsis mannii* Naudin et *Lagenaria siceraria* (Molina) Standl. *Biotechnol. Agron. Soc. Environ.* 2003, 7 (3-4) : 189-199.
29. Micheau P. *Lecture socio-foncière des terroirs. Introduction à une démarche méthodologique élaborée par Grigori Lazarev*. CNEARC.1997, 48.
30. Waziri Mato M. Quelques facteurs de changement des systèmes agraires sahéliens : le cas des milieux humides du sud du département de Zinder. *Annales de l'Université Abdou Moumouni de Niamey*. Actes du colloque SPP/E tenu à Niamey du 14 au 15 décembre 1995 ; thème : Agri-cultures en mutation. 1996, 233-256.
31. Penot E. Mise en cohérence entre systèmes techniques, systèmes sociaux et territoires : ces hévéaculteurs de la province de Kalimantan-Ouest (Indonésie). Evolution des pratiques et dynamique des territoires. *Cahiers Agriculteurs*. 2004, 13 : 450-458.
32. Empereira L., Pinton F. et Second G. Gestion dynamique de la diversité variétale du manioc en Amazonie du Nord-Ouest. *Nature, Science et Société*. 1998, 6 (2) : 27-42.
33. Baco M. N., Biao G., Pinton F. et Lescure J.-P. les savoirs paysans traditionnels conservent-ils encore l'agrobiodiversité au Bénin ? *Biotechnol. Agron. Soc. Environ.* 2007, 11 (3) : 201-210.
34. FAO. *Agriculture, alimentation et nutrition en Afrique : un ouvrage de référence à l'usage des professeurs d'agriculture*. FAO éd., Rome. 2002, 442.
35. Delisle H. *Urban food consumption patterns in developing countries: Some issues and challenges*. Rapport de consultant inédit, FAO, Rome. 1990.
36. Sadik N. Croissance démographique et crise alimentaire. In : FAO, *Alimentation, nutrition et agriculture*, n°1. 1991.
37. MERF, 2014. Stratégie et Plan d'Action National pour la Biodiversité du Togo SPANB 2011-2020. Rapport final; 126 p + annexes.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

- Fig.: figure;
- &: and;
- Trs: tours;
- Min: minute;
- PMAD: Food melliferous plants endangered [In French];
- PMSM: Spontaneous minor melliferous plants [In French];
- PMCM: Crops minor melliferous plants [In French];
- PMSNM: Spontaneous non-minor melliferous plants [In French]