

Uses and management of black plum (*Vitex doniana* Sweet) in Southern Benin

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Abstract — Introduction. Black plum (*Vitex doniana*) is an indigenous fruit tree species important for the livelihoods of rural populations. Currently, there is renewed national and international interest in black plum, and it has emerged as a priority species for domestication in Africa. The present work addressed farmers' indigenous knowledge of the use and management of the species among different socio-cultural groups in Benin, taking into account gender differences. The specific objective of this work was to study the knowledge, uses, local gathering practices and management systems of *V. doniana* that are part of the traditions of the communities in Southern Benin.

Materials and methods. A total of 150 participants randomly selected from three socio-cultural groups provided survey responses. Information collected mainly referred to the motivation of respondents to conserve black plum trees on their land, the local uses and the management practices to improve the regeneration and production of the black plum. **Results and discussion.** The study showed that knowledge of black plum is well distributed in the community. However, people have different interests in using black plum and there is variable knowledge of use and management practices. The food and medicinal categories were the most important uses. There were no significant differences in knowledge of the management and utility of black plum between men and women, or across socio-cultural groups. **Conclusion.** Given its value to the communities in southern Benin, black plum should be prioritized for domestication.

Benin / *Vitex doniana* / indigenous knowledge / domestication / traditional uses / ethnobotany

Utilisation et gestion du prunier des savanes (*Vitex doniana* Sweet) au sud du Bénin.

Résumé — Introduction. Le prunier des savanes (*Vitex doniana*) est une espèce fruitière indigène importante pour la subsistance des populations rurales. Actuellement, il y a un regain d'intérêt national et international pour cet arbre qui apparaît comme une espèce prioritaire pour la domestication en Afrique. Notre travail a porté sur une étude des connaissances autochtones des agriculteurs quant à l'utilisation et à la gestion de l'espèce en fonction de différents groupes socio-culturels du Bénin, en tenant compte des différences entre les sexes. L'objectif spécifique de ce travail a été d'étudier les connaissances, les usages, les pratiques de cueillettes locales ainsi que les systèmes traditionnels de gestion de *V. doniana* chez les populations du sud du Bénin.

Matériel et méthodes. Un total de 150 participants choisis au hasard dans trois groupes socio-culturels a été soumis à une enquête. L'information recueillie a porté principalement sur la motivation des répondants à conserver les pruniers des savanes sur leurs terres, sur leurs utilisations et sur leurs pratiques de gestion locales pour améliorer la régénération et la production de ce fruitier. **Résultats et discussion.** L'étude a montré que la connaissance du prunier des savanes est bien partagée par la population. Cependant, l'utilisation de l'espèce varie en fonction de l'intérêt des personnes et il existe une connaissance variable de son utilisation et de sa gestion. L'utilisation en aliments et médicaments a prédominé sur les autres usages. Il n'y a pas eu de différences significatives de connaissances sur la gestion et l'utilisation du prunier des savanes entre les hommes et les femmes, ou selon les groupes socio-culturels. **Conclusion.** Compte tenu de sa valeur pour les populations du sud du Bénin, la domestication du prunier des savanes devrait être une priorité.

Bénin / *Vitex doniana* / connaissance indigène/ domestication / utilisation traditionnelle / ethnobotanique

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1. Introduction

In many countries, non-timber forest products (NTFPs) are an under-utilized resource, and it is only in recent years that their potential to enhance the livelihoods of poor people has been appreciated [1–3]. In addition, with advances in crop plant genetics and the surging interest in biotechnology, many scientists increasingly recognize that wild tree species can play a vital role in future economic development [4]. Local communities consider wild tree species as essential elements not only for their diet but also in their socio-cultural rituals [5]. Use and management of these plants are an everyday practice for most rural communities. This shows that rural communities have extensive knowledge of native tree species. This information in making decisions concerns the sustainable use of these plant resources [6–8]. To be sustainable, land use management systems in the tropics should provide the private livelihood needs of subsistence farmers (food security and cash generation); the global needs for international commodities (timber and plantation crops); and international environmental services (biodiversity and sinks for greenhouse gases to minimize global climate change) [2, 9]. To meet these needs, the domestication of indigenous fruits and their integration into diverse agroforests are important components of a strategy for the improvement of land use in Africa [10].

Vitex doniana Sweet is one of the most abundant and widespread tree species occurring in savannah regions. It is a woody agroforestry tree species said to have been domesticated by local communities in Benin [1]. Its importance can be attributed to its status as a multiple-use plant [11]. For example, the plant is widely used for food, medicinal purposes and as a source of firewood. *Vitex*'s sweet prune-like fruit is edible and is occasionally sold. The leaves are also often used as vegetables, whereas almost all parts of the plant have medicinal properties [12–14]. The fruits are used to prepare wine and the pounded leaves are added to warm filtered sorghum beer [14]. Only a small number of ethnobotanical studies have focused on *V. doniana* [12–14, 15] and none

have evaluated, at a local or regional level, the extent of local knowledge of its use and management. These parameters, among others, may help in the determination of future strategies for both the sustainable management and the domestication of the species. The aim of our study was to identify and characterize the knowledge, uses and local management practices of *V. doniana*, in order to provide the basis for a sustainable domestication of the species.

2. Materials and methods

2.1. Study area

The study was carried out in the Guineo-Congolian climatic zone of Benin, located between latitudes 6°25' and 7°30' N. Mean annual rainfall is 1200 mm. Relative humidity varies between 69% and 97%, and mean daily temperatures range from 25 °C to 29 °C. The soils are either deep ferrallitic or rich in clay, humus and minerals. The native vegetation consists of dense semi-deciduous forests and Guinean savannas. The active vegetation period lasts 7 to 8 months. Data were collected from the districts of Covè, Zagnanado, Za-Kpota and Zogbodomey (figure 1).

2.2. Sampling

Based on preliminary investigations among 100 individuals randomly sampled among various ethnic groups in the study area, it was found that 34% of respondents had knowledge of at least one use for the species. This information was used to calculate the sample size according to the formula of

$$\text{Dagnelie [16]: } n = \mu_{1-\alpha/2}^2 \frac{F_n(1-F_n)}{\delta^2},$$

where n is the total number of surveyed people in the study, *i.e.*, the sample size; $\mu_{1-\alpha/2}$ is the value of the normal random variable for a probability value of $\alpha = 5\%$; $\mu_{1-\alpha/2} = 1,96$; F_n is the proportion of people having knowledge of at least one use of the species ($p = 0,34$); and δ is the expected error margin of any parameter to be computed

from the survey, which was fixed at 0.08. Under these assumptions, the sample size to use was established to be 135 ± 48 people. For practical reasons, 150 people were used in our study.

2.3. Ethnobotanical survey

2.3.1. Communities in the study area

The Adja, Fon and Yoruba are the most represented socio-cultural groups in our study area. From a literature review, it was found that people in this region are popularly known to be involved in *V. doniana* exploitation. People belonging to the same socio-cultural group share language, traditions, values, perceptions and beliefs. In addition, men and women do not have the same knowledge [17, 18]. Therefore, we expected some variability in knowledge of natural resources like black plum among socio-cultural groups and according to gender category.

2.3.2. Data collection

Data were collected between September and October 2010, using individual structured interviews. Questionnaires focused on indigenous names of species, the motivation of respondents to conserve the species under their land use system, local uses, and the management practices to improve the production and regeneration of black plum. To carry out the ethnobotanical study, data collectors had to temporarily live in the region. Local informants provided additional information, and interviews were conducted in the presence of a translator if needed.

2.4. Data analysis

In order to determine the distributions of knowledge and use of *V. doniana* over communities, five different parameters were calculated (table I). Details on the indices used and their application can be found in past studies [17, 19–21].

Interviewees were grouped by socio-cultural group (Adja, Fon and Yoruba) and gender (men and women). With respect to the aforementioned class criteria, six subgroup combinations were constituted. A comparative analysis based on five quantitative



Figure 1. Location of the districts of Covè, Zagnanado, Za-Kpota and Zogbodomey in Southern Benin, where various ethnic groups were surveyed to study the uses and management of black plum (*Vitex doniana* Sweet).

measures was performed to assess the knowledge of the interviewees according to their socio-cultural group and gender. Since the collected data were not normally distributed (Ryan–Joiner test of normality), the non-parametric Kruskal–Wallis test was performed in MINITAB 14. A data matrix comprising the relative frequencies of black plum interviewees’ answers was then submitted to Principal Component Analysis (PCA) using SAS 9.0. Variations in knowledge according to the different subgroups were identified.

3. Results

3.1. Local names of black plum

Vitex doniana is designated in each language by different local names (table II).

3.2. Motivation to conserve black plum trees

According to the respondents, the black plum tree is maintained in farms because of its different uses and high marketing value.

Table I.Parameters calculated for studying the uses and management of black plum (*Vitex doniana*) in Southern Benin.

Index	Calculation	Description	References
Interviewee diversity value (ID) ID = U_x/U_t	ID = number of use citations by a given informant (U_x) divided by the total number of uses (U_t)	Measures how many interviewees used a given species and how this knowledge is distributed among the interviewees	[21] [22]
Interviewee equitability value (IE) IE = ID/IDmax	IE = Interviewee diversity value (ID) divided by the highest diversity index value found (IDmax)	Measures the degree of homogeneity of the interviewees' knowledge	[20] [22]
Use diversity value (UD) UD = U_{cx}/U_{ct}	UD = the number of indications registered for each category (e.g., food, construction and fuel) (U_{cx}) divided by the total number of indications for all of the categories (U_{ct})	Measures the importance of the use categories and how they contribute to the local use value	[20] [22]
Use equitability value (UE) UE = UD/UDmax	UE = diversity value (UD) divided by the highest use diversity index found (UDmax)	Measures the degree of homogeneity of knowledge with regard to the use categories	[20] [22]
Consensus value of use types (CTU) CTU = $[(TU/U_t) / S]$	CTU = number of times a given use is reported (TU) divided by the total number of uses (U_t). This value is then divided by the types of use separated within each category (e.g., food, coal and firewood)	Measures the degree of concordance among interviewees with regard to the uses of a given species	[18] [22]

Table II.Common names of *Vitex doniana* in each socio-cultural group surveyed in Southern Benin.

Socio-cultural group	Language	Local name
Adja	Adja	Fontchi
Yoruba	Nago	O'ri/Igui o'ri
Fon	Fongbé /Mahi	Fontin

The principal motivation for maintaining it is its use as food (70% among the Adja, 48% among the Fon and 27.5% among the Yoruba). The Adja socio-cultural group also showed the highest motivation frequency (30%) for black plum medicinal uses, followed by the Yoruba (25%) and Fon (20%). Thirty percent of Fon conserved the black plum for marketing purposes. In total, 37.33% of interviewees did not find black plum was worthy of conservation on their farm.

3.3. Diversity and distribution of uses among interviewees

Vitex fruits are consumed fresh at maturity while parboiled young leaves are used like any other African leafy vegetable. All interviewees confirmed use of the species as food and 95% of the interviewees consumed both fruits and leaves. The others eat only leaves. Overall, twenty-five diseases were recognized to be treated with black plum. Leaves, fruits, bark and roots are all involved in disease treatment (*table III*). Most of the trees found at homesteads are preserved for religious uses. *Vitex doniana* trees have a great socio-cultural and mythological importance for local people. Further uses include timber for joinery and firewood.

There were no significant differences ($H = 4.99, p > 0.05$) cited in terms of diversity of uses (ID) between men and women nor between the different socio-cultural groups ($H = 2.49, p > 0.05$) (*table IV*). However, there were significant differences in

terms of equitability value (IE) between men and women ($H = 1.155, p < 0.05$) as well as between socio-cultural groups ($H = 3.486, p < 0.05$) (table IV). The average total equitability value (IE) was 0.50, indicating that half of the people in the community knew more than others about the uses of this species. Knowledge about the uses of this species was fairly well distributed over the study area.

3.4. Interviewee consensus value for use types

Six types of uses of *V. doniana* represented by the consensus value for the types of use (CTU) were cited. There were no significant ($p > 0.05$) differences between socio-cultural groups nor men and women. The type of use having the greatest importance was food resource (0.84) followed by medicine, wood and soap (0.61, 0.14 and 0.12, respectively) (table V).

3.5. Use diversity value

The highest values for use diversity (UD) were evidenced for the digestive problems category (0.22), genito-urinary problems (0.14), and wounds and burns (0.11). These contributed widely to the local use value. Additionally, these categories obtained the highest values for equitability (0.98, 0.61 and 0.49, respectively), indicating that knowledge of black plum's medicinal properties is widely distributed within the sample population ($N = 150$) (table VI).

3.6. Regeneration and management of *V. doniana*

Natural regeneration was found to be the only rejuvenation technique used in the traditional system. People usually harvest the desired resources without any additional attention being paid to their regeneration and management. The communities either consumed the fruit in nature and/or brought the fruit back to the village for home use. However, protection and pruning were noticed as traditional management practices. People protect young

Table III.
Main uses of black plum (*Vitex doniana*) according to socio-cultural groups surveyed in Southern Benin.

Plant part	Category	Uses
Young leaves	Food	Cooking leafy vegetable
	Medicine	Treatment of wounds
Mature leaves	Medicine	Treatment of malaria
		Treatment of stomach ache
		Treatment of painful menstruation
		Treatment of burns
	Art	Making ink
Fruits	Food	Direct consumption
	Medicine	Treatment of fatigue
		Treatment of constipation
Roots	Medicine	Treatment of poisoning
	Medicine	Male impotence
Bark	Medicine	Treatment of sterility
		Treatment of haemorrhoids
		Treatment of dysentery
		Treatment of upset liver
		Treatment of cough
Trunk	Fuel	Firewood Charcoal
	Building	Building framework Building household goods
Tree	Beekeeping	Building traditional beehives
	Religion	Building Vodou (local religion) temples

plants that they find on their farm from environmental threats and, especially, against predators that could compromise the plants' development. Pruning is carried out to produce more young leaves which are consumed as vegetables but also to

Table IV.
Quantitative knowledge parameters calculated for *Vitex doniana* in Southern Benin.

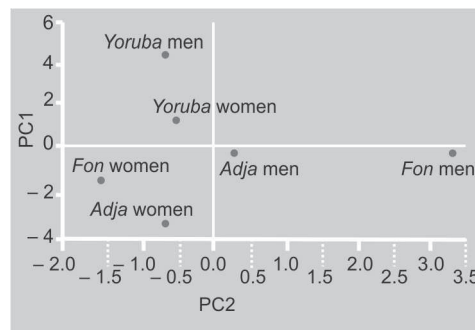
Subgroups		ID mean ± standard error	IE mean ± standard error
Adja	men	0.1229 ± 0.0073	0.57 ± 0.03
	women	0.0574 ± 0.022	0.35 ± 0.14
Fon	men	0.1057 ± 0.0085	0.43 ± 0.03
	women	0.1050 ± 0.0078	0.39 ± 0.03
Yoruba	men	0.1211 ± 0.0077	0.64 ± 0.04
	women	0.1185 ± 0.0078	0.73 ± 0.05
Adja group		0.1054 ± 0.0094	0.51 ± 0.05
Fon group		0.1054 ± 0.0058	0.41 ± 0.02
Yoruba group		0.1203 ± 0.0057	0.67 ± 0.03
Total people surveyed		0.1094 ± 0.0039	0.50 ± 0.02

Total number of interviewees: 150; Number of use citations: 37; Types of use: 7.
ID = Interviewee diversity value; IE = Equitability value.

Table V.
Consensus values for the types of use (CTU) of *Vitex doniana* in Southern Benin.

Type of use	CTU
Food	0.84
Medicine	0.61
Wood	0.14
Soap	0.12
Ink	0.07
Myth	0.061

Figure 2.
Projection of the different subgroups (men and women) of three ethnic groups (Adja, Fon and Yoruba) of Southern Benin onto the first and second axes of a PCA showing the correlations between these subgroups and their uses of *Vitex doniana*.



improve fruit production. Ninety percent of respondents confirmed they prune the trees. They also protected the trees if they

did not adversely affect their agricultural production.

3.7. Link between local knowledge, socio-cultural group and gender

Principal component analysis (PCA) on local knowledge and traditional management of black plum showed that the first two axes explained 69% of the variation observed. Correlations between *Vitex doniana* characteristics and the two PCA axes were calculated (table VII). The projection of the different subgroups onto the first and second axes (figure 2) makes it possible to highlight the uses of the people surveyed. Taking into account the correlations between *V. doniana* characteristics and the principal axes (table VII), the projection of the socio-cultural/gender groups onto the first and second axes (figure 2) shows that Yoruba people (men and women) consume the leaves and fruits; use leaves for making ink; and use timber for construction and making household goods. Adja women conserve black plum on their land for its utility as food and for mythical reasons. PCA axis 2 clearly separates Fon men and women. Fon women are motivated to conserve black plum for its utility as food and for marketing. Fon men conserve it for its

use as medicine and firewood and for sheltering wild bee colonies so that they can have honey.

4. Discussion and conclusions

4.1. Indigenous knowledge and valorization of black plum

Our study focused on *Vitex doniana*, a multi-purpose fruit tree species in Benin. Each socio-cultural group has a different name for the black plum, suggesting a long history of using the tree species. Black plum trees are conserved for their multiple functions: food, medicine, small craft industries and commercial value. The use of different parts of the species in various ailments contributes to the health security of the rural communities. For example, leaves are used in cases of ulcers, wounds and male sterility. The leaves are merely consumed as ordinary vegetables. Toxicological studies in the species have not been carried out. More toxicological and pharmacological studies must be done in the future in order to contribute to a better valorization of ethnobotanical knowledge of black plum. The number and diversity of uses are indicative of the role of this plant in the surveyed socio-cultural groups. Apart from the uses mentioned in our study, other uses of different plant parts of the species have been reported elsewhere in Africa [12–14, 22]. This variation in the uses can be explained by cultural differences and specific local population needs.

There were no gender or socio-cultural group differences in the knowledge of use and management of the black plum. Local knowledge of black plum is fairly distributed among the people of Southern Benin. However, older men tended to have greater knowledge about black plum, especially concerning its medicinal properties. The use of *V. doniana* as a food and medicinal source is common in Southern Benin. This apparently uniform spread of knowledge would be explained by the fact that knowledge is passed on through generations with time. This homogeneity is also associated with the fact that *V. doniana* is used by local

Table VI.

Use diversity (UD) and use equitability (UE) values for different use categories of *Vitex doniana* in Southern Benin.

Use category	Use diversity (UD)	Use equitability (UE)
Problems with the digestive system	0.22	0.98
Genito-urinary problems	0.14	0.61
Wounds and burns	0.11	0.49
Food	0.08	0.37
Dermatological problems	0.08	0.37
Heart troubles	0.08	0.37
Malaria	0.05	0.25
Construction uses	0.05	0.23
Firewood	0.05	0.23
Dental problems	0.03	0.12
Ocular problems	0.03	0.12
Beekeeping	0.03	0.12
Ink	0.03	0.12
Myth	0.03	0.12
Soap	0.03	0.12

Table VII.

Correlation between *Vitex doniana* characteristics and principal component analysis factors.

Use	PC1	PC2
Building	0.96	-0.03
Joinery	0.96	-0.10
Medicinal use	0.83	-0.22
Ink	0.83	-0.29
Soap	0.81	0.07
Eating leaves	0.76	0.00
Eating fruits	0.75	0.09
Charcoal	0.49	0.06
Myth	-0.84	-0.19
Food	-0.70	-0.56
Market value	-0.37	-0.47
Medicinal value	-0.30	0.71
Wood	-0.06	0.94
Beekeeping	-0.06	0.94

people as a food source and for its medicinal value [21]. Many wild food plants are also used for medicinal purposes. According to Etkin, “wild foods are consumed not only for their calorific value, but also for other nutrient and pharmacological benefits” [23]. In the context of increasing interest in the health potential of foods reflected in the growing literature on “functional food”, “pharmafood” or “nutraceuticals” [24], further studies on *V. doniana* nutritional and medicinal properties may be needed to more accurately assess its potential as a new alternative crop or a promising food and/or medicinal species.

4.2. Management and domestication of black plum

No silvicultural practices (*e.g.*, planting and sowing) were mentioned in the current study. The communities did not see the need to plant *V. doniana* despite its importance. The relatively significant numbers of trees found in the area even though the species is under constant threat from farming and deforestation is one of the factors explaining this situation. However, black plum has been reported as a domesticated species in Benin [25]. Domestication has been defined as a man-induced change in the genetics of the species to conform to human desires and agroecosystems. Thus, Clement describes five stages in the domestication process: 1) wild (plants exhibit no modification due to human activity); 2) incidentally co-evolved (plants show adaptations to anthropogenically disturbed environments but have not been modified by human selection); 3) incipiently domesticated (plants show some modification due to human selection, but the average phenotype is still within the range found in the wild); 4) semi-domesticated (plants show significant modification by human selection but are not dependent on human intervention for survival); and 5) domesticated (plants can only survive in cultivated landscapes) [26]. Under this scenario, *V. doniana* is still in the early (first and second) stages of the domestication process. It can-

not therefore be considered as a domesticated species.

Vitex doniana is a species which is protected in fallow areas and planted as a fruit tree near homesteads [12]. It is planted in Ivory Coast [13] and Nigeria [22]. *Vitex doniana* is utilized for various purposes and can therefore be regarded as a locally used species with multiple functions. Many traditional management practices to improve production were reported for other important agroforestry parkland trees such as *Vitellaria paradoxa*, *Parkia biglobosa* [27] and *Blighia sapida* [28]. The richness of knowledge and management techniques can be particularly valuable for developing strategies for sustainable management of plant resources. Recent studies have documented that some of the management practices have had some effect on the populations of various species, which can be interpreted as forms of incipient domestication [29]. In other words, cultural aspects guide the selection and management of desirable specimens [21]. These management practices may cause modifications in frequencies of phenotypes in the populations of some species and, in some cases, even provoke an increase in the frequency of desired phenotypes [29]. There are therefore links between management techniques and the perception of variation of traits [29]. These features include local use preferences, specific classifications that describe the quality of the trait desired and the management of the species *in situ* [21]. Future research must emphasize local preferences and criteria of variation of black plum in order to domesticate the species. It would also be interesting to study the possible morphological differences among wild and planted trees of this species in order to document if these practices have had some effect on the features of the trees.

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Uso y gestión del ciruelo de la sabana (*Vitex doniana* Sweet) en el sur de Benín.

Resumen — Introducción. El ciruelo de la sabana (*Vitex doniana*) es un cultivo frutal indígena, importante para la subsistencia de las poblaciones rurales. En la actualidad, vuelve a aparecer un interés nacional e internacional por este árbol, que se presenta como un cultivo prioritario para la domesticación en África. Nuestro trabajo se centró en estudiar los conocimientos autóctonos de los agricultores sobre el uso y la gestión de la especie, según los diferentes grupos socioculturales de Benín, teniendo en cuenta las diferencias entre sexos. El objetivo específico de este trabajo fue el de estudiar los conocimientos, los usos, las prácticas de recogidas locales, así como los sistemas tradicionales de gestión de *V. doniana* en las poblaciones del sur de Benín. **Material y métodos.** Se sometió a una encuesta un total de 150 participantes, elegidos al azar en tres grupos socioculturales. La información reunida se centró principalmente en la motivación de los encuestados por conservar los ciruelos de la sabana en sus tierras, en sus usos y en sus prácticas de gestión locales para mejorar la regeneración y la producción de este frutal. **Resultados y discusión.** El estudio mostró que la población comparte bien el conocimiento del ciruelo de la sabana. Sin embargo, el uso de la especie varía en función del interés de las personas y existe un conocimiento variado de su uso y de su gestión. El uso en alimentos y en medicamentos fue predominante, en comparación con los otros usos. No se presentó un conocimiento dispar, en cuanto a la gestión y el uso del ciruelo de la sabana, entre hombres y mujeres ni entre los distintos grupos socioculturales. **Conclusión.** Habida cuenta de su valoración por las poblaciones del sur de Benín, la domesticación del ciruelo de la sabana debería ser una prioridad.

Benín / *Vitex doniana* / conocimiento indígena / domesticación / usos tradicionales / etnobotánica

