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Use of local knowledge for contributing to the conservation of *Caesalpinia bonduc* (L.) Roxb in southern Benin (West Africa)

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ABSTRACT

Natural resources such as medicinal plants are important in the livelihood systems of many local people around the world. The high anthropogenic pressure on these species lead to their progressive disappearance. This is the case of *Caesalpinia bonduc*, a medicinal plant widely used in southern Benin but already extinct in the wild. The remaining individuals can only be found in agroforestry systems and home gardens. Therefore, it is necessary to assess the factors responsible of the decline of the species for its sustainable conservation. This study aimed to assess traditional knowledge, perceptions and strategies for an effective management of the species in southern Benin. A semi-structured interview was conducted with 602 household heads randomly chosen from 19 localities. The fidelity level (FL), index value related to useful organs (IVO) and Overall ethno-botanical use value (OUV) of the species were estimated. To describe ethnic groups-related differences, a principal component analysis (PCA) was implemented on OUV. Chi-Square test was used to check the dependence between socio-demographical characteristics of the respondents and local perceptions and strategies. A factorial correspondence analysis (FCA) was then performed on the citation frequencies of different variables to describe the relationship between ethnic groups and local perceptions and strategies. In total, 20 use properties were reported for the species with 10 previously undocumented uses of the species. The roots are the most used organ with IVO = 50%, followed by the leaves (IVO = 45%). The species is most used in traditional human medicine (FL = 100%). A strong relationship was found between ethnic groups and use of the species but also between ethnic groups and perceptions and management strategies. Respondents acknowledged that the species has decreased (80% of them) and even has disappeared (18%) in the wild. According to the informants, the main causes of the decline of the species are roots overexploitation (53.7%), intensive use in traditional pharmacopoeia (37%) and agriculture expansion (32.6%). Respondents also acknowledged that there is an urgent need for the species conservation (96%). Reduce intensity of harvesting plant parts, cultivating the species in nurseries, planting and protecting seedlings in fields were cited as methods

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of conserving the species. This study provides a precious contribution to the conservation of *C. bonduc* in southern Benin. Therefore, we recommend for any actions aiming to rehabilitate the species in its natural stands, local people' priorities and knowledge should be considered.

1. Introduction

Life would not be possible for local people in African countries without availability of non-timber forest products (NTFPs). They extract fruits, leaves, barks, roots and flowers from plants for their subsistence and primary health needs (Malaisse, 2010; Jiofack et al., 2010). Up to 90% of the population in African countries rely on medicinal plants as a source of drugs (Hostettmann et al., 2000). Due to their importance, forest resources in general and medicinal plants in particular are facing a decline in their populations. For instance, in Benin, the loss of forests was estimated to 50,000 ha/year by Food and Agriculture Organization in 2015 (FAO, 2015). Unfortunately, local people knowledge on the plant species is enormous but is not sufficiently researched and recorded (Simbo, 2010). Therefore, there is an urgent need to assess traditional knowledge and perceptions on these species to contribute to their sustainable conservation. In this light, this study focused on *Caesalpinia bonduc* (L.) Roxb in southern Benin.

C. bonduc, is a thorny shrub belonging to the family Caesalpiniaceae and native to Guineo-Congolian climatic zone (White, 1983). It is distributed throughout tropical and subtropical areas where it is mainly found in disturbed environments (Assogbadjo et al., 2011). Since the independence of Benin in 1960, several species of high importance such as *Milicia excelsa*, *C. bonduc*, *Khaya senegalensis*, *Afzelia africana* and *Pterocarpus erinaceus* are being overexploited and threatened due to demographic growth and the lack of alternative sources of incomes, making the population totally dependent on the natural resources (Soury, 2007). However, no silviculture package (tree establishment, growth, etc.) has been undertaken to contribute to their conservation (Gogan, 2010).

C. bonduc is highly appreciated in southern Benin where it is called *Adjikountin* in Fon, Gun and Mahi, *Igui ayo* in Nago and *Adikouichi* in Adja. It is the most commercialized medicinal plants in this region (Vodouhê et al., 2008). The mainly used organs are the roots, leaves and seeds (Padonou et al., 2015). The roots are widely used in the treatment of prostate diseases in Africa, which compromises the long-term viability of the species (Hutton, 2001; Upadhyay et al., 2001; Hessou et al., 2009). Leaves are used to treat menstrual pain, memory and sexual weakness (Yashwant, 2014). Seeds are involved in the treatment of diabetes and malaria (Chakrabarti et al., 2005). The seeds also serve to play *awalé* game (Assogbadjo et al., 2011). The species is currently rare and endangered in the world (Harden, 2002) and extinct in the wild in Benin (Adomou, 2005; Assogbadjo et al., 2012).

The livelihood of local people in southern Benin is highly associated with the use of *C. bonduc* and this gives them a profound knowledge of this resource. The National Registration of Population indicated six main ethnic groups in southern Benin, namely Fon, Adja, Nago, Mahi, Gun and Aïzo (INSAE, 2003). Agriculture remains the main activities of these communities (INSAE, 2003). According to Lykke (2000), the use of local knowledge is a quick and reliable method of acquiring information on natural resources without employing sophisticated tools. Thus, indigenous knowledge-based assessment of the decline of *C. bonduc* is needed to fill the gap between environmental research and local knowledge. Previous ethnobotanical studies have concluded that there is an unequal knowledge and perception of plant species among local people related to ethnicity and cultural beliefs (Gaoue and Ticktin, 2009; Gouwakinnou et al., 2011; Tiétiambou et al., 2020). Such information is crucial for contributing to understanding the factors leading to the decline of *C. bonduc* and developed strategies for its conservation. In Benin, studies conducted on the most used species like *Adansonia digitata* (De Caluwé et al., 2009), *Parkia biglobosa* (Koura et al., 2011) and *Sclerocarya birrea* (Gouwakinnou et al., 2011) revealed significant difference in local people' knowledge according to their ethnic groups. Therefore, we hypothesized that local people from southern Benin have ethnobotanical knowledge depending on their socio-cultural groups (or ethnic groups) that could be useful for the conservation of *C. bonduc*.

Previous studies on the species in Benin were focused on seed morphology and plant growth (Padonou et al., 2015), contribution of ethnic migrations on propagation and morphological variability between climatic zones (Assogbadjo et al., 2012); ethnic differences in the use of the species (Assogbadjo et al., 2011); and seeds germination techniques (Hessou et al., 2009). In order to contribute to effective management and conservation of *C. bonduc*, this study uses ethnobotanical data to: (1) assess diversity and pattern of use of the species in southern Benin, (2) analyze the local perceptions on the decline of the species and (3) assess local strategies for its conservation.

2. Material and methods

2.1. Study area

This study was conducted in Guineo-Congolian zone of Benin (southern Benin), located between latitudes 6°25′ and 7°30′N (Fig. 1). This zone is characterized by a bimodal rainfall regime from April to June and from September to November, with 1200 mm as mean annual rainfall (Assogbadjo et al., 2011). The relative humidity varies between 69% and 97% while the mean daily temperatures range from 25 °C to 29 °C (Assogbadjo et al., 2011). The mainly encountered soils are deep ferrallitic and

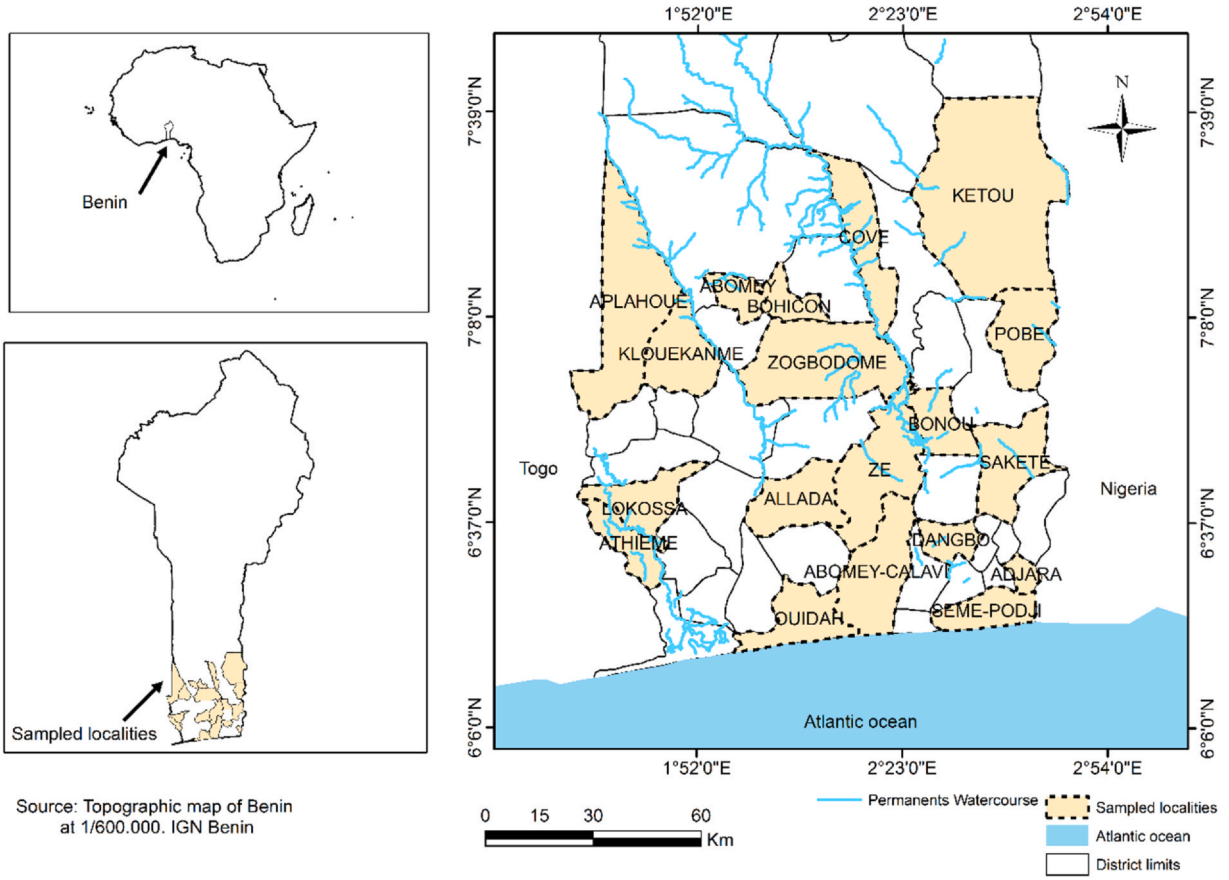

Fig. 1. Map of southern Benin showing the geographical position of the 19 sampled localities.

alluvial or heavy clay soils. The vegetation is a mosaic of cultivated lands and small relic forest patches. The primary vegetation was dense semi-deciduous forests and Guinean savanna.

2.2. Data collection

Preliminary investigations were conducted with 60 randomly chosen interviewees (Dagnelie, 1998). Pictures of the leaves, fruits and seeds of the species (Fig. 2) were kept and shown to each informant. The proportion of respondents knowing and using *C. bonduc* was calculated as P = 59/60, P ≈ 0.9833. With the value of P, sampled size was computed using the formula (Dagnelie, 1998):

(a) Leaves and fruits of *Caesalpinia bonduc* (b) Seeds of *Caesalpinia bonduc*

Fig. 2. Pictures of leaves, fruits and seeds of *C. bonduc* kept and shown to the informants during the interviews.

$$n = U^2_{1-\alpha/2}[P(1-P)/d^2],$$

where:

- n is the total number of informants within a locality;
- $U_{1-\alpha/2} = 1.96$ for $\alpha = 0.05$;
- P is the estimated proportion of the interview respondents in the preliminary survey.
- d is the expected error margin of any parameter to be estimated from the interviews (d is equal to 5%).

In total, N = 602 people were sampled. Table 1 presents the size of people chosen per locality, ethnic group, gender and age group.

Using a questionnaire, a semi-structured interview was conducted with the sampled people. Asked questions were related to (i)- the part used, (ii)- the use forms of the species, (iii)- the perception on the species status, and (iv)- the strategies for the conservation.

2.3. Data analysis

The parameters computed were:

- Index value related to useful organs (IVO) was determined following (Assogbadjo et al., 2011) as:

$$IVO = \frac{N_0 x 100}{N_t}$$

Where N_t is the total number of identified properties for all organs and N_0 the number of properties for an organ.

- Fidelity level (FL)

The use frequency per use category was computed following (Friedman et al., 1986) as:

$$FL = \frac{S}{N}$$

where S is the number of interview respondents who gave a positive answer to the use of *C. bonduc* for a given use category. N is the total number of respondents.

- Overall ethno-botanical use value (OUV) was computed per ethnic group following (Agbo et al., 2019) as:

$$OUV = \frac{RU_c x 100}{RU}$$

Where RU_c the total number of uses reported by all respondents in the ith ethnic group for each use category and RU the total number of uses for whole use categories.

Frequencies of indigenous perceptions on the species status and strategies used for its conservation were computed. Chi-Square test was then applied to check the dependence between socio-demographical characteristics (ethnic groups, sex and age) of the respondents and local perceptions and strategies. Moreover, a factorial correspondence analysis (FCA) was performed in order to describe relationship between ethnic groups and local perceptions and strategies using R software (R version 3.6.1) (R Core Team, 2019). To establish ethnic groups-related differences on the use of the species, principal component analysis (PCA) was applied on OUV in R.

3. Results

3.1. Diversity and pattern of use of C. bonduc in southern Benin

Five organs namely leaves, flowers, seeds, stems and roots are widely used for many purposes (Table 2). In total, 20 use forms were reported by local people for all organs with roots having higher index value of useful organs (50%). Among others, roots are frequently used to prevent prostate gland diseases, to treat malaria, stomachache and sexual weakness. The leaves are involved in infection prevention and used to treat headache and fever. The seeds are used in practices such as games and for worship practices like *Fâ* ritual[1] (Table 2).

[1] In his work entitled "Voodoo: Man, Nature and Gods" Charlier Ph. (2020) quoting Mercier P. (1962) indicates that worshiping the Fâ is "worshiping one's destiny, some say to his soul". In reality, each circumstance posing potential problems opens the possibility for the initiate to question the Fâ, that is to say to consult the bokonon or soothsayer who will interpret the voice of fate: trip to be programmed (departure date to be determined), next birth (choice of the child's first name), recurring nightmares, woman to woo or avoid, problem of infertility or sterility, etc.

Table 1
Number of informants sampled per locality, cultural group, gender and age group.

	Size of sample	Percentage (%)
Locality:		
Aplahoué	60	10.0
Athiémé	31	5.2
Klouékanmè	39	6.5
Lokossa	30	5.0
Ouidah	40	6.6
Adjara	23	3.8
Bonou	30	5.0
Dangbo	29	4.8
Sèmè Kpodji	21	3.5
Kétou	34	5.7
Pobè	31	5.2
Sakété	32	5.3
Abomey	50	8.3
Abomey-Calavi	17	2.8
Allada	18	3.0
Bohicon	35	5.8
Covè	35	5.8
Zè	17	2.8
Zogbodomè	30	5.0
Cultural groups:		
Mahi	34	5.7
Fon	225	37.4
Gun	98	16.3
Nago	79	13.1
Adja	123	20.4
Aïzo	37	6.2
Others	6	1.0
Age group:		
Youth	114	18.9
Adults	428	71.1
Old people	60	10.0
Gender:		
Male	419	69.6
Female	183	30.4

The species is more intensively used in traditional human healthcare system than in any other application since all informants (100%) use different plant parts to treat ailments (Fig. 3). About 33. 20% of the informants used the species for cultural practices whereas 16.61% exploited it for worship purposes. The species was infrequently used for traditional veterinary medicine and animal feed (4.98% of respondents).

Results of PCA performed on OUV revealed that 66.3% of overall variance was explained by the first two components (Fig. 4). There was a strong relationship between ethnic groups and use categories. Indeed, Fon and Adja were located on the same side of the PCA axes as medicinal and worship use categories meaning that they had knowledge on the use of *C. bonduc* for traditional medicine and for worship purposes. Mahi and Aïzo were located on the same side respectively as veterinary and cultural use categories showing that Mahi had knowledge on the use of the species for traditional veterinary medicine while it is mostly used by the Aïzo for cultural practices. The other ethnic groups had the lowest level of knowledge on the species utilization as they were located near to the center of the axes.

3.2. Local perception of change and decline in C. bonduc population

About 80% of informants stated that the population of *C. bonduc* is declining in recent times both in abundance and distribution (Fig. 5). While 18% of respondents mentioned that the species has disappeared in the wild, a small proportion of them think that its population is increasing (2%) or stable (1.3%).

The main perceived factors contributing towards the decline and the disappearance of *C. bonduc* included roots overexploitation (53.7%), traditional pharmacopoeia (37%) and vegetation clearance for agricultural expansion (32.6%) (Fig. 6). Climate change, herbicides applications, use for building materials and firewood production were less responsible of the changes in the species.

Fig. 7 shows an example of a dead plant as a result of roots mutilation.

Chi-squared tests show that there was no statistic difference on local perceptions of the species changes between gender ($\chi^2 = 6.39$, df = 6, p value = 0.381) or age groups ($\chi^2 = 4.55$, df = 12, p value = 0.971). However, a significant difference was found between ethnic groups ($\chi^2 = 231.97$, df = 42, p value <0.001).

Table 2
Plant parts with the associated use forms and index value related to useful organs (IVO).

Plant part	Use form	IVO (%)
Leaves	Malaria treatment	45
	Used as antibiotic	
	Stomachache treatment	
	Fever treatment	
	Have laxative effect	
	Oedema treatment	
	Low weight prevention	
	Headache treatment	
	Infection prevention	
Flowers	Used against memory weakness	15
	Used for *Fâ* ritual	
	Malaria treatment	
Seeds	Used for the game *adji*	30
	Used for *Fâ* ritual	
	Used to make easy child dentition	
	Oedema treatment	
	Used against insomnia	
	To treat toothache	
Stem	Malaria treatment	15
	Used as antibiotic	
	Used to treat hemorrhoid	
Root	Prevention of prostate gland diseases	50
	Used against sexual weakness	
	Malaria treatment	
	Used as antibiotic	
	Oedema treatment	
	Used against tiredness	
	Stomachache treatment	
	Fever treatment	
	Angina treatment	
	Infection prevention	

Results of FCA performed to link ethnic groups and local perceptions of *C. bonduc* decline in southern Benin showed that the first two axes explain 84.1% of the observed variations (Fig. 8). The factors responsible of the decline of the species varied according to the ethnic groups. In Fig. 8, Gun and Nago were located on the same side of the FCA axes as agricultural expansion, materials cuttings, climate change and pharmacopoeia. In other words, Gun and Nago perceived that vegetation clearance for agricultural expansion, cutting building materials, climate change and plants use in traditional pharmacopoeia are more responsible of severe disturbance in the species population. On the contrary, Mahi, Aïzo, Fon and Adja were located on the same side of the FCA axes as roots overexploitation, firewood production and herbicides applications. Thus, for these ethnic groups the three factors are perceived as responsible of the species degradation.

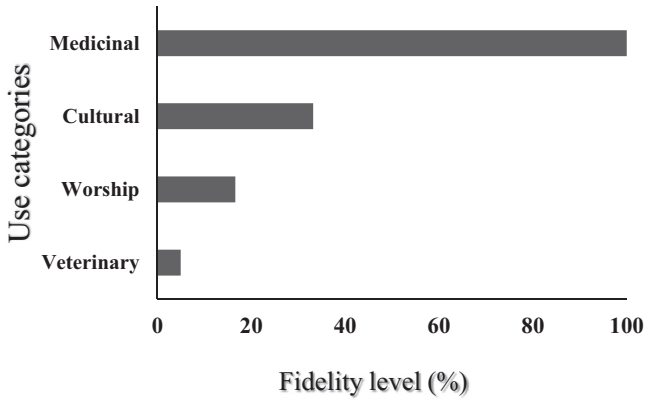

Fig. 3. Use frequency per use category of *C. bonduc*.

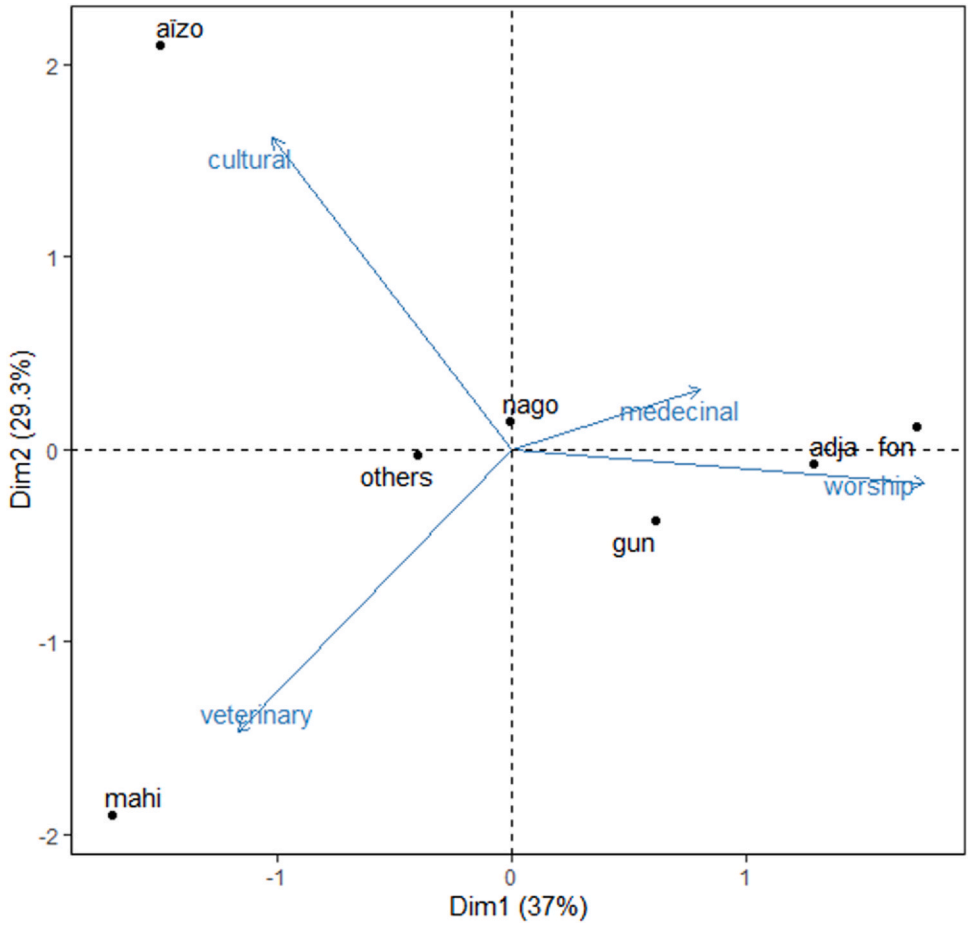

Fig. 4. Axis system of the principal component analysis (PCA) showing the link between ethnic groups and use categories. Black text indicates the ethnic groups while the blue text shows the use categories (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.).

3.3. Local strategies for the conservation of C. bonduc

Most of the informants (65.7%) classified the need for conservation of the species as very urgent while 30.7% of them classified the conservation need as urgent (Fig. 9). About 3.2% of respondents think that there is not so urgent while 0.5% do not see any need for conserving the species.

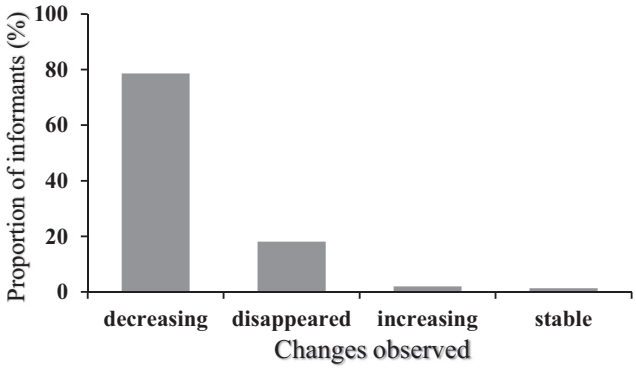

Fig. 5. The different changes observed in *C. bonduc* population and their importance in terms of proportion of informants.

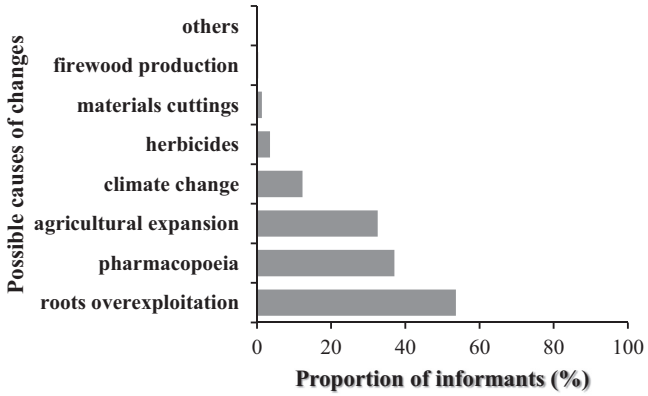

Fig. 6. Threat factors responsible of decline of *C. bonduc* population and their importance in terms of proportion of informants.

Fig. 7. A dead plant of *C. bonduc* observed in the Lokossa locality.

Several strategies have been developed by local communities for the species conservation (Fig. 10). The most used strategies were reduction of plant parts harvesting (55.3% of interviewees) and plants cultivation in nursery for its plantation in agro-forestry systems and home gardens (41.4%). About 24.3% of the informants reported that they protect seedlings in fields. A small proportion of them reported to conserve seeds (4.8%) or practice apiculture (2.8%).

Local strategies for the species conservation depended on the ethnic groups ($\chi^2 = 233.23$, df = 30, p value <0.001). On the contrary, there was no link between conservation strategies and gender ($\chi^2 = 8.14$, df = 5, p value = 0.113) or age groups ($\chi^2 = 1.92$, df = 10, p value = 0.997).

Results of FCA indicated that 83.3% of the observed variation were explained by the two first axes (Fig. 11). Correlations between ethnic groups and conservation strategies revealed Gun and Nago were located on the same side of the FCA axes as harvesting reduction meaning that these ethnic groups reduce plant parts harvesting for the sustainability of *C. bonduc*. Accordingly, Aïzo practice apiculture for conservation of the species. Moreover, Fon, Adja and Mahi use several approaches for the conservation of the species. They protect seedlings in fields, practice seeds conservation and seedlings cultivation for plantation in fields.

4. Discussion

4.1. Use and ethnobotanical knowledge on C. bonduc in southern Benin

This study highlights the importance of *C. bonduc* to the local people of southern Benin. Almost all parts of the species are used for a wide range of purposes. A total of 20 use properties were described for the species from previous studies in Benin (De Souza, 2006; Hessou et al., 2009 Assogbadjo et al., 2011). Our study reveals 10 previously undocumented uses of the species: leaves serve as antibiotic and also have laxative effect, serve for preventing low weights in babies and to treat

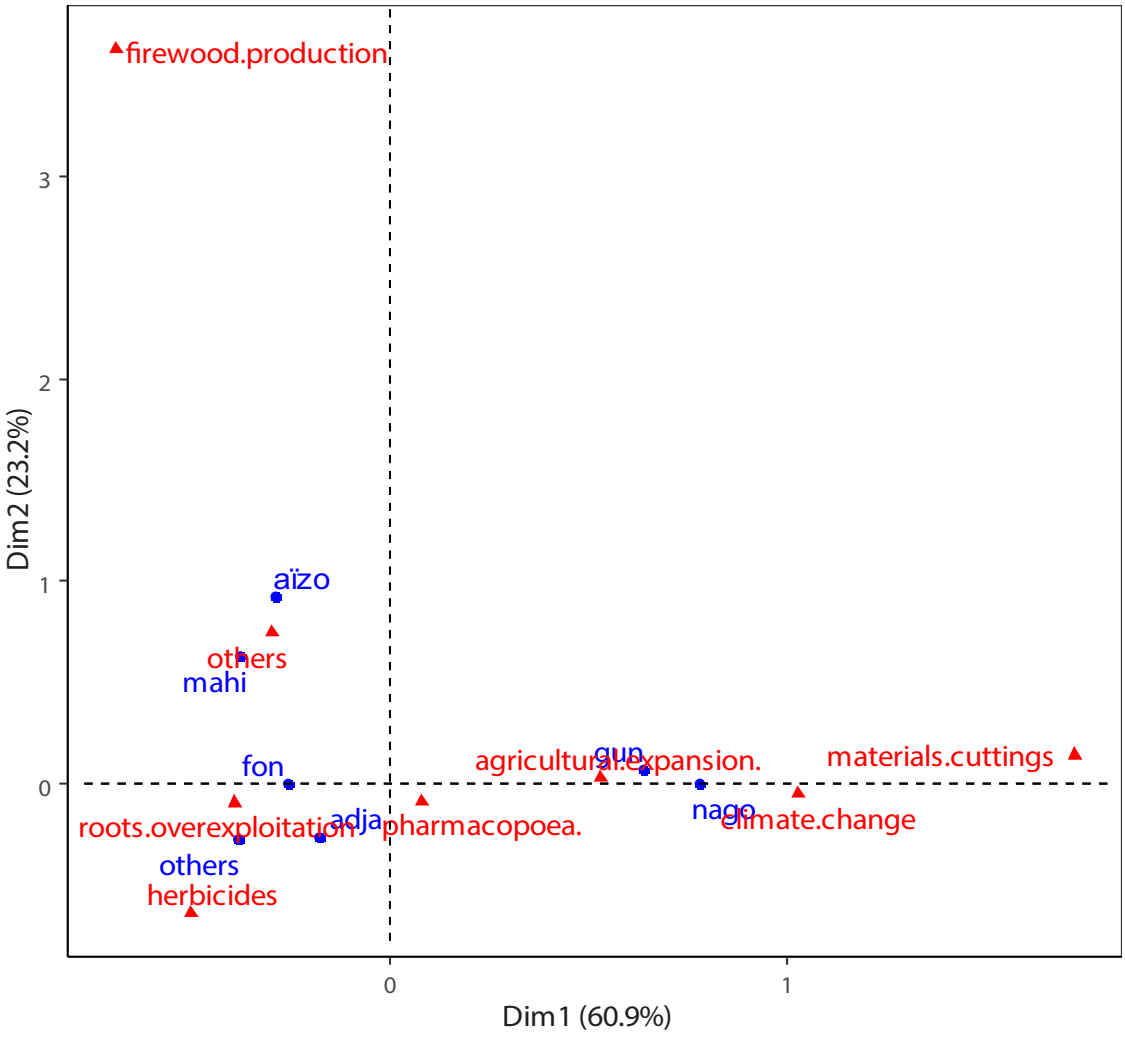

Fig. 8. Axis system of the factorial correspondence analysis (FCA) showing the link between ethnic groups and local perceptions. Blue text indicates the ethnic groups while the red text shows the main factors responsible of *C. bonduc* decline (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

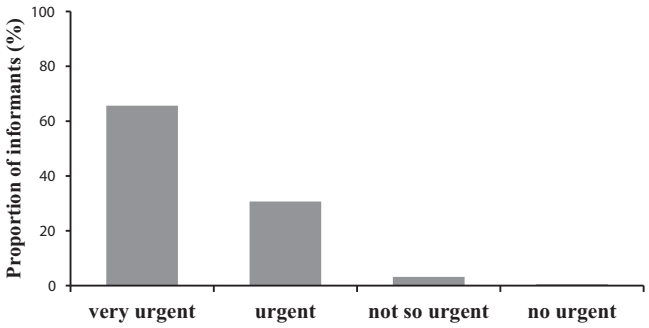

Fig. 9. Respondent's opinions on need for conservation of *C. bonduc*.

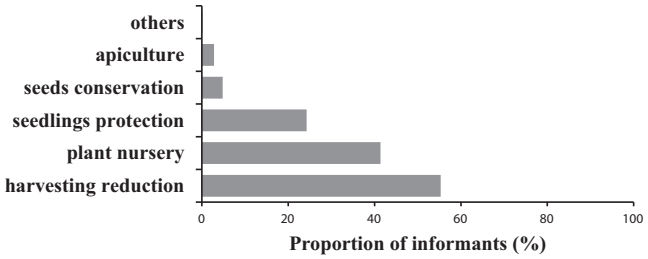

Fig. 10. The different strategies used for conservation of *C. bonduc* and their importance in terms of proportion of informants.

headaches and prevent infection, seeds are used to ease teeth development in children, to treat insomnia and toothache, stem is used against hemorrhoid while roots are involved in the treatment of tiredness. This study therefore confirms the multipurpose character of the species but also its importance to local people in southern Benin.

Moreover, our results showed high link between ethnic groups and use categories. While Fon and Adja had more knowledge on the use of the species for traditional medicine and for worship purposes, Mahi uses it for traditional veterinary medicine and

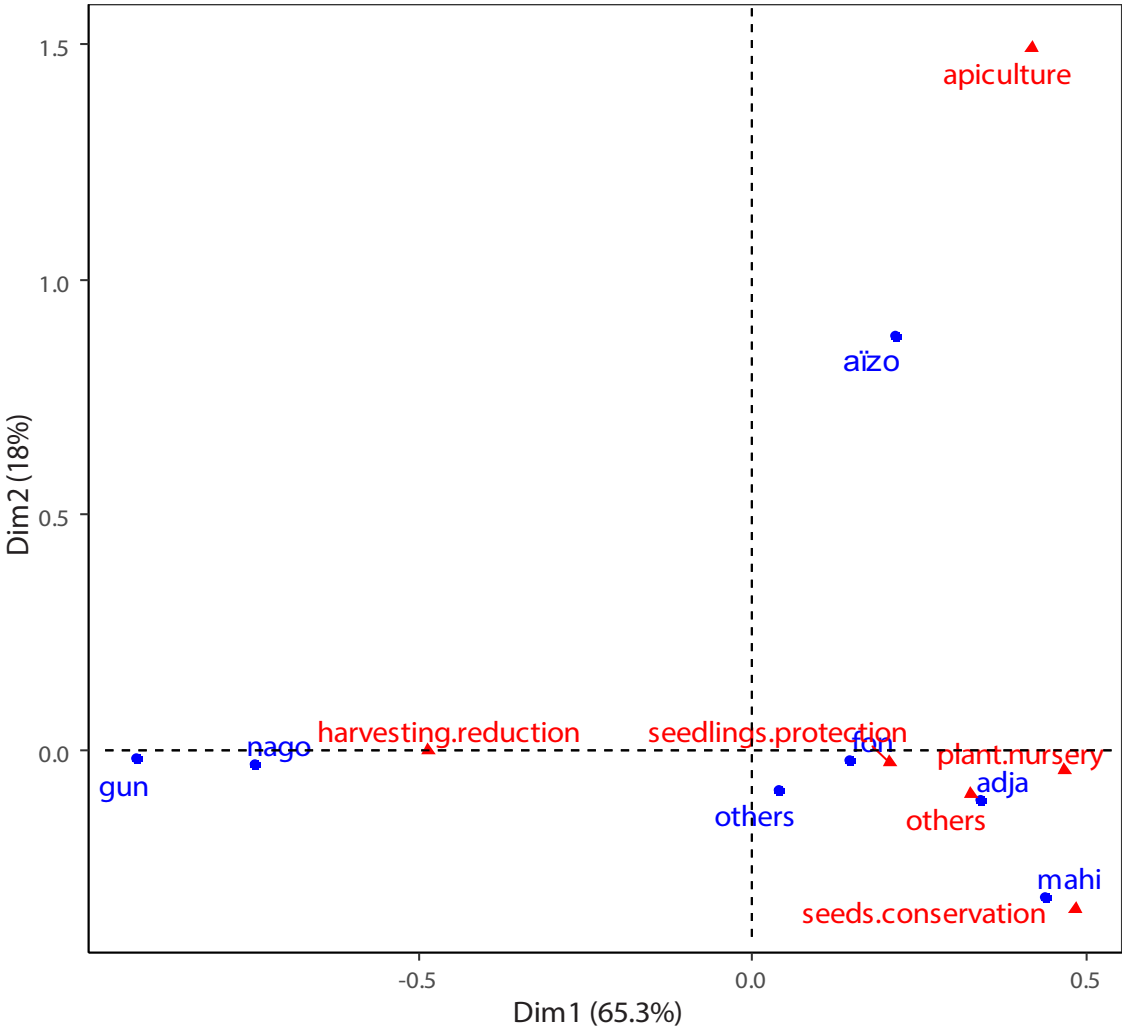

Fig. 11. Axis system of the factorial correspondence analysis (FCA) showing the link between ethnic groups and conservation strategies. Blue text indicates the ethnic groups while the red text shows the strategies used for the conservation of *C. bonduc* (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

Aïzo for cultural practices. This result may be related to the cultural difference between the investigated ethnic groups. Indeed, in Benin, each ethnic group has its own cultural behavior, know-how and manners which are passed from one generation to the other one (Donou Hounsode et al., 2016; Kouchadé et al., 2017). There is therefore difference in the use and knowledge of plant species according to the ethnic groups. Consequently, plant species found in an ecological zone is considered as the heritage of the local communities who have settled there and knowledge related to them is characteristic of the communities (Dassou et al., 2015). Accordingly, knowledge on *C. bonduc* is acquired through a long experience accumulated and passed down from one generation to the next. These accumulated experiences are therefore the main source of information at ethnic group level about the species. For instance, this is the case for Mahi (the species is used for veterinary purposes) and Aïzo (cultural practices) who have a specific knowledge of the species. Other studies obtained similar findings and stated the uneven distribution of indigenous knowledge for plant species use (Fandohan et al., 2010; Koura et al., 2011; Sop et al., 2012; Balima et al., 2018). However, some similarities have been noted between ethnic groups related the knowledge on *C. bonduc*. For instance, the fact that the Fon and Adja have similar knowledge could be explained by the link between these two groups. Indeed, historically, they are from "Adja-Tado" and have the common ancestor and still live together on the "Plateau of Abomey" where they mixed and share some traditional knowledge (Anignikin, 2001). This confirms that socio-cultural realities and promiscuity between ethnic groups of a geographic space would have an impact on the knowledge of the woody species (Rakotoarimanana et al., 2008; Atakpama et al., 2012). Other opportunities such as marriage strengthen inter-ethnic relations which remain dynamic other time and space (Atakpama et al., 2012).

4.2. Local perception on decline of C. bonduc and strategies developed for its conservation

Identifying various social perceptions of a particular endangered species can contribute to its conservation (Cortés-Avizandaa et al., 2018). Our study revealed that local populations in southern Benin are aware of the decline and even of the disappearance of *C. bonduc* from the wild. According to them, overexploitation of the roots, traditional pharmacopoeia and vegetation clearing for agriculture expansion are the main causes of this decline. According to Mbuvi and Boon (2008), the use of the roots for medicinal purposes can have serious consequences both of ecological point of view and for the survival of edible wild plants. We also noted a variation of the factors responsible of the decline of *C. bonduc* between the different ethnic groups. Ethnic groups are defined as referring to large groups of people classified according to their common racial, tribal, religious, linguistic or cultural origin or background (Teka et al., 2008). Several studies carried out on biodiversity emphasize that ethnic, social, cultural and geographic factors are the main controllers of number of species used by local communities and their perceptions on these resources (Vandebroek et al., 2004; Sop et al., 2012; Agossou et al., 2012).

Understanding local perceptions of endangered species can be useful in determining the level of acceptability and support for a particular conservation action (Bennett, 2016). Local people in southern Benin are aware of the urgency of conserving *C. bonduc*. In fact, more than 96% of those surveyed recognized the urgent need to develop conservation strategies for the species because of its current status and importance. Previous studies have also shown that a better knowledge of endangered species leads to positive attitudes and increased support for their conservation (Bandara and Tisdell, 2003; Wilson and Tisdell, 2005; Martín-López et al., 2007; Sawchuk et al., 2015). To reduce the rate of decline of the species, local populations in southern Benin use multiple conservation strategies. They reduce the intensity of collection of plant parts, produce seedlings in nurseries and transplant in home gardens and practice beekeeping as bees are known to serve as the main pollinator of the species. The home gardens, which are socio-cultural spaces clearly demarcated near family properties where perennial and annual species are planted (Fernandes and Nair, 1986) play an important role in maintaining biological diversity and also assist households to improve their income and their living conditions (Galluzzi et al., 2010).

The differences and similarities in perceptions and conservation strategies obtained from this study may also be linked to geographical location of the surveyed groups. Indeed, Gun and Nago are located in the southeastern Benin where they mainly practice agriculture. This region is subjected to high demographic pressure (Soury, 2007). Hosting Ouémé valley, considered as the most fertile African river valley after the Nile in Egypt (Djidohokpin et al., 2020), southeastern Benin is much subjected to agricultural pressure. This implies habitats degradation from agriculture and logging. It is therefore not surprising that Gun and Nago cite agriculture expansion and materials cuttings as responsible for the decline of *C. bonduc*. In addition, they perceived changes in climatic conditions as factor contributing to the disappearance of the species (Agossou et al., 2012). Moreover, they cited the use of the species in pharmacopoeia as a factor in its decline which can be attributed to the fact that they use medicinal plants as primary source of drugs. They are also recognized as traders of medicinal plant organs in local markets of southeastern Benin. It is also noted that they cited the same conservation strategies, namely harvesting reduction. These results can also be attributed to the cohabitation of these two ethnic groups in the same locality which promotes knowledge exchange.

On the opposite, Mahi, Aïzo, Fon and Adja perceived root overexploitation, firewood and herbicide as factors responsible of the changes in the species population. These ethnic groups are scattered across the "Abomey and Allada plateaus" in southern and southwestern Benin (Assogbadjo et al., 2011; Houessou et al., 2012). There are many similarities between their perceptions and conservation strategies. This could be explained by the cohabitation for decades which may have generated a dissemination of strategies between communities. Indeed, they are commonly mixed and share most folk knowledge, traditional value and rituals regarding many practices (Houessou et al., 2012). The specificity obtained for Aïzo (apiculture) can be attributed to the particularity of this group which holds its own knowledge stemming from experiences (Houessou et al., 2012).

4.3. Implication of the study for the species conservation

Local people in southern Benin are aware of changes in *C. bonduc* due to long-standing anthropogenic pressure. It is clear that there is a declining trend of species in the study area. It is known that local knowledge-based management strategies could ensure a focus on the species that are most valuable to local societies (Sulieman et al., 2012). Therefore, we recommend that for any rehabilitation activities for the species, local people' priorities and indigenous knowledge should be taken into account. Incorporation of such priorities can give conservation strategies a better chance for success, because the active participation of local communities to determine their well-being is more productive compared to influences coming from outside (Sulieman et al., 2012).

Moreover, we recommend circa-situ conservation strategy for the conservation of the species in southern Benin. This approach has been identified as an effective conservation strategy in traditional agroforestry systems and home gardens (Sanchez et al., 2010). Indeed, through circa-situ, we recommend capacity building of local communities to raise their ability to grow the species and replant in traditional agroforestry systems and home gardens. They should also be made aware of good practices and harvesting techniques for the plant parts used in medicine or for other purposes.

5. Conclusions

This study proved the ability of *C. bonduc* to provide local people with one of their fundamental needs (good health). Its organs are required for the treatment of several diseases and disorders. The study also revealed that the use pattern of the species and knowledge of the local communities is ethnically determined. These outputs confirm our hypothesis that local people from southern Benin have ethnobotanical knowledge depending on their socio-cultural groups that could be useful for the conservation of *C. bonduc*. In addition, cultural origins and geographical locations have favored the knowledge sharing between ethnic groups. Thus, local community-based conservation approaches involving people from different ethnic groups, origins and geographical locations in the study area could be a guarantee for sustainable management of *C. bonduc*. Moreover, conservation activities undertaken by local people until now need to be accompanied by the central government, NGOs and scientists. For instance, what is the seed dispersal mechanism of *C. bonduc*? What are the levels of genetic diversity and how are they distributed among all populations of the species in Benin? What are the threats to these populations in short and long term? For which populations an action is urgent? There is no response for these questions for moment in Benin. In order to effectively conserve the species, more knowledge on levels of genetic diversity, seed dispersal mechanism and economic importance is required.

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Author statements

BEL conceived the work with advices from DS and RGK. BEL collected the data. BEL and FES processed the data and performed the statistical analyses. BEL and FES drafted the manuscript with contribution of DS. RGK supervised the work. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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