

## Ethnobotanical Survey of Mangrove Plant Species Used as Medicine from Ouidah to Grand-Popo Districts, Southern Benin

Hubert O Dossou-Yovo<sup>1\*</sup>,  
Fifanou G Vodouhè<sup>1,2</sup> and  
Brice Sinsin<sup>1</sup>

- 1 Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin
- 2 Faculty of Agronomy, University of Parakou, Benin

\*Corresponding author: Dossou-Yovo HO

✉ dohuoly@yahoo.fr

Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin.

Tel: 00229 97957040

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### Abstract

This study investigated the importance of mangrove to dwellers of Ouidah and Grand-Popo Districts, Southern Benin and focused on the medicinal exploitation of mangrove plant species. Data were collected through individual and group interviews on forty respondents. The respondents comprised traditional healers, fishermen, salt preparation specialists and students since medicinal plants harvesting can be done by all categories of the mangrove dwellers. They were required to provide details on mangrove plant species used as medicine details of the plant parts used, the preparation technique and availability of the species. Fourteen species belonging to thirteen genera and eleven families were recorded as medicinal plants in the study area. These species were used by the locals in the region to treat nine diseases and disorders. Malaria was ranked as the most important disease for which mangrove plant species are used. The most important plant parts collected were leaves (64% of plants) and roots (21% of plants). Species such as *Mitragyna inermis* (Willd.) Kuntze, *Rhizophora racemosa* (G. Mey.), *Avicennia africana* (L.) are on the verge of extinction because of overexploitation of their roots. Long-term conservation strategies of the mangroves are needed.

**Keywords:** Conservation; Ethnobotany; Ethnomedicine; Mangroves; Medicinal plants

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### Introduction

The importance of medicinal plants has been widely reported throughout the world. A study by Cunningham [1] revealed that about 70 to 80% of the world population depends on medicinal plants for their primary healthcare. Ghatapanadi et al. [2] reported 52 medicinal plant species used by traditional healers in Gulbarga District, India. A comparative study of medicinal plants used in rural areas of Namibia and Zimbabwe showed that 16 species were used in both countries [3]. Moreover, plant species are harvested from the wild by people as raw materials to commercial pharmaceutical factories and for local informal trade [4-6].

Species with medicinal properties are harvested from a wide range of vegetation types. A study carried out in Benin reported that local populations surrounding the Pendjari National Park used plant species found on termitaria as medicine [7]. Elsewhere, local people in the lowlands of Konta in Ethiopia use plants as medication Bekalo et al. [8] and medicinal plants are

also collected by local populations from sacred groves in India [9]. Extracts of *Rhizophora mucronata*, a mangrove species in India, exhibited high anti-plasmodial activity [10].

Thus, medicinal plants in developing countries are important, and to ensure a sustainable conservation and long-term exploitation of these plants, various ethno botanical investigations in different ecosystems, including hotspots where plants are majorly harvested by people are necessary. Such investigations are necessary to identify the potential effect on species harvested and define sustainable management tools of concerned ecosystems. The major contribution of this article is to fill information gap concerning the use of mangrove species in traditional medicine. Mangroves (tropical coastal vegetation dominated by species of mangrove trees) in Benin have received some attentions in recent times. For instance, the geological characteristics of mangrove soils were carried out by Gaillard et al. [11]. Teka [12] evaluated the degradation and endogenous strategies for participatory restoration and conservation of mangroves. Teka et al. [13] assessed the processes of migration, agricultural dynamics, and

coastal changes through remote sensing and socio-economic surveys. Although these works deal with the socio-economic importance of mangrove in the geographical area of the present study, the authors did not provide detailed information about the species used locally in traditional medicine. Dwellers depend on the mangrove species to ensure their health care. Investigating medicinal plant use in this ecosystem will contribute to its conservation. The present research will provide scientific data on the medicinal exploitation of the coastal mangrove from Ouidah to Grand-Popo.

## Materials and Methods

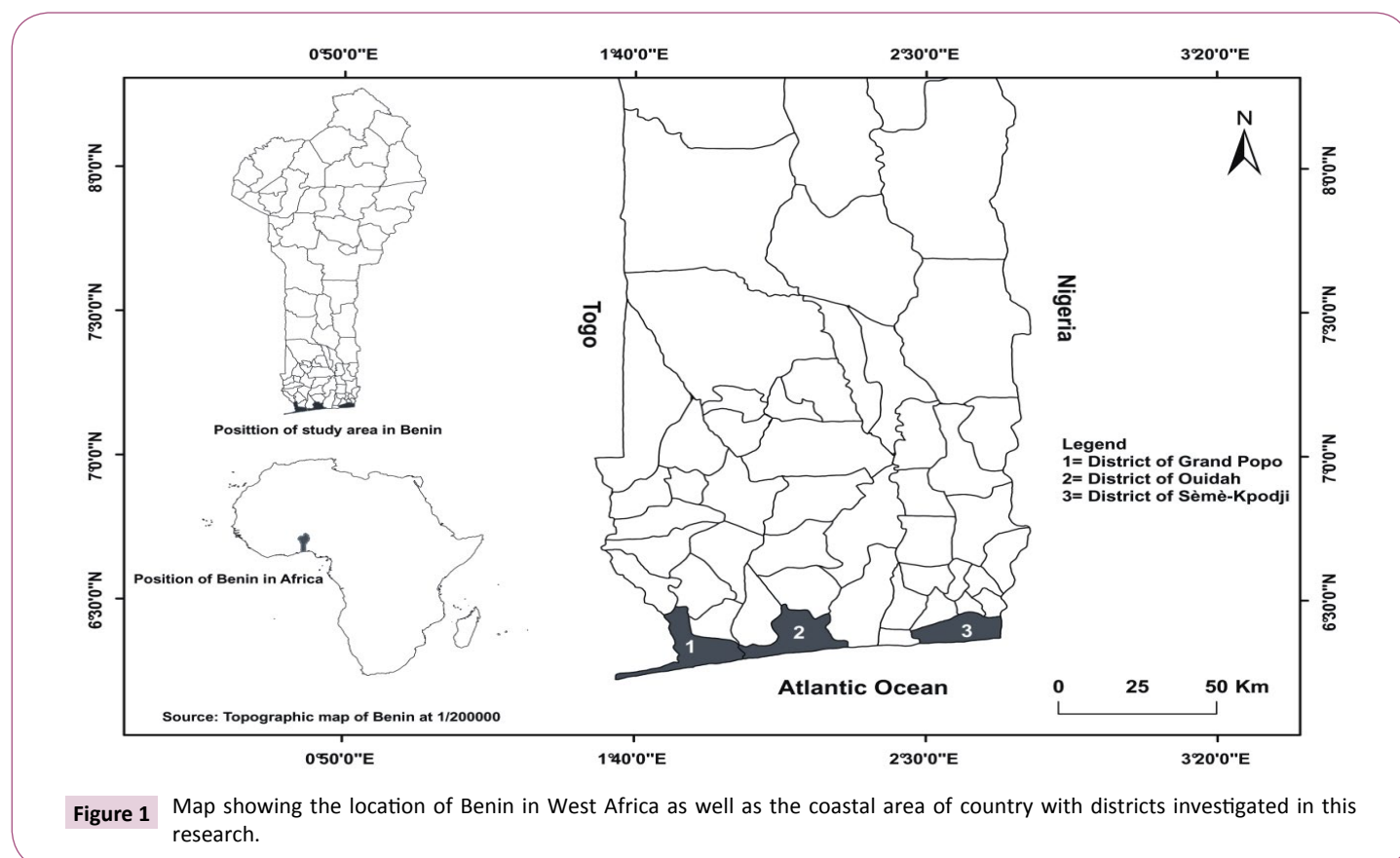
### Study area

The study area covers the coastal region of Benin which comprises three districts (Ouidah, Grand-Popo and Sèmè-Kpodji; **Figure 1** situated on the Gulf of Guinea of the Atlantic Ocean in West Africa. It extends between 1°35' and 7°30' eastern longitude from Togo in the west to Nigeria in the east, and between 6°20' and 7°30' northern latitude [14]. The coastal region covers an area of 12,000 km<sup>2</sup> corresponding to 10.5% of the national surface. The littoral is in the sub-humid tropical climate zone Troll [15] and is characterized by two rainy seasons from April to July and October to November, and two dry seasons, from August to September and December to March [16]. Afouda and Houanye [17] recorded an annual precipitation ranging from 820 to 1300 mm and the annual average temperature is about 33°C. The most significant soil types are sandy soils, hydromorphic soils, and ferralitic soils [16].

Adomou [18] stated that the native vegetation is essentially composed of a semi-deciduous forest which has been transformed in a mosaic of traditional agroforestry systems (fallows, fields and plantation) and human settlements. The main activities generating income in the study zone are crop production, fishery, salt production and trade. The Beninese mangrove supplies fuel and service wood, forage, fishery products, medicinal plant species and cooking salt for local communities; mangrove areas are also used for agricultural purposes and human settlements [14]. The study area is threatened because of a decrease in mangrove land cover and its overexploitation.

### Data collection and analysis

Ethnobotanical surveys were conducted in five different villages surrounding the lagoon from Ouidah to Grand-Popo Districts to gather information related to utilization of plant species as medicine. The research population comprised traditional healers, fishermen and women specialized in salt production. Since young people are also involved in collection of medicinal plants, some students were included in the research sample. In total, forty respondents participated in the research and data were collected from them using a semi-structured questionnaire and individual interviews. Informants were asked to provide local names of the mangrove plant species used as medicine, the diseases treated with them, and the plant organs used, as well as their view on the current state of species availability. Respondents were asked to list species by their local names, and where possible they were identified in the field using illustrated guide to West African weeds Akobundu and Agyakwa [19], the



**Figure 1** Map showing the location of Benin in West Africa as well as the coastal area of country with districts investigated in this research.

illustrated reference book of Arbonnier [20], and the Benin Analytic Flora [21]. Samples of species that were not identified directly in the field were collected for subsequent identification at the National Herbarium of Benin at the University of Abomey-Calavi. Data were recorded and analyzed using Excel software. The importance of each disease to the mangrove dwellers was assessed regarding the number of plant species recorded as used for its treatment. A Chi-squared test was performed to compare the proportion of recorded species according to parts used as medicine. In addition, a correspondence analysis was carried out to correlate plant parts used as medicine and diseases were recorded with regards to total number of plant species recorded for the disease treatment. Minitab 17 was used for the analyses at 0.05 probability level.

## Results

### Diversity of species used as medicinal plants by mangrove dwellers

Results showed various plant species used as medicine by the mangroves dwellers (Table 1). A total of fourteen (14) plant

species were recorded as medicinal; these species belong to thirteen (13) genera and eleven (11) families. The most represented genus was *Senna* with two species and the most represented family was *Caesalpiniaceae* with two genera *Caesalpinia* and *Senna* and three species *Caesalpinia bonduc* (L.) Roxb., *Senna occidentalis* (L.) Link and *Senna alata* (L.) Roxb. *Rhizophora racemosa* (G. Mey.) and *Avicennia africana* (P. Beauv.). Two species characterizing mangroves ecosystems in tropical areas were listed by respondents as medicinal.

### Diversity of plant parts used

With regards to plant parts used as medicine, the roots of three plants (*Rhizophora racemosa*, *Avicennia africana* and *Caesalpinia bonduc*, 21%), were exclusively exploited while the leaves were mentioned as the only part used for the majority of species (nine, 64%). There was one species [*Newbouldia laevis* (P. Beauv.)] of which both leaves and bark were recorded as used. Similarly, *Mitragyna inermis* (Willd.) Kuntze was the only specie in which bark and roots were mentioned. The comparison of proportion of recorded species according to parts used as medicine revealed significant difference (X-squared=16.381, df=3,

**Table 1:** Plant species used as medicine in the Ouidah-Grand-Popo Mangrove.

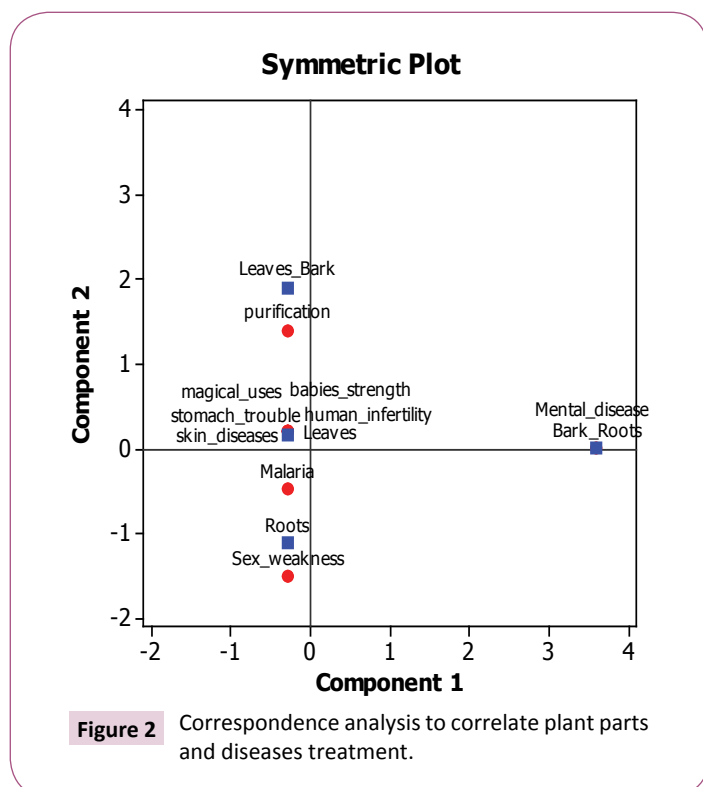
Scientific names	Local names	Parts used as medicine	Diseases treated (ethnic group mentioning)	State of Availability	Threats identified by authors
1. <i>Rhizophora racemosa</i> (Rhizophoraceae)	Wéto (Pedah)	Roots	Malaria (Pedah)	Available but threatened	Anarchic exploitation of the species roots as medicine.
2. <i>Avicennia africana</i> Syn. <i>Avicenniagerminans</i> (Avicenniaceae)	Akpontin (Xwla)	Roots	Malaria (Xwla)	Available but threatened	Anarchic exploitation of the species roots as medicine.
3. <i>Paspalum vaginatum</i> (Poaceae)	Gbakon (Xwla)	Leaves	Babies are washed with its tisane to become strong (Xwla )	Available but threatened	Exploitation without any control
4. <i>Caesalpinia bonduc</i> (Caesalpiniaceae)	Adjikouitin (Xwla and Pedah)	Roots	Male sexual impotence(Xwla and Pedah)	Quite scarce	Species overexploited throughout the country. Very threatened and scarce along the mangrove
5. <i>Argemone mexicana</i> (Papaveraceae)	Hwèchégnon (Xwla and Pedah)	Leaves	Ritually used during conflicts to enhanceperformance(Xwla and Pedah)	Scarce along the mangrove	Exploitation without any control
6. <i>Annona senegalensis</i> (Annonaceae)	Agnouglwetin (Xwla and Pedah)	Leaves	Human infertility (Xwla and Pedah)	Available but threatened	Exploitation without any control
7. <i>Senna occidentalis</i> (Caesalpiniaceae)	Kinkeliba (Xwla and Pedah)	Leaves	Malaria (Xwla and Pedah)	Available but threatened	Exploitation without any control
8. <i>Senna alata</i> (Caesalpiniaceae)	Lakpalakpaman (Xwla)	Leaves	Skin infections and diseases (Xwla)	Scarce	Exploitation without any control
9. <i>Jatropha curcas</i> (Euphorbiaceae)	Gnoukpotou (Xwla and Pedah)	Leaves	Malaria and stomach trouble (indigestion) (Xwla and Pedah)	Scarce	Exploitation without any control
10. <i>Newbouldia laevis</i> (Bignoniaceae)	Kpatoman (Xwla)	Leaves and bark	Leaves for purification rituals; bark used to prepare infusion drunk early in morning to be healthy (Xwla)	Scarce	Exploitation without any control
11. <i>Spondias monbin</i> (Anacardiaceae)	Akinkontin (Xwla)	Leaves	Purification rituals (Xwla)	Scarce	Exploitation without any control
12. <i>Moringa oleifera</i> (Moringaceae)	Kpatiman (xwla)	Leaves	Malaria (xwla)	Scarce	Exploitation without any control
13. <i>Azadirachta indica</i> (Meliaceae)	Nimutin (Xwla)	Leaves	Malaria (xwla)	Scarce	Exploitation without any control
14. <i>Mitragyna inermis</i> Syn. <i>Mitragyna africana</i> (Rubiaceae)	Nkiwu (Pedah)	Bark and roots	Mental disease (Pedah)	Available but threatened	Exploitation without any control

p-value=0.0009472). These results confirm that leaves were the most used part in medicinal preparations. Collection of roots of species such as *M. inermis*, *R. racemosa*, *A. africana*, *C. bonduc* and *P. guajava* involves destruction of the plant.

Informants reported that the distance travelled to collect sufficient material of the parts of most species has increased in recent decades. For this reason, six species out of fourteen (42%) were generally mentioned by dwellers as available but threatened. The majority, eight (57%) were recorded as scarce or quite scarce. These results suggest overexploitation and threats to the mangrove community.

### Diversity of diseases and illnesses treated

The fourteen species recorded during the research were reportedly used to treat a total of nine diseases and disorders. These were malaria, male sexual impotence, human infertility, skin infection, stomach disorders and mental disease. A relatively great number of plant species (06) were mentioned in malaria treatment by informants. The plant part mostly used in malaria treatment was leaves (mentioned for four species) followed by roots (recorded for two species). The exploitation of plants for purification rituals protecting against bad spirits ranked second as it was mentioned for two species, and leaves were the only part used for that purpose. The correlations between plant parts and diseases (correspondence analysis, **Figure 2**) showed that malaria, stomach disorder, ritual uses, human infertility, skin disease and infant weakness are treated using leaves. Impotence is treated with roots while mental disease is treated using both bark and roots. Leaves and bark are used for purification purposes.



## Discussion

### Diversity of mangrove species used as medicinal plants

A total of fourteen plant species belonging to thirteen genera and eleven families were recorded as medicinal plants. This indicates that the mangroves are quite important in the dwellers' life. This confirms the results of Bandaranayake [22] who highlighted the economic importance, medicinal values and other uses and functions of mangroves. With regards to the diversity of medicinal plants in West Africans habitats, Cole [23] reported thirteen species, representing 3% of all recorded species, from tropical swamps and wetlands. Similar to the present research findings, the author mentioned *Rhizophora racemosa* as a medicinal mangrove swamp tree. *Caesalpinia bonduc* recorded here was also reported as a medicinal plant used against helminthiasis in Bangladesh [24]. Earlier, Krishna Murti [25] had also found the genera *Rhizophora* and *Avicennia*, recorded in this paper, as medicinal plant in the aquatic ecosystem of the Ganga, India. The author also emphasized the medicinal, nutritive and antipollutant properties of common mangrove plants of the Ganga. This shows that mangroves are recognized worldwide as biodiversity hotspots. Thus, in order to guarantee the heritage of indigenous knowledge related to medicinal plants it is crucial to effectively manage and conserve these ecosystems. The most represented genus recorded during this work was *Senna*. The medicinal properties of many *Senna* species have been investigated worldwide. For instance, Darah and Halim [26] reported the antimicrobial activity of *Senna alata* from Malaysia. Muthu et al. [27] recorded three *Cassia* species (botanically renamed *Senna*) as medicinal plants used by traditional healers in a district of India.

de Lacerda [28] highlighted the important medicinal utilization of mangroves in Latin America, Africa and Asia. Earlier, Cunningham [1] reported that 70 to 80% of the world populations use medicinal plants for their primary healthcare. So medicinal plants are important in the life of all populations and especially for african ones and there is an increasing need to gather information related to them [7]. However, the usefulness of these plants also leads to overexploitation for medication and constitutes a serious threat to their survival. For instance, although *Rhizophora racemosa* and *Avicennia africana* are categorized as Least Concern IUCN [29], the present research suggests that they are under threat since the collection of their roots leads to whole plant destruction. Okpiliya et al. [30] reported in the mangrove forest ecosystem of Calabar, Nigeria that nearly 50% increase in individual annual income can be gained by exploiting these trees for sale. These authors considered that this income acted as an incentive which leads to depletion of mangrove by individuals as a source of livelihood.

In addition to the threats mentioned above, *Caesalpinia bonduc* (not yet assessed by IUCN), of which roots are used, may also face a high risk of extinction due to unsustainable harvesting. So there is a need for special management tools to ensure the sustainability of use of these threatened species. For instance,

due to the high exploitation, Balasubramanian et al. [31] called for conservation of *Caesalpinia bonduc* in a wildlife sanctuary in India. *Mitragyna inermis*, of which roots and bark were mentioned as used, is supposed to be more threatened than the previous species of which only the roots are utilized. However, further work to assess the intensity of plant parts harvesting is needed to confirm this view.

The nine species of which leaves were reportedly used parts are considered less threatened than the other species. However, if leaves are harvested together with reproductive organs from plants, this practice will endanger the reproductive potentials of the species. So the mangrove dwellers should be sensitized and trained in sustainable harvesting techniques of plant parts, including the protection of juvenile plants.

In general, the majority of recorded species were mentioned by informants as threatened because of the distance they have to travel in order to harvest sufficient materials. This reveals pressure on the ecosystem and it confirms findings of Adomou et al. [32] who reported that, although mangroves in southern Benin are ecosystems hosting conservation priority species, they do not benefit from any special conservation program. With regards to the high human population growth, sustainable management and conservation tools are needed in the mangrove ecosystem from Ouidah to Grand-Popo districts.

### Diversity of diseases and illnesses treated

The mangrove plant species are a good source of potential bioactive compounds which exhibit many therapeutic properties [10]. A total of nine diseases were recorded as being treated using the fourteen plant species. This reveals the diversity of ethnomedical knowledge of the mangrove dwellers. Malaria, one of the most prevalent infectious diseases in the world Ravikumar et al. [10], is the most frequently recorded disease in the present research, being treated using six different species. Ravikumar et al. [10] found that extracts of *Rhizophora mucronata*, a mangrove species in India, exhibited high antiplasmodial activity. In the present study, *Rhizophora racemosa* was mentioned for malaria treatment. This suggests that species of the family Rhizophoraceae have efficient antiplasmodial activity. Elsewhere, Dossou-Yovo et al. [7] also recorded malaria among diseases treated using termitaria-related plant species in Pendjari Biosphere Reserve in Benin. These observations confirm the importance of medicinal plants in combating malaria throughout Benin. Thus it is crucial to define long-term and sustainable conservation strategies for ecosystems from which species exploited for medicinal use are harvested. Since leaves were the most recorded used part in malaria treatment, it may be assumed that the treatment of malaria by the mangrove dwellers (**Table 1**) does not constitute a significant threat to the functioning of this ecosystem.

The exploitation of plants for purification rituals ranked second with regards to the number of species mentioned. Similar to these findings, Mafimisebi and Oguntade [33] noted socio-cultural and magico-religious practices involving the preparation

and use of plant medicines for farmers' health in Southwest Nigeria. In sub-Saharan Africa, for instance, palms are used for rituals in traditional medicine [34]. Africans have always shown close, magico-religious relationships with nature and many African populations still employ spiritual recipes inherited from their ancestors. Such rituals and other magico-religious practices, despite being considered efficient by practitioners, have, up to date, never been explained scientifically. In this paper, only leaves were mentioned as being used for these purposes. Thus it may be assumed that the exploitation of the mangrove plant species for magico-religious practices and rituals does not threaten ecosystem sustainability and functioning.

The present research revealed that the roots of *C. bonduc* were mentioned by dwellers as a treatment for male impotence. A previous study Assogbadjo et al. [35] had also stated the intensive utilization roots in addition to many other uses from the leaves and seeds in Benin. The species has the status of a threatened multipurpose scrambling shrub within the country so its collection by mangrove dwellers constitutes a noticeable threat. Therefore, it is very important to increase people's awareness of the importance of in-situ and ex-situ conservation of *C. bonduc*. As shown by Ticktin [36], harvest of NTFP can affect ecological processes at many levels, from individual and population to community and ecosystem [37,38]. So the medicinal use of mangrove species may affect the functioning and sustainability of this ecosystem unless conservation strategies are defined for the mangrove.

### Conclusion

Fourteen plant species were recorded as being medicinal. These species belong to thirteen genera and eleven families. Among all diseases recorded, malaria was the only disease against which the highest number of medicinal species was mentioned. This use was followed by ritual utilization of plants. Leaves, bark and root were recorded as being used. Depending on species, species such as *M. inermis*, *R. racemosa*, and *A. africana* are threatened in the mangrove as they were exploited for their roots leading to plant destruction. The study reveals that the mangrove provides many healthcare services to surrounding populations who recognize the scarcity of mangrove species in recent decades. Long-term sustainable conservation strategies as well as the increase of the mangrove dwellers' awareness are needed through a joint collaboration of the two districts, Ouidah and Grand-Popo, forestry stakeholders and NGOs.

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