



RESEARCH ARTICLE

REVIEWED Economic value, endogenous knowledge and distribution of *Picralima nitida* (Stapf) T. Durand and H. Durand in Africa

[version 2; peer review: 1 approved with reservations, 1 not approved]

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Abstract

Background: *Picralima nitida* (Apocynaceae) is an important African medicinal plant species. It is frequently used in traditional medicine and pharmaceutical industries for manufacture of drugs against infectious diseases, malaria, diabetes and cancer. Despite its importance, the species can be rare, especially in the Dahomey Gap (in contrast to the Guineo-Congolese region). There is also a controversy on its distribution. Without knowing the drivers of plant species rarity it is impossible to address the issue of the controversy of its distribution and unsustainable use as well as safeguarding endogenous knowledge of its uses.

Methods: Ethnobotanical surveys were conducted in the Dahomey Gap with 120 informants randomly interviewed. A literature review of scientific papers and books was used to provide information on the uses, distribution and threats of the species in the Guineo-Congolese region.

Results: The results revealed that *P. nitida* products were more expensive in the Dahomey Gap than the Guineo-Congolese region. All parts of the species were collected and used for 34 treatments. The species had low density and distribution in Dahomey Gap compared to the Guineo-Congolese region.

Conclusions: *P. nitida* is used across its distribution areas with important economic values. Adapted management strategies are needed for the sustainable use and conservation of the species..

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Any reports and responses or comments on the article can be found at the end of the article.

Keywords

Climate gradient, Dahomey gap, Guineo-Congolese region, *Picralima nitida*, distribution, conservation.

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REVISED Amendments from Version 1

In this version, the major revision has been done in the Introduction section, Material and Methods section and Discussion and Results. The introduction has been reproduced taken into account the recommendations. The specific objectives have also been reformulated.

About the material and method section, the average temperature and relative humidity of study areas have now been provided. The details have also been done on data collection, literature search and ethics and consent.

In the Result and Discussion section, the Discussions have been improved in places according to the recommendations of the reviewers. In reference section, two new references have been added at the end.

Any further responses from the reviewers can be found at the end of the article

Introduction

Picralima nitida is one of the most important medicinal plant species in Africa (Bickii *et al.*, 2007). In West African folk medicine, *P. nitida* is widely used for the treatment of several diseases. The species is known as a febrifuge and a cure for infectious disease (Akabassi *et al.*, 2017), malaria (Betti *et al.*, 2013), diabetes (Teugwa *et al.*, 2013) and pain (Aguwa *et al.*, 2001). In Central African folk medicine, the species is used in different ways. For instance, in Cameroon and Guinea, a decoction of the fruit and the bark is taken to treat coughs or typhoid fever (Adjanohoun *et al.*, 1996). In Gabon and Cameroon, in the Pahouin tribe, the fruit and bark are chewed in small quantities to appease hunger during long walks in the bush Bickii *et al.*, 2007. In Congo a bark decoction is

taken as a purgative or to treat hernias and, mixed with other plants, to relieve gonorrhea. In addition to its medicinal uses, *P. nitida* provides an income to millions of households in Africa. In Benin, a kilogram of seeds of *P. nitida* is sold for about US \$ 5 by dealers of medicinal plants (Akabassi *et al.*, 2017). In Cameroun, *P. nitida* contributes to more than 12% of household income of Nguila and Mbangassina villages (Yakeu, 2012).

Despite its importance, there is a serious problem of species management. At the international level, there no conservation initiatives on the rare *P. nitida* plant species based on data on the International Union Conservation for Nature (IUCN) Red List of Threatened plant species. At local level, some research works showed that plant species is vulnerable because of the overexploitation of its organs. For instance, in the typical Guineo-Congolese (GC) region, e.g. Nigeria, it occurs only in the wild under no form of management and is under threat of extinction (Gbadamosi, 2014). It is the first critically endangered species among the four species used by the indigenous populations of the eastern region of Cameroon for the typhoid fever treatment (Betti, 2004). In the Dahomey Gap (DG) region, e.g. Benin, *P. nitida* is very rare and at low density (Akabassi *et al.*, 2018; Akabassi *et al.*, 2020). In Togo, Holaly *et al.* (2015) reported the presence and use of *P. nitida* in the Maritime region of Togo. As far as distribution concerned, there is a controversy on the exact distribution areas of *P. nitida*. According to Adjanohoun *et al.* (1996) the range of *P. nitida* extends from Côte d'Ivoire to Uganda including the Democratic Republic of Congo and Cabinda region in Angola with a gap in Togo (Figure 1). Eyog Matig *et al.* (2006) report that *P. nitida* is a tropical African species distributed in Ghana, Côte d'Ivoire, Nigeria, Angola, the Democratic Republic of Congo, Cameroon and Tanzania. Once more, Togo is not mentioned

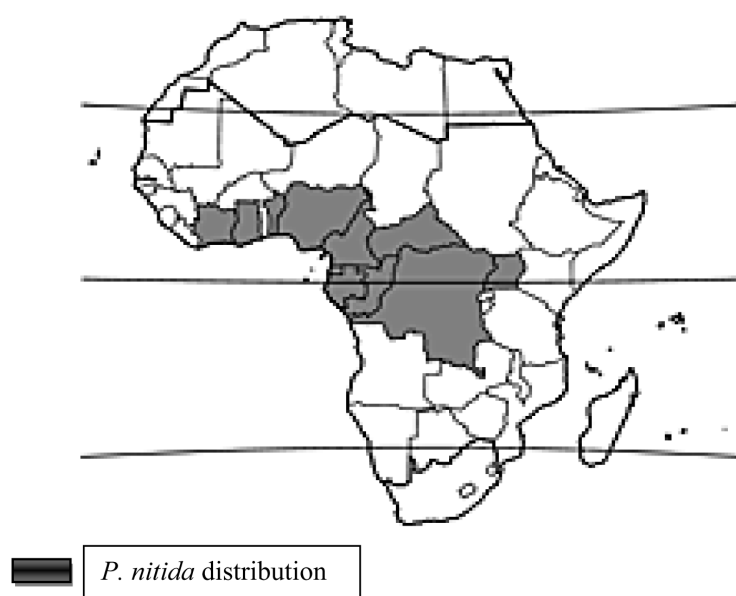


Figure 1. *P. nitida* distribution. Figure 1 has been reproduced with permission from [Adjanohoun *et al.*, 1996].

as a distribution area of the species. Omino (1996) reported that the distribution area of *P. nitida* does not cover the DG. However, the inventory of the new angiosperm species in the flora of Togo revealed that *P. nitida* is found in the ecological district IV of the country (Akpagana *et al.*, 1994). Despite the importance of the species, the serious problem of its management and the existence of controversy on its exact distribution areas, there is no policy and regulation available to guiding the sustainable management of *Picralima nitida* medicinal plant species. This paper aims at assessing the economic value, document the endogenous knowledge on the plant species, and sheds a light on the distribution of *P. nitida* (Stapf) T. Durand and H. Durand in Dahomey Gap's region by talking the following research questions: (1) what is the economic value of the *P. nitida* species around the study area? (2) to what extent local communities know about the ethnobotanical values of the species? (3) what are the drivers of species rarity around the study area? (4) what is the current distribution of the species around the study area?

There is a need to dispel the ambiguity over the distribution areas of this species and to document the important threats to its conservation. This study assesses (1) the economic value and endogenous knowledge of *P. nitida* in Africa and (2) the effect of climate gradient on the species distribution.

Methods

Study areas

The study areas were typical GC regions (Cameroon, Central African Republic, Congo Brazzaville, Côte d'Ivoire, Democratic Republic of Congo, Gabon, Ghana, Nigeria and Uganda) characterized by rainforests with a rainfall of up to 2500 mm, and

the DG region (Benin and Togo) characterized by savannas that extend down to the coast with a mosaic of rainforest (Figure 2). The DG is the dry zone that separates the two blocks of forest in tropical Africa (Bongers *et al.*, 2004). The overall annual rainfall varies between 900–1400 mm. The average temperature of these two regions varies between 25 and 29°C with a relative humidity between 69 and 97%.

Economic value and endogenous knowledge of *P. nitida* in Africa

Sampling. Based on preliminary surveys among 90 individuals randomly sampled among various ethnic groups in DG on the use of the species, it was found that 85% in Benin and 83% in Togo 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 Dagnelie (1998).

$$n = U_{1-\alpha/2}^2 \times \frac{p(1-p)}{d^2}$$

With n the size of the sample, p the proportion of peoples using the species ($p = 0.275$; from the preliminary survey), $U_{1-\alpha/2} = 1.96$ is the value of the normal random variable at probability value of $\alpha = 0.05$ and d is the margin error of the estimation of any parameter to be computed from the survey. A value of 8% was considered. Under these assumptions, 120 people were sampled during the main survey.

Data collection

Individual interviews were conducted in Togo and Benin with a total of 120 (60 per country) key informants. The main local languages interviewed were Fon, Goun, Nago, Yorouba,

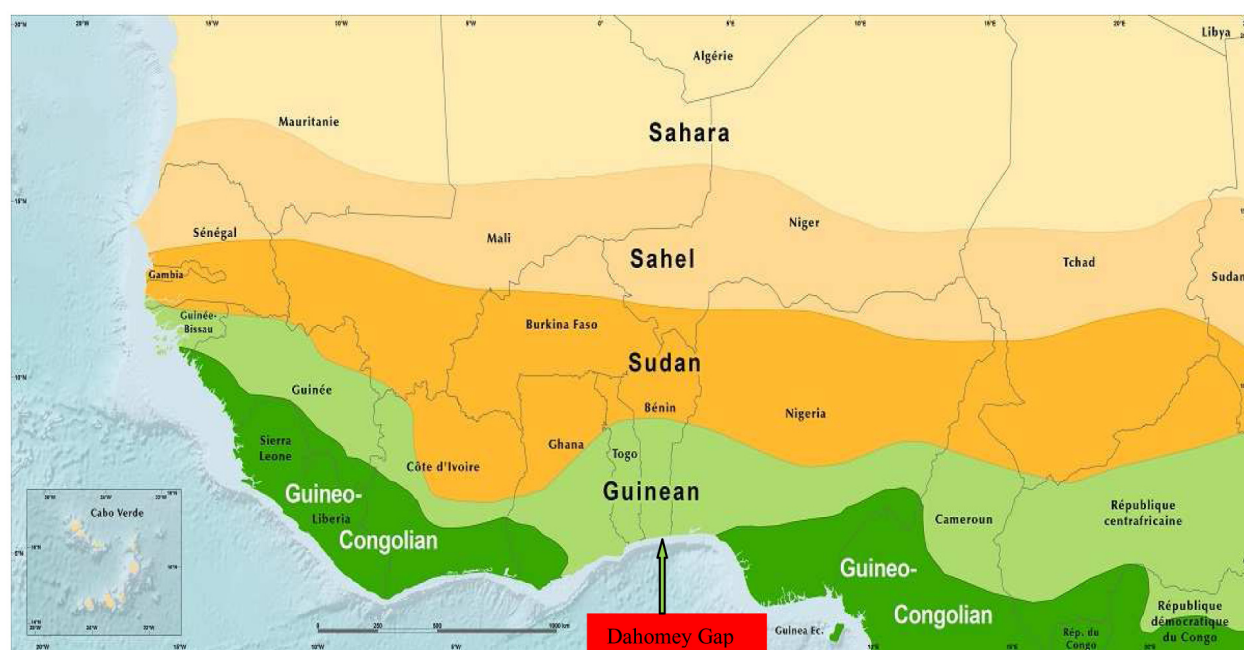


Figure 2. Guineo-Congolese region and Dahomey Gap. Figure 2 has been reproduced with permission of [Church, 1966].

Adja in Benin and Mina, Ewe, Kotafon in Togo. The survey has been piloted prior to its use. In Benin, the survey covered two phytodistricts (Pobè and Vallée de l'Ouémé where the species is only presented (Akoègninou *et al.*, 2006) and 30 informants were selected in each phytodistricts. In Togo, the survey covered Danyi located in ecological district IV (only presence area of the species (Akpagana *et al.*, 1994) and 60 informants were selected. The survey was performed between January and July 2018 and conducted in the local language using a questionnaire (see *Extended data*) (Akabassi, 2020c) (Akabassi, 2020d). The survey was carried out through the households using a local guide. The local guide approached households in person and participants aged 18 and over were considered regardless of education level, ethnicity and gender. Households were selected at random, however, households with sellers of medicinal plants were systematically selected. After this Approach, a focus group discussion has been performed in each country to cross-check information gathered. In Benin, 45 people indicated their willingness to participate at the focus group discussion while 42 people volunteered in Togo. Most informants were selected from localities with at least one *P. nitida* individual. These localities were Ifangni, Sakété, Adja-Wèrè, Ikpilè, Kétou, Avrankou, Adjara, in Benin and Kouma, Danyi, Akposso-Akébou, Kpalimé-Atakpamé in Togo. Data were collected on the economic and socio-cultural values of the species, the uses and organs used, the frequency of use and main threats of the species.

Literature search

In the typical GC region, data were collected through a literature search. The original articles obtained from various databases including Google Scholar (www.scholar.google.fr), ScienceDirect (www.sciencedirect.com), Scopus, PubMed Central and African Journals Online (www.ajol.info) in addition to reports and thesis. Biodiversity databases (www.prota.org and GBIF.org) were used to gather information on the importance of the species. The main research theme used were: "Economic value" AND "*Picralima nitida*"; "Endogenous knowledge" AND "*Picralima nitida*"; "Distribution" AND "*Picralima nitida*"; "Togo" AND "*Picralima nitida*"; "Benin" AND "*Picralima nitida*". A total of 31 published articles between 1996 and November 2018 were selected based on their importance for the topic. All articles not dealing with ethnobotanical importance and distribution of *P. nitida* were excluded. Letters, encyclopaedia, case-reports, manuals and guidelines were also excluded. The data that were extracted from selected articles were the socio-economic importance, the different traditional uses of *P. nitida* organs, mode of preparation, dosage and coordinates of study location.

Ethics and consent

Ethical approval was not sought for this study. The study is deemed by the researchers to be low risk, as it did not record any identifying information of participants; was not an interventional or clinical-based study. However, a consent has been received from community leaders and participants of the DG and ensured informed consent was received for data collection and analysis.

Data analysis

The importance of *P. nitida* for the surveyed populations was determined by the calculation of the use frequency of the plant properties (FUP).

$$FUP = (Rv + Rah + Raf) \times 100 / Ne;$$

Ne is the total number of interviewees; Rv, Rah and Raf are the number of old, adult and young interviewees that used the property, respectively. A property was considered as 'credible' in case FUP is above 50% (Assogbadjo *et al.*, 2011a; Camou-Guerrero *et al.*, 2008).

The global credibility level of the plant properties was calculated as follows:

$$GCLP = (Nvc + Nvpc) \times 100 / Ntv;$$

Nvc is the number of 'credible properties'; Nvpc, the number of 'probable credible properties' and Ntv, total number of identified properties. The GCLP-value showed the importance of a plant property: GCLP < 25% (little important); 25 ≤ GCLP < 50% (fairly important); 50 ≤ GCLP < 75% (enough important) and 75 ≤ GCLP < 100% (very important) (Assogbadjo *et al.*, 2011b; Camou-Guerrero *et al.*, 2008).

The most used plant organ was identified through the computation of the index value related to useful organs (IVO).

$$IVO = Nvo / Ne \times 100;$$

Nvo, the number of properties in the organ; Ne, the total number of identified properties.

Further, based on the literature review and the above analysis, absolute global credibility (AGC) for each use was calculated using the following formula:

$$AGC = Npu / Ntp \times 100;$$

With N_{pu} the distribution areas of the use X, N_{tp} the total distribution area of the species. A usage is considered absolute if AGC ≥ 50%. The countries (Uganda and Central African Republic) where no information was obtained on the use value of the species were not taken into account.

Basing on the collected data, the uses of the species were grouped into three fields of traditional application, namely: medicine, medico-magic and culture. A use was considered medicinal when results from the use of one part of the species associated or not with other plants or ingredients of animal without any ritual, prayers or incantations. A use was considered medico-magic when it associates the medicinal use with ritual, prayers or incantations. A use was considered cultural when practices during ritual ceremonies, funeral ceremonies, weddings, sacrificial rites and handicraft.

Distribution and density of *P. nitida* around both study areas

Data collection and analysis. In DG, the samples of *P. nitida* were collected during the ethnobotanical survey carried out between January and July 2018 in Benin and Togo in order to study the distribution and the density of the species. The zones of presence of the species in Benin (phytogeographical districts of “Pobè and Vallée de Ouémé”) and Togo (ecological subdivision IV of Togo) were explored. The presence of *P. nitida* was obtained through a field exploration in collaboration with local population. The collaboration was largely done with the medicinal plant dealers to identify the presence of the species. The georeferenced coordinates were recorded for each sample of *P. nitida* identified. A total area of 4590.52 km² was explored in Benin, while 115.765 km² was explored in Togo. In the typical GC region, data on the species distribution were collected GBIF website. The species occurrence coordinates were gathered from the GBIF.org (16 May 2018) GBIF Occurrence Download <https://doi.org/10.15468/dl.powalw> and ArcGIS 10.2 (ESRI, Redlands, California, USA) were used to create a distribution map showing the current spatial distribution of the species. In this present study, the occurrence points of *P. nitida* were qualified of average when the number of occurrence points gathered not reach two hundred. When it exceed two hundred, it qualified of high.

Results and discussion

Economic value and endogenous knowledge of *P. nitida* in Africa

Economic value of *P. nitida*. The survey conducted in the DG revealed that the largest fruit of *P. nitida* (about 1000 g) cost US\$1 per unit, the average (about 700 g) US\$0.80 and the smallest (about 300 g) US\$0.5. One seed costed US\$ 0.05. A kilogram of *P. nitida* seeds cost between US\$6 and US\$10. In the GC region, e.g. Ghana, *P. nitida* seeds were dried, powdered, encapsulated and sold as “Picap capsules” that cost between US\$12.99 and US\$225 depending on the quantity (http://database.prota.org/PROTAhtml/Picralima_nitida_En.htm). In Cameroon, seeds, bark and fruit were sold (US\$5 for 550 g of seeds or bark) in local markets (Betti, 2002; Betti, 2004). In Congo, 800 g of fruit cost about US\$1 (<https://thegradekratom.com/product/akuamma-seeds/>). This indicated how the species can contribute to household income. *P. nitida* products were more expensive in the DG. *P. nitida* is very rare in this region and this probably justifies the high prices observed in the DG. The species was mainly found in home gardens and/or house yards in the DG. The domestication of non-timber forest species like *P. nitida* is an opportunity to alleviate poverty with positive benefits on the environment, since new plantations of *P. nitida* will contribute to reduce the greenhouse gas emission. It is therefore important to develop a management program for the sustainable use of the species. This can offer more jobs and help in poverty alleviation in countries such as Cameroon where the species contributes to 12% of household income (Yakeu, 2012).

Endogenous knowledge of *P. nitida* and drivers of species rarity. In the DG, 24 uses of the organs of *P. nitida* including roots, bark, leaves and seeds were cited (Table 1). A total of

Table 1. Use frequency of *P. nitida* properties in the Dahomey Gap.

Organ	use	FUP (%)		IVO (%)	
		Benin	Togo	Benin	Togo
Root	-Diabetes	59.58	75.55		
	-Sexual weakness	15.83	-		
	-Hemorrhoid	31.25	33.27	28.57	22.22
	-Bellyaches	54.16	51.18		
	-Toothache	18.33	-		
	-Cough	31.25	37.30		
Bark	-Spleen Infection	15.00	12.00		
	-Sexual weakness	15.83	16.89	14.28	11.11
	-Infertility	17.91	-		
	-Analgesic	45.30	-		
	-Poisoning	30.45			
Leaves	-Diabetes	59.58	57.58		
	-Malaria	75.41	78.42	19.05	18.67
	-Cold	02.50	-		
	-Measles	06.66	05.45		
Seed	-Angina	100.00	100.00		
	-Diabetes	59.58	95.75		
	-Malaria	75.41	72.46		
	-Analgesic	66.66	66.66	80.95	83.33
	-Diarrhea	00.42	01.40		
	-Kwashiorkor	02.91	-		
	-Bellyaches	54.91	-		
	-Worms	23.33	21.73		
	-Measles	06.66	06.66		
	-Infertility	17.91	-		
	-Fever	07.91	06.91		
	-Cough	31.25	30.27		
	-weaning	30.41	30.43		
	-Good luck	12.08	-		
	-Sexual weakness	15.83	15.53		
	-Rituals	66.66	55.76		
	-Against abortion	07.50	05.50		
	-Infectious Diseases	85.50	83.50		
	-Hernia	20.25	15.25		

FUP, Use frequency of *P. nitida* properties; IVO, index value for useful organs.

seven uses were credible (infectious diseases, angina, malaria, bellyaches, rituals, analgesic and diabetes). The overall credibility of the uses was 75.94% in Benin and 70.94% in Togo. This indicated that *P. nitida* is very important in the the DG. The seed was the most important organ used in the DG (79.16% in Benin and 83.33% in Togo). As a consequence, the species is highly threatened since the removal of this organ causes the species death and this can lead to the extinction of wild populations of *P. nitida*, as already reported by Akabassi *et al.* (2017). The credible uses were the same in both countries. The similarity between these two countries of the DG in the use of the organs of *P. nitida* may be related to the close cross-border exchanges between these two countries that share some ethnic groups,

cultures and ancestral traditions native from the Tado kingdom, located in Dahomey (Kossi, 1990). For instance, Mina, Fon and Ewe are ethnic groups shared between the two countries which favor knowledge dissemination.

In the GC region, 24 uses of the organs of *P. nitida*, including the roots, bark, leaves, seeds, fruits and wood, were cited (Table 2). A total of four uses were credible (diabetes, malaria, fever and sexual weakness). The overall credibility of the plant uses in the GC region was 60.85, indicating that *P. nitida* was important in this region. The seed was the most important organ used in the Guineo-Congolese region followed by the wood, fruit, leaves, bark and root (Table 2). This indicate that the species is highly threatened not only in DG but also in GC region. Since the seeds constitutes the regeneration organ of the plant species, the overuse of this organs can lead to the genetic diversity reduction and sometimes to extinction of wild populations of *P. nitida*.

In the DG and GC regions, *P. nitida* was most frequently used against malaria, followed by measles, diabetes, worms, sexual weakness, hernia, fevers, infectious diseases and diarrhoea, as well as for shovel handles and spoons (Table 3). Shovel handles and spoons were a specific use in the GC region. Among these diseases, malaria is a principal cause of mortality and poverty in Africa (WHO, 2011). The use of the organs of *P. nitida* to treat these diseases will contribute to reduce mortality and poverty in Africa.

Knowledge of the species in the DG was significantly greater than that in the GC region (Figure 3). This difference may be explained by the low density of the species in the DG, which forces the users to give more attention to the species. Some uses were specific to certain regions with good credibility as the case of the use of the seeds to treat tonsillitis in the DG. The different uses of the species mentioned in this paper could help local communities to benefit from the medicinal values of the species. Moreover, the fact that some uses were specific to each climate zone will be relevant when defining for each zone a valorization program of the species. This results are corroborate with those of Fakeye *et al.* (2004) who were showed the antimicrobial property of *P. nitida* stem bark extract in the pharmaceutical field.

In both climate zones (DG and GC regions), among the uses identified, 26 were of medicinal, three in medico-magic and three cultural (Table 4).

In the DG, each the three fields were used, whereas in the GC region, *P. nitida* was not considered for medico-magic use. This confirms the stronger level of knowledge on the species in the DG. The cultural differences and specific local population needs between the two climates zones may also explain this variation in use (Dadjo *et al.*, 2012).

About the main drivers of species rarity, in addition to overuse of *P. nitida* organs (adverse anthropogenic actions), the rarity

Table 2. Use frequency of *P. nitida* properties in Guineo-Congolese region.

Organ	use	FUP (%)	IVO (%)
Root	-Sexual weakness	14.84	12.5
	-Malaria	65.23	
	-Jaundice	15.22	
Bark	-Jaundice	18.45	16.66
	-Infertility	39.23	
	-Hernia	24.45	
	-Gonorrhoea	17.88	
Leaves	-Malaria	70.65	16.66
	-Vomiting	10.90	
	-Otitis	22.60	
	-Measles	25.76	
Seed	-Malaria	80.02	41.66
	-Analgesic	72.78	
	-Diarrhea	44.53	
	-Vomiting	06.03	
	-Cough	12.10	
	-Vermifuge	15.69	
	-Pneumonia	16.92	
	-Abscess	27.60	
	-Sexual weakness	55.87	
	-Leucorrhoea	46.71	
Fruit	-Hernia	24.76	16.66
	-Cough	45.55	
	-Fever	60.78	
	-Poisoning	25.03	
	-Diabetes	92.15	
Stem	-Infectious diseases	40.34	33.33
	-Paddles	07.34	
	-Weaving	10.90	
	-Shuttles	20.01	
	-Dolls	12.35	
	-Combs	25.03	
	-Shovel handles	26.74	
	-Incense stands	23.45	

FUP, use frequency of *P. nitida* properties; IVO, index value for useful organs.

of species could also be due to abiotic factors such as climate and soil. It is therefore important to develop a management program for the sustainable use of the species.

Current distribution and density of *P. nitida* around both study areas

Distribution and density of *P. nitida* in the DG. During the investigation in Togo, *P. nitida* was found in the southwest of the country, 185 km from Lomé at 800 m altitude in “Danyi Dzogbégan” region at monastery “Abbaye de l’Ascension”. This region is situated in ecological district IV, corresponding to

dense semi-deciduous forests. *P. nitida* was not found in natural vegetation. The distribution map of the species elaborated by Adjanooun *et al.* (1996) did not include Togo. This may be due to the lack of information available on the species in 1996 or the absence of the species in natural habitats. Moreover, the individual of the species observed in the monastery may be introduced after 1996.

In Benin, *P. nitida* was found in forest in the phytogeographic zones of “Pobè and Vallée de l’Ouémé” located in the southeast of the country and characterized by the GC climate condition. The occurrence of the species decreases either in latitude from the south or in longitude from the southeast. In addition to forests, *P. nitida* was found in home gardens and home yards in the DG.

The species is almost absent in the dry forests of the DG (Figure 4). *P. nitida* was found at very low density in the DG (0.020 ind./km² and 1.75 ind./village in Togo and 0.022 ind./ km² and 1.87 ind./village in Benin). The DG is not a suitable habitat of the species because of the dry climate in this region. The occurrence of the species in this region may be the results of long domestication process due to the importance of the species to the local populations. This may explain why some authors (Eyog Matig *et al.*, 2006; Omino, 1996) do not consider the DG to be a distribution area of *P. nitida*.

Current distribution of *P. nitida* in Guineo-Congolese region.

In all the countries of the Guineo-Congolese region (Cameroon, Central African Republic, Congo Brazzaville, Côte d’Ivoire,

Democratic Republic of Congo, Gabon, Ghana, Nigeria and Uganda), *P. nitida* was found in forests. In Cameroon, *P. nitida* occurred in forests (52%) and farms (30%) (Yakeu, 2012). The occurrence point of *P. nitida* can be qualified in two ways (Figure 4). In the Upper Guinea (from Guinea and Sierra Leone to Ghana” Western Region”), the occurrence of *P. nitida* was average. In Lower Guinea (Nigeria and eastward; “West Central

Table 3. Absolute global credibility of uses.

Use	Absolute global credibility (%)
Malaria	88.88
Measles	77.77
Diabetes	77.77
Infectious Diseases	55.55
Diarrhea	55.55
Deworming	77.77
Hernia	66.66
Fevers	66.66
Sexual stimulant	77.77
Shovel handles and spoons	55.55

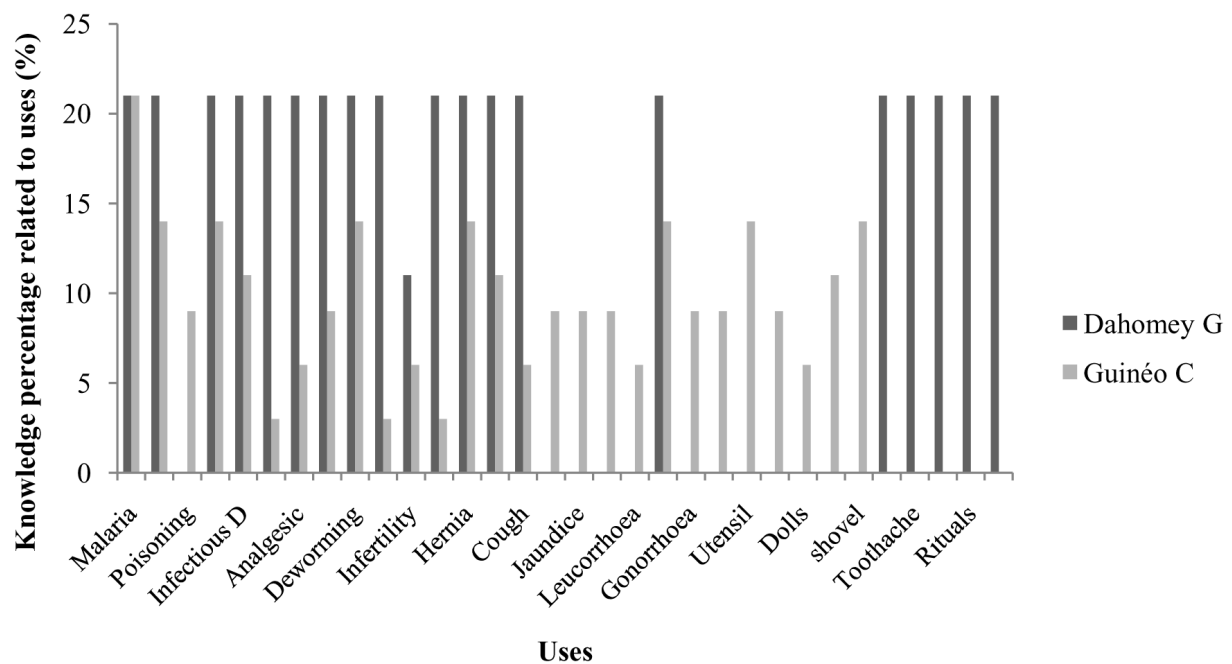
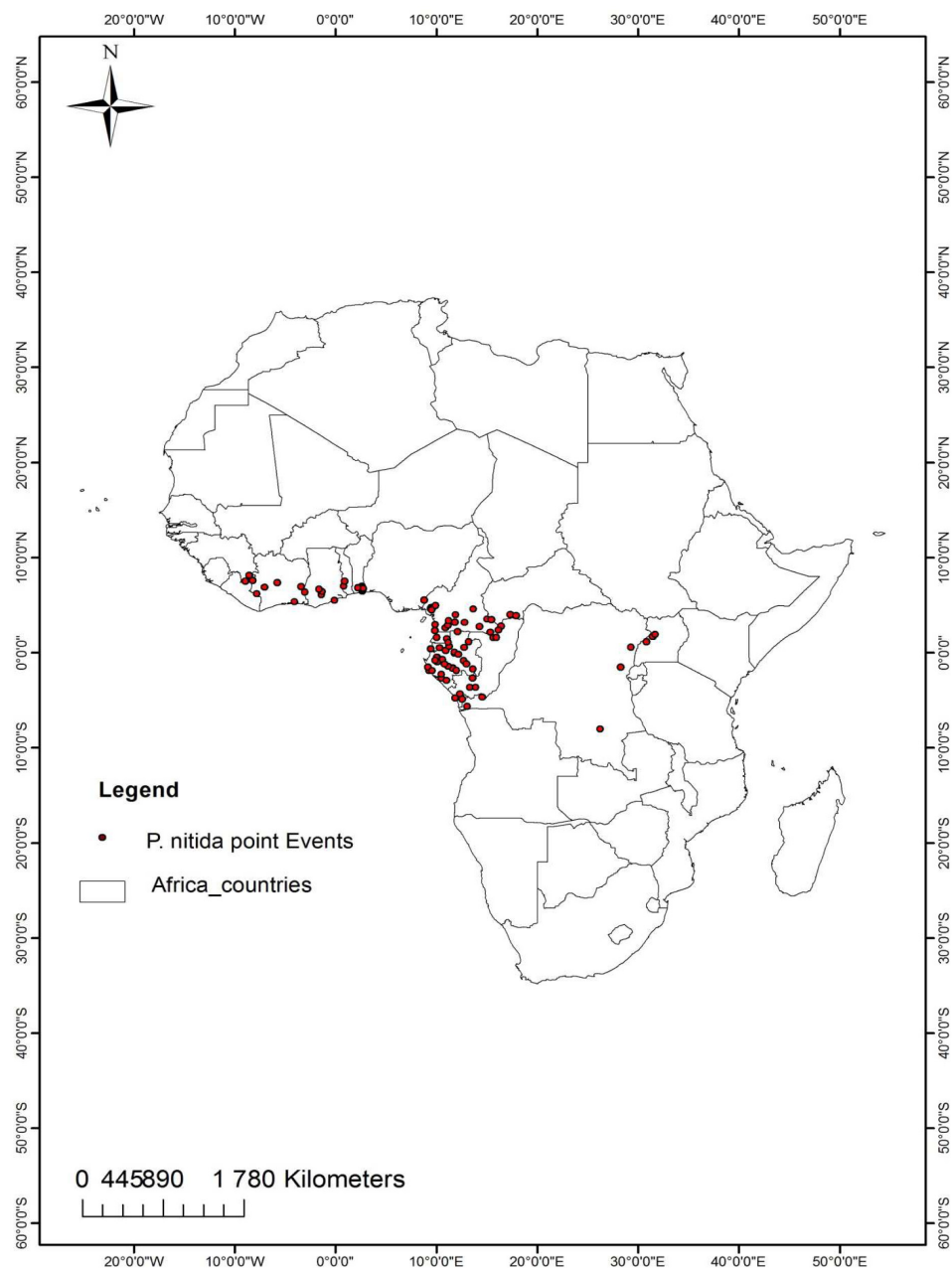


Figure 3. Knowledge on *P. nitida* in Dahomey Gap and Guineo Congo region.

Table 4. Medicinal, medico-magic and cultural practices of *P. nitida* organs.

Medicinal practices	Medico-magic practices	Cultural practices
Malaria – Angina – Diabetes – Analgesic – Against abortion Diarrhea – Hemorrhoid – Measles – Fevers – Cough – Bellyaches – Infectious diseases Infertility – Painful period – Cancer – Disinfection – Tension – Toothache – Sexual weakness – Hernia – Jaundice – Vomiting	Inhumation rituals – Good luck – Paralysis	Weaning – Wedding ritual – Utensils – Initiation Rites in couvents of “Egoungoun and Oro” (traditional religions)

**Figure 4. Occurrences of *P. nitida* in Africa.**

Region”), *P. nitida* had many occurrences that may be justified by the highest rainfall observed in this area, especially in western Cameroon, which experiences 3,000 mm of precipitation per year (Lefèvre, 1967).

Individual-level responses to the ethnobotanical survey and geographical distribution locations are available as *Underlying data* (Akabassi, 2020a) (Akabassi, 2020b)

Conclusion

The organs of *P. nitida* (seed, bark and fruit) are sold in the DG and GC region and contribute in households’ income. The species has a total of 24 uses in medicine, medico-magic and culture in Dahomey gap and GC region with more credible uses and knowledge in the DG. *P. nitida* is rarer in the DG than in GC region. The Seeds was the most important organ used around the study area. The Adapted management strategies are needed for the sustainable use and conservation of the species in the two climatic zones.

Data availability

Underlying data

This study contains the following underlying data:

The Knowledge Network for Biocomplexity: Database Economic value, endogenous knowledge and distribution of *Picralima nitida* (Stapf) T. Durand & H. Durand in Africa. 2020. Ethnobotanical and Geospatial data. <https://doi.org/10.5063/F189146R> (Akabassi, 2020a).

This project contains the pooled responses of participants and GPS data of where *P. nitida* samples were identified in Benin and Togo

The Knowledge Network for Biocomplexity: Dataset detailed of ethnobotanical study on *Picralima nitida* (Stapf) T. Durand and H. Durand. <https://doi.org/10.5063/F1TX3CQ9> (Akabassi, 2020b).

This project contains the individual-level responses of participants from Benin and Togo.

Extended data

Knowledge Network for Biocomplexity: Blank questionnaire of ethnobotanical study on *Picralima nitida* in Dahomey Gap, West Africa, 2020. <https://doi.org/10.5063/F1P84987> (Akabassi, 2020c).

This project contains a blank copy of the ethnobotanical survey used in this study.

The Knowledge Network for Biocomplexity: Blank copy of the questions, Ethnobotanical study on *Picralima nitida* in Dahomey Gap (Benin and Togo). <https://doi.org/10.5063/F1SX6BKX> (Akabassi, 2020d).

This project contains a blank copy of the questions that were asked to the individuals in Togo and Benin related to ethnobotanical study on *Picralima nitida*.

Data are available under the terms of the [Creative Commons Public Domain “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

Acknowledgements

We thank the local communities of the Dahomey Gap for sharing their knowledge on the species.

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Open Peer Review

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Version 2

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Christian Mikolo Yobo 

Département d'Ecosystèmes Terrestres, Institut de Recherche en Ecologie Tropicale du Centre National de Recherche Scientifique et Technologiques (IRET/CENAREST), Libreville, Gabon

Reviewer's comments:

Overall conclusion about the paper:

At the current status, the paper still needs further improvements, especially the results section. Two key results still need to be integrated in the manuscript, especially:

1. About the drivers of local/endogenous knowledge loss across both regions; and
2. About the drivers of the scarcity of the resource across both regions.

The paper cannot be indexed.

The title of the article has changed as follows: The price, amounts sold dynamic, endogenous knowledge loss and distribution of *Picralima nitida* (Stapf) T. Durand and H. Durand across the Dahomey Gap and Guinea-Congolese regions.

Questions needed to be clarified:

About the drivers of endogenous knowledge loss across both regions:

Do you have any data on local knowledge/endogenous knowledge loss (or the drivers of) about the *Picralima nitida* (Stapf) T. Durand and H. Durand across both regions?

1. If yes, please provide such data to back up the idea about documenting such an important local know how for the populations of both regions?
2. If not, the objective of the paper may need a bit of twist or change. It is up to the availability of the data.

About the drivers of the scarcity of the resource across both regions:

Do you have any data on the drivers of the scarcity of the *Picralima nitida* (Stapf) T. Durand and H. Durand across both regions?

1. If yes, please provide such data to back up the idea about the current distribution of the

- plant species across both regions?
2. If not, it might be a bit difficult to argue about the causes driving the scarcity of the plant species across both regions unless you discuss only the current distribution of the plant species on the light of the available literature. This is only in the case that you did not gather data on the drivers of plant species scarcity.

Overall summary:

The summary of the paper has been improved. Please have a look at the annotated manuscript itself (available [here](#)) for further assessment.

Introduction:

- The introduction of the paper has also been improved and the general objective of the paper as well. The latter point has been changed as follow “This paper aims at assessing the price dynamic economic value of *P. nitida* (Stapf) T. Durand and H. Durand, document the endogenous knowledge on the plant species, and sheds a light on the drivers of species scarcity, and its distribution in Dahomey Gap (DG) and Guinea-Congolese (GC) regions through mix approaches”.
- In this objective, there is a need to provide data on the drivers of local/endogenous knowledge loss as well as the information about the drivers of plant species decline across the Dahomey Gap (DG) and the Guinea-Congolese (GC) region.
- Additional information has been added to the annotated manuscript itself (available [here](#)). Please have a look for further assessment.

Material and methods:

Some remarks have been directly added into the annotated manuscript itself (available [here](#)). Please have a look and respond accordingly.

Results and discussion

Results (The missing key results):

These two results need to be added in the paper to tackle the issue at stake in this paper:

1. About the drivers of local/ endogenous knowledge loss across both regions; and
2. About the drivers of the scarcity of the resource across both regions.

Discussion:

1. The importance of endogenous knowledge on plants used to treat various diseases across both regions,
2. The factors causing the erosion/loss of local knowledge;
3. The factors affecting the current distribution of the plant species across both regions, and
4. The opportunity to overturn the issue of endogenous knowledge's loss and approaches to slow down the loss of the scarce plant species while ensuring its sustainable management across both regions.

Additional information has been added to the annotated manuscript itself (available [here](#)). Please have a look for further assessment.

Conclusion:

In this section, please assess whether the paper has contributed to answer to the following aspects of your research paper (the specific objectives of the paper):

- The price and selling amounts dynamics of *P. nitida* (Stapf) T. Durand and H. Durand across both regions;
- Documenting the various uses of the plant species and the drivers of loss of local/endogenous knowledge about usages of that plant species across both regions;
- Shed a light on the drivers of species scarcity, and its distribution across both regions.

Recommendations:

As key recommendations, the authors should suggest some solutions to safeguard the loss of local/endogenous knowledge and approaches for sustainable management of the plant species around across both regions.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 27 October 2020

<https://doi.org/10.21956/aasopenres.14256.r28032>

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Martin J. Potgieter 

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The authors seem intent on doing the minimum to get this paper through as quickly as possible. This minimum effort is achieved via the following strategies:

1. No correcting or addressing issues raised.
2. Removing/deleting controversial issues rather than comprehensively addressing them, thereby uplifting the quality of the paper. Removing these issues just leads to unconnected parts – the Abstract is an excellent example of this strategy and its unintended consequences.
3. Addressing discussion issues via one or two non-referenced low-quality non-scientific sentences.
4. The paper cannot proceed forward with this amount of unprofessional grammar/editorial

issues. It also makes it extremely difficult to review and judge the quality and value of the scientific content.

5. The authors indicate Ethical approval was not sought for this study, as the study was deemed by the researchers to be low risk, as it did not record any identifying information of participants; was not an interventional- or clinical-based study. However, it is currently industry standard to seek and obtain ethical clearance from the research institution (in this case University of Abomey, University Félix Houphouët Boigny, and National University of Agriculture).

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Biodiversity, ecology, phytomedicine, ethnobotany

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Version 1

Reviewer Report 10 August 2020

<https://doi.org/10.21956/aasopenres.14183.r27676>

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The paper deals with the importance of *Picralima nitida* (Stapf) T. Durand and H. Durand, known as an important African medicinal plant species in Dahomey Gap region in general and in Togo in particular, especially at the glance of its: i) economic value, ii) endogenous knowledge and distribution. However, the paper failed to take into consideration several aspects such as i) poor knowledge about the exact distribution of the *Picralima nitida* plant species, ii) the issue of erosion of local knowledge and the need for its safeguard; iii) the causes of plant species (*Picralima nitida*) rarity, and iv) any available initiatives/interventions that have been carried out to address the issue along with any available policy and available regulations in place to guide sustainable management of biodiversity in general and *Picralima nitida* medicinal plant species in particular. Undermining such background knowledge has contributed to lowering the quality and strength of the paper. As a result, in its current stage, the paper could not be accepted for indexing, unless

important ameliorations are made.

Please see my detailed comments in the PDF file found [here](#).

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: NTFP Socioeconomics, Livelihood assessment, Ethnobotany, NTFP value chains assessment, NTFP resource management, and policy and regulation assessment

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 06 Oct 2020

Ghislain AKABASSI

Answer to Reviewer 2: Christian Mickolo Y.

Introduction

R: I would rather suggest that the authors focus on the background of his paper as follows: In Dahomey Gap's region or West African region, they should point out the following...

A: *This recommendation has been taken into account in the indicated part of the manuscript.*

R: I think that this general objective does not capture the full content of the paper as a result I suggest the following one "This paper aims at assessing the economic value, document the endogenous knowledge on the plant species, and sheds a light on the distribution of *Picralima nitida* (Stapf) T. Durand and H. Durand in Dahomey Gap's region by talking the following research questions:

1. What is the economic value of the *Picralima nitida* species around the study area? 2. To what extent local communities know about the ethnobotanical values of the species? 3. What are the drivers of species rarity around the study area? 4. What is the current distribution of the species around the study area?

A: *All questions addressed here have been considered in the introduction of this new version.*

R: What solutions can be suggested to overturn the issue of species rarity around the study area?

A: *No data has been collected about this recommendation.*

Study area:

All questions and recommendations suggested by the reviewer about of the study area have been considered and integrated in this new version of the manuscript.

Data collection:

Preliminary survey:

R: How many respondents did you approach regarding the ethnobotanical uses, economic value, and distribution of the plant species around both selected study areas?

A: *Based on preliminary surveys among 90 individuals randomly sampled among various ethnic groups in DG on the use of the species.*

R: What were the results regarding the ethnobotanical uses, economic value, and distribution of the plant species during such a phase?

A: *It was found that 85% in Benin and 83% in Togo of respondents had knowledge of at least one use for the species.*

Main survey:

R: In both countries, how did you access and sample the 120 key informants? • Are the local languages used in both countries different or similar? In the case that they are different, there might be also differences in uses and practice of local knowledge so how did you do to capture such differences? What are the reasons that drove you to select the following two phytodistricts (Pobè and Vallée de l'Ouéomé) in Benin? The same question holds for the case of Togo. • What are also the other criteria for selecting the key informants in the survey? What are the other data collection approaches did you use such as transect walk, field observation, group discussion, etc, especially to cross- check information gathered?

A: *Individual interviews were conducted in Togo and Benin with a total of 120 (60 per country) key informants. The main local languages interviewed were Fon, Goun, Nago, Yorouba, Adja in Benin and Mina, Ewe, Kotafon in Togo. The survey has been piloted prior to its use. In Benin, the survey covered two phytodistricts (Pobè and Vallée de l'Ouéomé) and 30 informants were selected in each phytodistricts. These two phytodistricts were selected because it were the only presence areas of *P. nitida* in Benin (Akoègninou et al. 2006). In Togo, the survey covered Danyi located in ecological district IV (only presence area of the species in Togo (Akpagana et al. 1994) and 60 informants were selected. The survey was performed between January and July 2018 and conducted in the local language using a questionnaire (see Extended data). The survey was carried out through the households using a local guide. The local guide approached households*

*in person and participants aged 18 and over were considered regardless of education level, ethnicity and gender. Households were selected at random, however, households with sellers of medicinal plants were systematically selected. After this Approach, a focus group discussion has been performed in each country to cross-check information gathered. In Benin, 45 people indicated their willingness to participate at the focus group discussion while 42 people volunteered in Togo. Most informants were selected from localities with at least one *P. nitida* individual. These localities were Ifangni, Sakété, Adja-Wèrè, Ikpinlè, Kétou, Avrankou, Adjarra, in Benin and Kouma, Danyi, Akposso-Akébou, Kpalimé-Atakpamé in Togo. Data were collected on the economic and socio-cultural values of the species, the uses and organs used, the frequency of use and main threats of the species.*

Literature search:

R: How many articles were obtained? • How much refinement was made to remove nonrelevant articles? • And how many articles remain now?

A: *In the typical GC region, data were collected on *P. nitida* through a literature search. The original articles obtained from various databases including Google Scholar (www.scholar.google.fr), ScienceDirect (www.sciencedirect.com), Scopus, PubMed Central and African Journals Online (www.ajol.info) in addition to reports and thesis. Biodiversity databases (www.prota.org and GBIF.org) were used to gather information on the importance and occurrence coordinates of the species. The main research theme used were: "Economic value" AND "*Picralima nitida*"; "Endogenous knowledge" AND "*Picralima nitida*"; "Distribution" AND "*Picralima nitida*"; "Togo" AND "*Picralima nitida*"; "Benin" AND "*Picralima nitida*". A total of 66 published articles were obtained and 31 published articles between 1996 and November 2018 were selected based on their relevant for the topic. All articles not dealing with ethnobotanical importance and distribution of *P. nitida* were excluded. Letters, encyclopaedia, case-reports, manuals and guidelines were also excluded. The data that were extracted from selected articles were the socio-economic importance, the different traditional uses of *P. nitida* organs, mode of preparation, dosage and coordinates of study location.*

Competing Interests: N/A

Reviewer Report 08 July 2020

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Martin J. Potgieter 

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General issues:

- The grammar of this paper needs serious professional proofreading before a next

submission.

Title:

- The title indicates: "Economic value, endogenous knowledge and distribution of *Picralima nitida* (Stapf) T. Durand and H. Durand in Africa" – However, this study was only confined to DG, Togo and Benin. Thus, vast areas of the distribution range of *P. nitida* are excluded from this study (e.g. South Africa). This implies that the title needs to be reformulated to indicate the localities of DG, Benin and Togo.

Abstract:

- Background: Effect of climate gradient on distribution is presented as an aim, but not captured in the title.
- Methods: threats not captured in title, no result presented on it – remove?
- Methods: density not listed, yet features in results/discussion section.
- Results: Treatments (human and/or veterinary?).
- Results: species had *low* density in Dahomey Gap – what constitutes *low* density?
- Results: No information presented on "Effect of climate gradient on distribution".
- Results: no information presented on threats, yet it features in methodology.
- Conclusions: Adapted management strategies are needed for the sustainable use and conservation of the species. – this is a recommendation, not conclusion – remove.

Introduction:

- Remove: It is a small tree which reaches 4–35 m in height. Its wood is pale yellow, hard, elastic and fine-grained with a high polish. *P. nitida* bears white flowers (about 3 cm long) with yellowish ovoid fruits at maturity. The leaves are broad and oblong with tough tiny lateral nerves of 14–24 pairs. This section is out-of-place.
- "In addition to its medicinal uses, *P. nitida* provides an income to millions of households in Africa." How so? Explain via an additional sentence.
- "The species is known as a febrifuge and a cure for infectious disease, malaria, diabetes and pain (Aguwa et al., 2001; Akabassi et al., 2017; Betti et al., 2013; Teugwa et al., 2013)". - The issue of string citation (listing multiple authors at end of sentence) is a pervasive problem in this manuscript. By placing multiple consulted sources at the end of a sentence implies all information in that sentence can be attributed to those authors – thus per implication they (authors) stated exactly the same information – in which case why cite more than one, when the most authoritative would suffice? This issue must be corrected by placing sources immediately after used fact inside the sentence, when dealing with multiple authors in a sentence, so as to explicitly attribute a specific fact to a specific source. Correct throughout the manuscript.

- Figure 1: does not show the full distribution range of the species, especially in southern Africa.
- "There is a need to dispel the ambiguity over the distribution areas of this species *and to document the important threats to its conservation.*" Where is the threat analysis and discussion?

Materials and Methods

- Study area:
 - "The study areas were typical GC regions (Cameroon, Central African Republic, Congo Brazzaville, Côte d'Ivoire, Democratic Republic of Congo, Gabon, Ghana, Nigeria and Uganda" – incorrect. The study area was confined to DG countries, Togo and Benin – rephrase.
 - Figure 2: "...characterized by *rainforests* with a rainfall of up to 2500 mm, and the DG region (Benin and Togo) characterized by *savannas* that extend down to the coast *with a mosaic of rainforest* (Figure 2)." Figure 2 does not show mosaic of rainforests or savannas.
- Economic value and endogenous knowledge:
 - "A preliminary survey was conducted in DG on the use of the species." Indicate (1) reasons for preliminary survey, (2) how many people surveyed and how.
- Data collection:
 - Indicate how key informants were selected.
 - Gender and age?
 - Indicate how households were selected.
 - Indicate themes of questionnaire.
 - Threats? No reporting of it in Results/discussion section.
- Literature search:
 - "The data that were extracted from selected articles were ... GPS coordinates of the individuals of the species." This is extremely strange (and unlikely) that GPS coordinates of individual plants are presented in the literature. Relook this.
- Ethics and consent:
 - Individuals involved in the study can only give consent, not ethical approval. Ethical approval was sought and given by which university? Indicate ethical clearance certificate number.
- Effect of climate gradient on species density and distribution:
 - "...in the typical GC region, data on the species density and distribution were collected using a literature review. This is extremely strange (and unlikely) that density of individual plants is presented in the literature. How old are the sources consulted? Still valid/relevant for period of this study? How complete was the information gathered via literature review? How was literature review done? Relook this.
- Results/Discussion

Economic value:

- "P. nitida seeds were dried, powdered, encapsulated and sold as "Picap capsules" that cost between US\$12.99 and US\$225 depending on the quantity..." – For which region/country is this? How old is this information? How scientifically correct is the information that is derived from a non-peer-reviewed web-based source.
- (<https://thegradekratom.com/product/akuamma-seeds/>). – web addresses not to be included in text – relocate to reference section.
- "P. nitida products were *more* expensive in the DG." – more than?
- "The domestication of non-timber forest species like P. nitida is an opportunity to alleviate poverty with positive benefits on the environment, since new plantations of P. nitida will contribute to reduce the greenhouse gas emission."- this is such a general statement as to apply to any plant species - relook.
- "It is therefore important to develop a management program for the sustainable use of the species." On the contrary, no information has been provided to indicate *unsustainable* use or harvesting. So why is a management program necessary? Because it is rare? But could be due to abiotic factors such as climate and soil, not necessary due to adverse anthropogenic actions. Relook.

Endogenous knowledge:

- Bark – is this stem bark or root bark?
- Bellyaches – replace with stomach aches.
- "This indicated that P. nitida is very important in the the DG." – this is a prime example of some of the many unprofessional editorial issues abound in this paper.
- Table 1 and Table 2: Why are leaves presented in plural, but other organs in singular?
- Table 1 and Table 2: Indicate if the fruit is mature and ripe, or not.
- Table 1 and Table 2: Stem – does this include wood+bark?
- "The seed was the most important organ used in the DG (79.16% in Benin and 83.33% in Togo)." Why and what would be the conservation impact/population sustainability impact? Discussion needed.
- "The seed was the most important organ used in the Guineo-Congolese region followed by the wood, fruit, leaves, bark and root (Table 2)." - Why and what would be the conservation impact/population sustainability impact? Discussion needed.
- "In the DG and GC regions, P. nitida was most frequently used against malaria, followed by measles, diabetes, worms, sexual weakness, hernia, fevers, infectious diseases and diarrhoea, ..." Are there any biochemical/microbiology papers found that scientifically

validate these claims? Discussion needed.

- "... uses were specific to certain regions with good credibility as the case of the use of the seeds to treat tonsillitis in the DG." Is there any biochemical/microbiology papers found that scientifically validate these claims? Discussion needed.
- "The different uses of the species mentioned in this paper could help local communities to benefit from the medicinal values of the species." – how so? Statement not clarified. Explanation needed.

Effect of climate gradient on density and distribution:

- *P. nitida* was found at very low density in the DG (0.020 ind./km² and 1.75 ind./village in Togo and 0.022 ind./km² and 1.87 ind./village in Benin). Is this information coming from literature (not cited). If not, then how was this determined? Individuals per village are meaningless – we do not know how large the village is. Density must only be expressed as individuals per km².

Distribution of *P. nitida* in Guineo-Congolese region:

- "In the Upper Guinea (from Guinea and Sierra Leone to Ghana" Western Region"), the occurrence of *P. nitida* was *average*. What constitutes *average*? Occurrence categories not presented in Materials and Methods section.
- In Lower Guinea (Nigeria and eastward; "West Central Region"), *P. nitida* had *many* occurrences ..."- What constitutes *many* occurrences? Occurrence categories not presented in Materials and Methods section.
- "... in western Cameroon, which experiences 3000 mm of precipitation per year (Lefèvre, 1967). This rainfall of 3000 mm per annum comes from 53 ago (1967). Rainfall data not reflective for the study period of this paper. Climate change in the last 50 odd years has significantly altered the numbers. Use more up-to-date sources and data.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Biodiversity, ecology, phytomedicine, ethnobotany

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 13 Jul 2020

Ghislain AKABASSI

Dear reviewer,

We provide below the Answer (A) to the Remark, recommendation and question (R) addressed.

Title:

R: The title indicates: "Economic value, endogenous knowledge and distribution of *Picralima nitida* (Stapf) T. Durand and H. Durand in Africa" – However, this study was only confined to DG, Togo and Benin. Thus, vast areas of the distribution range of *P. nitida* are excluded from this study (e.g. South Africa). This implies that the title needs to be reformulated to indicate the localities of DG, Benin and Togo.

A: This study involves in addition to DG (Benin and Togo) the Guineo-Congolese region which include the Upper Guinea (from Guinea and Sierra Leone to Ghana" Western Region") and the Lower Guinea (Nigeria and eastward; "West Central Region"). *Picralima nitida* is native from the Guineo-Congolese region. According to Bongers *et al.* 2004, Poorter *et al.* 2004, Church, 1966, and White, 1983, the Guineo-Congolese region does not include South Africa. Moreover, there is no occurrence of the species in South Africa on GBIF database. I will be very pleased if you could update the occurrence of the species on GBIF with the reference points in South Africa. This will help to improve the distribution map of the species.

Abstract

R: Methods: threats not captured in title, no result presented on it – remove?

A: The threats on the species were addressed based on the overexploitation of its organs. The section on Endogenous knowledge of *P. nitida* in the results provides information on the exploitation of the organs of the species. The seed was the most important organ used in the Guineo-Congolese region followed by the wood, fruit, leaves, bark and root"; "The seed was the most important organ used in the DG (79.16% in Benin and 83.33% in Togo)". The overexploitation of the seeds, bark and root (vital organ of the plant) are an important threat on the conservation of the species. Other threat of the species in the article is the climate gradient. The species is scarce in DG compared to Guineo-Congolese region.

Introduction:

R: Figure 1: does not show the full distribution range of the species, especially in southern

Africa.

A: This figure is provided by Adjanohoun et al. (1996). If the species is also present in South Africa, it will be good to update the occurrence of the species that will contribute to update the figure in future publication

R: "There is a need to dispel the ambiguity over the distribution areas of this species and to document the important threats to its conservation." Where is the threat analysis and discussion?

A: In this study the threats were mainly assessed in relation to the importance of the species for the local populations. The use of the various organs (especially the seeds) of the species without any form of sustainable management constitutes a threat to the sustainability of the species.

In addition, the second part of this study dealing with threats to the species is its frequency according to the climate gradient. In this study, we found that in both DG countries. For instance, in Benin the occurrence of the species decreases either in latitude from the south or in longitude from the southeast. Its presence is reduced to a few isolated individuals found in home gardens. In the Guineo-congolese zone the density of the species is high in the zones with high rainfall such as the Democratic Republic of Congo, Cameroon (Please consult GBIF website). These different results showed the effect of climate gradient on the distribution of *P. nitida*.

Materials and Methods

R: Figure 2: "...characterized by rainforests with a rainfall of up to 2500 mm, and the DG region (Benin and Togo) characterized by savannas that extend down to the coast with a mosaic of rainforest (Figure 2)." Figure 2 does not show mosaic of rainforests or savannas.

A: Figure 2 showed the DG and Guineo-Congolese regions. In the figure, the Guinean-Congolese part has been marked green. The two green parts have been separated by the Dahomey Gap. According to literature (Adomou, 2005, Akoegninou et al., 2006, Church, 1966) the Guineo-Congolese region is forest area characterized by rainforests with a rainfall of up to 2500 mm, and the DG region (Benin and Togo) characterized by savannas that extend down to the coast with a mosaic of rainforest.

Economic value and endogenous knowledge:

R: "A preliminary survey was conducted in DG on the use of the species." Indicate (1) reasons for preliminary survey, (2) how many people surveyed and how.

A: A preliminary survey was conducted in DG on the use of the species to calculate the sample size to be used in the full study, according to the formula of Dagnelie (1998).

Data collection:

R: Indicate how key informants were selected, Gender and age? Indicate how households were selected.

A: Please see this section of methodology "The survey was carried out through the households using a local guide. The local guide approached households in person and participants aged 18 and over were considered regardless of education and gender. Most informants were selected from localities with at least one *P. nitida* individual. Data were collected on the economic and socio-cultural values of the species, the uses and organs used, the frequency of use and main threats of the species.

Ethics and consent:

R: Individuals involved in the study can only give consent, not ethical approval. Ethical approval was sought and given by which university? Indicate ethical clearance certificate number.

A: Ethical approval was not sought for this study. The study is deemed by the researchers to be low risk, as it did not record any identifying information of participants; was not an interventional- or clinical-based study. However, a consent has been received from community leaders and participants of the DG and ensured informed consent was received for data collection and analysis.

Competing Interests: N/A