Diversity of Tree Species Used in Wood Carving and the Impact of Their Use on Forest Conservation in Benin.

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Research Article

Keywords: Fragmentation, Reforestation, Use Value, Wood Carving.

Posted Date: September 11th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-75014/v1

Abstract

This research aimed at assessing the diversity of timber species used in wood carving in southern Benin, impact of this activity on forest conservation, and carvers' willingness to contribute to species conservation. A preliminary survey was conducted to determine the number of wood carvers in three districts of Southern Benin. Then, a semi-structured questionnaire served to collect data from twelve wood carvers. Twenty-two species were used in wood carving with most species having red or yellow wood. The purchase of wood in industrial markets was the predominant source followed by the direct purchase from plantation and tree owners. *Diospyros mespiliformis, Chlorophora excelsa*,*Tectona grandis* and *Gmelina arborea* were species of which woods were most However, Gmelina arborea and Chlorophora excelsa exhibited the highest Use Value meaning their relative importance in terms of diversity of uses. All carvers reported the scarcity of woods and the destruction of forests and plantations for logging were the main cause; 25% of them own plantations of G. arborea and A. auriculiformis. Carvers indicated their willingness to have plantations of T. grandis and G. arborea for personal use and trade. Promoting reforestation and timber species plantation through sustainable tools is needed, and sensitizing them about forest conservation.

Introduction

Forests play a key role in people's life and are of inestimable value. Forests are vital natural resources (WWF, 2020) and crucial for the achievement of the Sustainable Development Goals (SDGs) (Simeons, 2018). Forests and their derivative timber and non-timber products have been used by societies around the world for thousands of years (Ramage et al., 2017), and also provide ecological services, contributing significantly to environmental stability (Simeons, 2018). Forests are also a treasury of medicinal plants and pharmaceutical ingredients (Dossou-Yovo et al., 2014, 2017). Wood harvested from natural forests and plantations is used for fuel, construction, and craft uses such as carving. Although timber and non-timber forest products remain an important source of livelihoods in large parts of the world, especially in Africa, their extraction is also a major driver of deforestation (UCS, 2016).

Wood carving has been a common cultural practice of civilizations throughout the ages. For instance, samples of wooden art bythe ancient Egyptians,Greeks, Romans and Chinese still exist. Wood carving plays a great role in the cultural identity of countries. In Benin, wood carving has been practised since time immemorial and many ancient wooden artifacts have been preserved, including many that explain the key role played by the country during the slavery period. Despite the cultural and historic importance of wood carving in Benin, no research has been conducted on this activity. Many people today still depend on wood carving for their livelihoods (Okrah, 2002; Appiah-Kubi et al., 2014; Kayode et al., 2016). As a result, much attention should be focused on this practice so as to ensure sustainable and improved

livelihoods for wood carvers and their families. To achieve this, natural and planted forests from which wood is harvested for carving should be well managed and conserved. The aim of this paper was toreport the diversity of timber species used in wood carving in Benin, the sources of wood used, and the relative importance of the most commonly used woods. From the perspective of sustainable forest conservation, the availability of wood to carvers and their willingness to contribute to species conservation were assessed. It was expected that the results of this study wouldenable forestry advisers and political leaders to better organize wood carving throughout the country.

Materials And Methods

Prior to data collection, a preliminarysurvey was conducted to record the total number of wood carvers in three districts of Benin, Ouidah, Abomey-Calavi and Cotonou. There werefivewood carvers in Ouidah, twoin Abomey-Calavi and five in Cotonou, based at the Benin artpromotion centers.These twelve wood carvers were interviewed using a semi-structured questionnaire to gather knowledge on the diversity of woods they used, their sources of wood, the ranking of the most used woods, and categories of art made with each wood. The availability of wood in recent years as well carvers' willingness tocontribute to timber species conservation were also investigated. Based onthe local names of recorded species, de Souza (1988) and Arbonnier (2002)were used to determine the botanical name of each species. Direct observations were also made of the woods that carversusedand the products made. In order to access the relative importance of the four most usedwoods,their Use Value (Zenderland et al., 2019) was calculated by dividing the number of uses for the concerned wood by the numberof carvers who mentioned the wood as most used. Carvers were also asked to free list the causes of wood scarcity or abundance in the recent years.

Results

1. **Diversity of woody species used in carving**

The wood of 22 species, belonging to 22 genera in 15 botanical families,were reported to be used in carving. The most represented family was the Caesalpiniaceae, represented by one species in each of three genera, *Afzelia africana*, *Delonix regia* and *Daniellia oliveri* (Table 1). The families Moraceae, Meliaceae, Verbenaceae, Mimosaceae and Anacardiace were each represented by two species, and there was one species in each of the remaining nine families. The wood used in carving exhibited a range of colours according to the respondents (Table 1). Four major colours were recorded, yellow (seven species including two described as clear yellow and yellow brown, respectively), red (seven species), white (six species including one described as ash) and black (two species).

2. Sources wood used in carving

Carvers reported four sources of woods used in carving. These were wood provided by customers themselves, wood bought by carvers in industrial or local informal markets, wood purchased by carvers from owners of plantations or individual trees, and the harvest of wood from carvers' own plantations.

The predominant source recorded was the purchase of wood in industrial wood markets (75% of respondents), followed by the direct purchase from plantation or tree owners (58% of respondents), the provision of wood by customers themselves (58% of respondents), and collection of wood from carvers' plantations (25% of respondents). It is important to highlight the low proportion ofcarverswho harvest wood from their own plantations.

3. Ranking of woods used for carving

Fifty percent of respondents reported wood of *Diospyrosmespiliformis* (locally called ébène in Fon; black wood) as the most used for carving while 42% mentioned the wood of *Chlorophoraexcelsa* (locally called lokotin; yellow brown wood) as the most used (Table 2).Wood of *Tectonagrandis* (têkitin in Fon; yellow wood) ranked third in this paper because it was mentioned by 50% of respondents as second most used. The fourth most used wood was *Gmelinaarborea* (mélina or fôfitin in Fon; white wood). Regarding the sources of the most used woods, all informants mentionedthe purchase of*D. mespiliformis* wood in industrial wood markets, wood coming from northern Benin.Some informants(25%) reported the purchase of the wood of *C. excelsa* from tree ownersand 17% of them insisted on its provision by customers themselves. Informants who mentioned *T.grandis* and *G.arborea* confirmed that they mostly purchased wood from tree and plantation owners as well as local informal markets.

4.The Use Value of the most used woods

In terms of utilization, the woods of*D. mespiliformis*, *C. excelsa*, *T. grandis* and *G. arborea*were all used for small and large ornamental arts. Additionally, the wood of *C. excelsa*was used to carve spiritual objects, and the woods of *T. grandis* and *G. arborea*were used to make table utensils**.** Among the most commonly used species, *C. excelsa* exhibited a relatively greaterimportance than*D. mespiliformis*as shown by the Use Value (Table 3). Although the wood of *G.arborea*was the fourth most commonly used, it hadthe highestUse Valuewhilewood of *D. mespiliformis* had the lowest Use Value.

5. Availability of woods according to carvers

All informants reported the scarcity of woods for carving in recent years. They also highlighted that wood has consequently become very expensive. With regards to the causes of this scarcity, six reasons were reported (Table 4). The most frequently mentioned cause of scarcity was thedestruction of forests and plantations for logging. The international trade of wood as well as political restrictions towards local trade of wood ranked second in the same proportion followed the exploitation of wood for charcoalproduction, population growth and lack of plantation.

6. Willingness to contribute to recordedspecies conservation

Only 25% of wood carvers owned plantations of *G. arborea* and *Acacia auriculiformis*, with an average area of 2.5 ha. All informants were interested in investing in woody species plantationsif they had more money. Fifty percent of carversreported that they would plant *G. arborea* while 42% would prefer to plant *T. grandis* plantations from which they could harvest woods for carving.

Discussion

1. Diversity of woody species used in curving

Twenty-three plant species were recorded as used in carving confirming that wood carvers have an extensive knowledge about the quality of woods and their utilization. The range of species used suggests that their exploitation can increase environmental pressure,contributing to forest fragmentation and local species loss all over the country. Trees are, most of the time, uprooted for wood collection so, although wood carving provides anincome to workers, it constitutes a threat to species conservation. Wood carving was reported as a threat to forest diversity in Ghana because of exploitation of endangered species (Okrah,2002). Kayode et al. (2016) recorded 39 plant species belonging to 23 families used in carving in Nigeria. Similarly, the wood carving industry in Kenya is highly dependent on indigenous tree species (Mutinda, 2014).

2. Types of woods recorded

The diversity of type of wood used confirms that the choice depends on items to be carved (Kayode et al., 2016). Woods, in addition to their colour also vary from soft to hard and this influences the items for which they are used. A relatively high number of species was recorded as giving red wood followed by species having yellow wood. This confirms the various attractive aspects searched for in wood by carvers and the assertion that the components of art include colour, patterns and the reproduction of visual likeness (Morris-Kay, 2010).

3. Sources of recorded woody species

The purchase of wood in industrial markets was recorded as the main source for carversfollowed by direct purchase from plantation and tree owners. A very low proportion of carvers ownedtheir own plantations from which woods may be collected. These aspects confirm that harvesting of wood for carving threatens the conservation of forests throughout Benin. The majority of wood traded in industrial markets comes from the central and northern parts of the country. So, natural forests and sometimesplantations are cut down to satisfy a growing demand forwood. Even customers who provided their own woods for carving are destroying individual trees that are expected to protect theenvironment. No informant mentioned the purchase of wood from public plantations meaning a lack of public forestry areas, plantations or agroforestry parks,wherein carvers couldget woods whenever they want provided they are able toafford its cost.

4. Ranking of woods used for carving

Diospyros mespiliformis ranked as the most used wood and informants who selected it were mostly those working in Cotonou. Carvers insisted that this wood is the most appreciated by tourists. The black colour may attract people and it is easy to sell art made with this wood even if the customers are local. Carvers using this wood targeted the international market by exporting their arts. The genus Diospyros is widely recognized for its black wood. Furthermore, informants highlightedits durability, hardness and ability to take a high polish. The collection of *D. mespiliformis* wood from natural forests to satisfy the

increasing demand is clearly a threat to the species conservation. *Chlorophora excelsa* is widely used in Benin as its wood serves to make sacred objects in addition to ornamental art. Similarly to the present findings, Okonkwo et al. (2016) reported the use of *C. excelsa* (Iroko) in carving sacred objects in Nigeria. In addition to the exploitation of this species in carving, it is widelyused in carpentry and as medicine in Benin (Ouinsavi et al., 2005). Several years ago, the pressure placed on populations of *C. excelsa*of its exploitation in Benin was stated (Sokpon et al., 2003) and its exploitation in carving no doubt increases its extinction rate. Alternativesshould be found to help carversmaintain their livelihoods without compromising the sustainability of the species. *Tectona grandis* and *G. arborea* are two plantation species that have been grown in Benin fordecades. They were recorded among the most used in carving. Similarly to the present findings, *T. grandis* has also been reported in wood carving in Ghana (Appiah-Kubi et al., 2014). *Tectona grandis* and *G.arborea* woods were purchased from tree and plantation owners which confirms a high pressure on these species as they are also highly demanded forcarpentry throughout the country. Carvers justified the use of *G.arborea* wood by the fact that its white colour gave an attractive aspect for arts.In addition, they argued that woods of *G.arborea* and *T. grandis*aresometimesmore availablethan other woods. Similarly, *G.arborea* and *T.grandis* were mostly preferred forwood carving in India (Sharma et al., 2013). *Tectona grandis* has been identified as the species with most potential for the establishment ofhigh-quality tropical hardwood plantationsunder sustainable forest management (Thulasidas and Baillères, 2017)

5. The Use Value of the most used woods

The results confirmed that the frequency of use of a species wood can sometimes contrast with its relative importance. *Gmelina arborea* and *C. excelsa* both had greater Use Value than *D. mespiliformis* despite the more frequent use of this species.These findings confirmed the importance of the Use Value to assess the relative importance of plant species in ethnobotanical studies.

6. Availability of woods according to carvers

The scarcity of woods recorded in this research confirmed the high environmental pressure placed on tree species used in carving. Forests are fragmented to satisfy wood demands for carving and many other purposes. Thishas negative impacts on biodiversity conservation all over the country. Reforestation programs taking into account woody species used in carving are necessary throughout the country. Priority species can be *C. excelsa* and *D. mespiliformis*. As *T. grandis*and *G. arborea*havealready been grown in plantations throughout the country for manydecades,leaders are encouraged to promote these speciesin plantations. It has been stated that, in Benin, farmers specialized in pole-wood production to supply urban demand for cheap construction timber (Aoudji et al., 2014). Largeindividual trees of *T. grandis* and *G. arborea* are needed to ensure a long-term wood carving activity in Benin because art made by carvers plays a great role in tourism and in the cultural identity of the country.

7. Willingness to contribute to recorded species conservation

Only a small proportion of wood carvers had their own plantations which confirmed that the wood supply for this activity contributes to the fragmentation of natural forests and existing plantations throughout the country. All carvers confirmed their willingness to establishplantationsif it was economically possible,and the majority of them would prefer plantations of *G. arborea* and *T. grandis*. They argued that *G. arborea* is a rapid growth species that can produce wood for sale and personal use in a short period of time and *T. grandis*,according to carvers, is a resistant and good quality wood. They also mentioned the trade of *T. grandis* wood for income generation as the species is highly demanded in carpentry in Benin and more widely in region.Similarly to the present findings, carvers in Ghana indicated their willingness to use any type of wood provided the tools and equipment for processing them work well (Appiah-Kubi et al., 2014). The present findings also confirmed the results of McEwan et al. (2020) who stated that the factors influencing the form of plantation include the type and nature of the plantation owner, and the change in demand for different and new forest products.Forestry advisers and political leaders needto takesuchfindings into account to promote plantations and ensure a sustainable wood carving industry throughout the country.In addition, carvers should be provided with tools for plantation management.

Conclusion

Many skilled artisans in Benin depend upon wood carving for their livelihoods. A diversity of species are used in carving in Southern Benin, the most used species being *D. mespiliformis*, *C. excelsa*, *T. grandis* and *G. arborea*. *Gmelinaarborea* and *C. excelsa*had the highest Use Value. Wood carving impacts on forest fragmentation and there is a need to promote reforestation and plantation, and to provide carvers with tools for plantation management. Carvers indicated their willingness to contribute to species plantation and conservation.Thisinvestigation on woody species used in carving in Benin is a pioneer research project that should help to stimulate further researchon this activity. For instance, further research is required on the financial aspects of wood carving,and the assessment of the ecological and dendrometric characteristics of the most used species in carving in order to better monitor the impacts of this activity.

Declarations

Acknowledgments

Authors are grateful to Professor Phil Harris from University of Coventry (United Kingdom) who edited the first draft of this paper. Thanks are also due to all carvers who participated in this research.

NO CONFLICT OF INTEREST

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Tables

Table 1. Woody species used in carving and wood colour as described by wood carvers.

Scien*tific name*	*Local* name in Fon	Botanical family	Wood colour
Acacia auriculiformis A.Cunn. ex Benth., 1842	Acacia	Mimosaceae	Black
Afzelia africana Sm. & Pers., 1798	Abzélia	Caesalpiniaceae	Red
Artocarpus communis J.R.Forst. & G.Forst., 1775	Blêfoutoutin	Moraceae	Yellow
Azadirachta indica A.Juss., 1830	Kininetin	Meliaceae	Red
Chlorophora excelsa (Welw.) C.C.Berg, 1982	Lokotin	Moraceae	Yellow brown
Cocos nucifera L., 1753	Agonkêtin	Arecaceae	Red
Daniellia oliveri (Rolfe) Hutch. & Dalziel, 1928	Zatin	Caesalpinaceae	Red
Delonixregia (Bojer ex Hook.) Raf., 1837	Fontin	Caesalpinaceae	Ash
Diospyros mespiliformis Hochst. ex A.DC., 1844	Ebène	Ebenaceae	Black
Eucalyptus camaldulensis Dehnh., 1832	Ecalitus	Myrtaceae	Clear yellow
Gardenia erubescens Stapf & Hutch., 1909	Dakplatin	Rubiaceae	Yellow
Gmelina arborea Roxb. ex Sm., 1810	Mélina	Verbenacea	White
Khaya senegalensis (Desr.) A. Juss., 1830	Zounza	Meliaceae	Red
Mangifera indica L., 1753	Amangatin	Anacardiaceae	White
Newbouldia laevis (P. Beauv.) Seem., 1864	Désrêguêtin	Bignoniaceae	White
*Prosopis africana (Gull. &Perr.)*Taub., 1893	Kakêtin	Mimosaceae	Red
Pterocarpus erinaceus Poir., 1804	Kosso	Papilionaceae	Yellow
Rauvolfia vomitoria Afzel., 1817	Atêtin	Apocynaceae	White
Spondias monbin L. 1753	Akinkontin	Anacardiaceae	White
Tectona grandis L.f, 1782	Têkitin	Verbenaceae	Yellow
Terminalia catappaL. 1767	Kolatin	Combretaceae	Red
Zanthoxylum zanthoxyloides (Lam.) Zepern. & Timler, 1981	Hêtin	Rutaceae	Yellow

Table 2. Ranking of the species most used in carving

Species	Percentage of respondents ranking the species	
	Most used	Second most used
Diospyros mespiliformis Hochst. ex A.DC.	50	0
Chlorophora excelsa (Welw.) C.C.Berg.	42	0
Tectona grandis L.	0	50
Khaya senegalensis (Desr.) A. Juss.	8	8
Gmelina arborea Roxb. ex Sm.	0	17
Acacia auriculiformis A.Cunn. ex Benth.	0	8
Daniellia oliveri (Rolfe) Hutch. & Dalziel	0	8
Afzelia africana Sm. & Pers.	0	9

Table 3.Use Value of the four woods most used in carving.

Wood	Number of uses	Number of informants mentioning	Use Value
Diospyros mespiliformis Hochst. ex A.DC.	2	6	0.33
Chlorophora excelsa (Welw.) C.C.Berg.	4	5	0.80
Tectona grandis L.	3	6	0.50
Gmelina arborea Roxb. ex Sm.	3	2	1.50

Table 4. Causes of wood scarcity in recent years according to carvers

Cause	Percentage of informants
Destructions of forests and plantations for logging	58
International trade of wood	17
Political restrictions on local trade	17
Wood exploitation for charcoal production	8
Lack of plantations	8
Lack of plantations	8