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IDENTIFICATION AND INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN) STATUS OF WOOD SPECIES USED FOR CHARCOAL PRODUCTION IN AMUKPE AREA OF SAPELE LOCAL GOVERNMENT OF DELTA STATE, NIGERIA

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ABSTRACT

Exploitation of charcoal producing trees in Amukpe area of Sapele, Delta State Nigeria was assessed with a view to ascertaining the impact of such anthropogenic activity on tree species distribution and diversity in the forest of Amukpe area. Structured questionnaire guide on targeted respondents and field observation were used to collect data. A total of 80 respondents in the area were interviewed. Also, secondary information was obtained from 10 lumberjacks, the regular suppliers of logs to the site. Preferences of trees for charcoal production and their abundance status were determined by the information provided by the respondents. The species' status on the International Union for Conservation of Nature (IUCN) red list of threatened species scale ranged was compared. The results obtained showed forty-one (41) indigenous tree species belonging to thirteen (13) different families (majorly hardwood) as charcoal producing trees. Most of the tree species in Fabaceae family were highly preferred by the respondents as charcoal producing trees, and were placed in the medium and high categories of preference. Thus, majority of the tree species in this family where confirmed rare, occasional and frequent. Twenty-one (21) of the highly preferred charcoal tree species were by consensus considered as being rare. This is in line with the IUCN (2019) red list of threatened species. It was concluded that charcoal producing tree species in Amukpe area are now endangered and rare, and it is recommended that there is need for sustainable use of forest trees in Amukpe area of Sapele.

Keywords: Charcoal, Tree species, Preference, Respondents, Amukpe

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INTRODUCTION

Charcoal production is a means to harness heat energy in both urban and rural settlements. Charcoal is of serious interest to many households, as it is one of the most economical domestic energy options (Brobbey *et al*., 2019). Charcoal is defined as the solid residue derived when wood is carbonized under controlled conditions in an enclosed space, usually a charcoal kiln, where constraint is exercised over the inflow of air during the carbonization process such that the wood does not burn to ashes as in conventional fire, but rather decomposes to form charcoal (FAO 2010; Kayhan, 2013; Soyinka 2013). FAO (2009) estimated that approximately 1.5 billion people in developing countries obtained 90% of their energy requirement from fuel-wood and charcoal. Charcoal usefulness is influenced by: higher calorific value per unit weight than fuel wood, ease of transit and smokelessness as compare to fuel wood (Sherman 1982; FAO 2009).

Charcoal production activities are usually high in the tropics. According to Kayhan (2013), much of the wood charcoal produced globally comes from villages set in wooded countryside of tropical countries, and is usually made in traditional earth and pit kilns (Chidumayo and Gumbo 2013). While charcoal use persists as requirement for thermal energy source in grilling process among vendors of local convenience foods such as roast plantain and fish, beef barbecue, roast maize and yam in Delta State. The reliance on the product as energy source has since worsened in the last two decades owing to Nigeria's economic upheaval and continuous raise in the prices of fossil fuel. These states of affairs necessitated the dependent on charcoal and firewood as cheap substitutes for domestic energy among the masses. However, the growing demand for the product and its large-scale production in Delta State Nigeria is now a concern, due to its ecological consequences of threat of deforestation, land degradation and climate impact (Brieland, 2015 and SEI, 2002). A recent statistical data revealed that Nigeria is the second largest producers of wood charcoal after Brazil (Ghilardi and Steierer, 2011), one of the world's principal consumers of the product (Kammen and Lews, 2005); and the biggest supplier to Europe (TFT, 2015). Delta State is one of the key producers and supplier of wood charcoal (Alimba, 2004). In recent time, extraction pattern of tree species producing charcoal in Amukpe area of Sapele, Delta State is deteriorating the forest structure and its ecological balance. Therefore, assessment of the impact of the activity in Amukpe is necessary. To this end, the present study is aimed at determining tree species preference for charcoal production among charcoal producers inAmukpe charcoal production site, the abundance and rarity status of the trees in the area.

MATERIALS AND METHODS

Study Area

The study was conducted in a charcoal production siteat Amupke, a suburb of Sapele town in Sapele Local Government Area (LGA) of Delta State Nigeria. The area is tropical, with a projected human population of 240,000 by year 2016. Sapele is about 450 km^2 and lies within Long. 5.42^0 and 6.45^0E'; Lat. 5.52^0 and 6.3^0N'. It is a hub to oil and gas exploration, and also agricultural processing area: located in the region known as South-South geopolitical zone of Nigeria. Generally, the area is low-lying without remarkable cliffs, but lies close to the popular River Ethiope. And also interlaces with rivulets and streams, which are synonymous with other parts of Niger Delta Region (Anonymous, 2017). Sapele is ethnically diverse: Urhobo is the main ethnic group in the region, although other ethnics such as Isoko, Itsekiri, Ijaw and Anioma who are of the linguistic stocks of Delta State are denizen of the area, as well as people from other parts of Nigeria. English is the State's Official language, but Nigeria Pidgin English is widely spoken in the area.

Sampling Strategies and Data Collection

Sampling procedure involving structured questionnaire guide on targeted respondentsand field observation after Gary (1995) were used to collect data. The major charcoal production site by Amukpe junction Sapele was selected for the study. A total of eighty (80) respondents who had been in the industry for a period not less than 10years, and are full time charcoal producers were selected and interviewed with the aid of questionnaire guide with respective to their knowledge of tree species used for charcoal productions. Secondary information was obtained from 10 lumberjacks. Also, group interviews were held at the sites relating to group consensus for the absent of conflict to be taken as equilibrium. Meanwhile, vernacular names of the trees mentioned by the respondents were confirmed and compared with floras of the region including those of Hutchinson and Dalziel (2014) and Aigbokhan (2014). Preference of the tree species used for charcoal by the respondents were confirmed from the information provided at the group interviews conducted in the production site, while the Abundant Status was established from the interview held with ten lumberjacks, the regular supplier of log to the site.

The abundant status of the species was established based on the time it would take to sight the species from the production site to the forest estates within the LGA. Species encountered in less than 1hour (<1hour) is considered abundant; those that would take

between 1-23 hours as frequent; those that would take between 1- 3days as occasional, and those that would take more than 3days as rare (Bongers*et al*., 1988).

RESULTS

The Socio-economic status of the respondents at the production site is presented in Table 1. The respondents, full time charcoal producers had been in the industry for not less than 10 years and had maintained a continuous domicile in Amukpe for a period of 15years in the Local Government Area (LGA). Seventy-seven percent (77%) of the respondents interviewed were female while twenty-three percent (23%) were male. The literacy status of the respondents showed that 92% where literate while 8% were illiterate. Ten percent (10%) of the respondents were <20 years, 77% belonged to the middle age class considered as the working class and 79% of the respondents were married. Variation was observed in the economic status of the respondents as volume and quality of charcoal produced influenced the economic status of the respondents; however, the majority (60%) falls within the average economic category (Table 1).

Table1: Socio-economic Status of the charcoal producers at the major charcoal production site in Amukpe

Description	Indicators											
	Sex		Age			Marital Status		Literacy Status		Economic Status		
	Male	Female	<20	20-60	>60	Married	Unmarried	Literate	Illiterate	Small	Medium	Large
Respondents Profile (%)	23	77	10	77	13	79	21	92	8	31	60	9

Forty-one (41) tree species belonged to 13 families were identified in the production site. The species were categorized based on the level of their preference for charcoal production (among the respondents) into high, medium and low level of preference. Twenty-four (24) of the tree species identified were highly preferred for charcoal production by the respondents. Eight of those belonged to family Fabaceae, two each belonged to Meliaceae and Ochnaceae families respectively, while one each belonged to Moraceae, Myristicaceae, Rosaceae, Myrtaceae, Ulmaceae and Rubiaceae families respectively (Table 2).

In the same vein, three each belonged to Sapotaceae and Phyllanthaceae families respectively. Conversely, those that were of medium preference were fifteen (15) tree species. Of those, seven belonged to Fabaceae family; two each belonged to Rhizophoraceae, Malvaceae and Moraceae families respectively while one each belonged to Phyllanthaceae and Irvingiaceae respectively (Table 2). On the other hand, the charcoal producing trees with low preference among the respondents were *Rhizophora mangle* and *Swartzia fistuloides* which belonged to Rhizophoraceae and Fabaceae families respectively (Table 2).

The Species identified and accessed as charcoal producing trees inAmukpe area are shown in Table 2.Among the charcoal producing trees assessed, *Albizia coriaria, Albizia zygia, Cola laurifolia, Irvingia gabonensis, Rhizophora mangle, Rhizophora racemosa, Treculia africana, Uapaca guineensis, Uapa castaudtii* and *Uapa caheudelotii* were abundant; while *Bobgunniafistuloides, Brachystegia nigerica, Erythrophleumivorense, Erythrophleum sauveolen, Haplormosia monophylla, Khaya senegalensis, Lophira lanceolata, Milici aexcelsa, Nauclea diderrichii, Pachystela brevipes, Prosopis africana, Prunus Africana, Synsepa lumafzelii, Synsepa lumstipulatum* and *Tremaorientalis* were rare. Conversely, *Albizia adianthifolia, Antides mavogelianum, Berlinia cogolensis, Brachystegia spiciformis, Distemonanthus benthamianus, Ficus sycomorus, Swartzia fistuloides* and *Syzgium guineense* were frequent among the charcoal producing trees (Table 2). Those occasionally found were *Anopyxis klaineana, Berlinia grandiflora, Entandrophra gmacylindricum, Lophiraalata, Nesogordonia papaverifera, Pentaclethra macrophylla, Piptadenia strumafricanum and Pynanthus angolensis.*

While the entire species listed in Table 2 were reportedly used for charcoal production, yet preference of tree species for charcoal production abound. Species with High 'Preference Status' (PS) were considered as best for charcoal production, and were rated as the most desirable by the respondents.

Table 2: Preferences and abundant status of tree species identified as charcoal producing tree among the respondents

S/N	Charcoal Producing trees	Family	Vernacular/ Common Name	*PS	**AS
1.	*Albizia adianthifolia* (Schumach)		Cream Albizia	Medium	Frequent
2.	*Albizia coriaria* (Weiw.)		Albizia, Mugavu	Medium	Abundant
3.	*Albiziazygia* (DC) J.F. Macbr.		Albizia, Okoru	Medium	"
4.	*Berlinia cogolensis* (Baker f.)		Berlinia	Medium	Frequent
5.	*Berlinia grandiflora* (Vahl)		Berlinia, Red oak	Medium	Occasional
6.	*Bobgunnia fistuloides* (Harms)		Oken	Mediun	Rare
7.	*Brachystegia nigerica* (Hoyle & J.)	Fabaceae	Okwen	High	"
8.	*Brachystegia spiciformis* (Benth.)		Okwen, Achi	High	Frequent
9.	*Distemonanthus benthamianus* (Baill.)		Satinwod, Ayan	Medium	Frequent
10.	*Erythrophleum ivorense*(A. Chev.)		Erun, Sasswood	High	Rare
11.	*Erythrophleum sauveolen* (G. & B.)		Sasswood	High	Rare
12.	*Haplormosia monophylla* (Harms.)		Akoti	High	Rare
13.	*Piptadenia strumafricanum* (Hook. f)		Ohen, Africa oak	High	Occasional
14.	*Prosopis africana* (Guill. &Perr.)		Iron wood, Okpei	High	Rare
15.	Swartzia fistuloides (Harms)		Akite	Low	Frequent
16.	*Pentaclethra macrophylla* (Benth.)		African oil bean, Ugba	High	Occasional
17.	*Irvingia gabonensis* (Baill.)	Irvingiaceae	Ogbono,	Medium	Abundant
18.	*Cola laurifolia* (Mast.)	Malvaceae	Laurel Cola, Ufau	Medium	Abundant
19.	*Nesogordonia papaverifera* (A. Ch.)		Redwood, Danta	Medium	Occasional
20.	*Entandrophragma cylindricum*(Sprague)		Sapele Mahogany, Cedar	High	Occasional
21.	*Khaya senegalensis* (A. Juss.)	Meliaceae	Okpe,	High	Rare
22.	*Ficus sycomorus* (L.)		Mulberry	Medium	Frequent
23.	*Milicia excelsa* (Welw.)		Iroko	High	Rare
24.	*Treculia africana* (Decne.)		Ukwa	Medium	Abundant
25.	*Pynanthusangolensis* (Welw.)	Myristicaceae	Akomu, False nutmeg	High	Occasional
26.	*Syzgiumguineense* (Hochst.)	Myrtaceae	Water Berry	High	Frequent
27.	*Lophiraalata* (Banks ex)	Ochnaceae	Eki, Azobe, Red iron	High	Occasional
28.	*Lophira lanceolata* (Tiegh.)		Dwarf red ironwood	High	Rare
29.	*Antidesma vogelianum* (Mull Arg.)	Phyllanthacea e	Currant tree, Ingolongolo	Medium	Frequent
30.	*Uapaca guineensis* (Mull. Arg)		Red Cedar, Uapaca	"	Abundant
31.	*Uapaca staudtii* (Pax)		Uapaca, Oyen	"	"
32.	*Uapaca heudelotii* (Baill.)		Oven, Otehor	"	"
33.	*Anopyxis klaineana* (Pierre) Engl	Rhizophoracea e	White Oak	Medium	Occasional
34.	*Rhizophora mangle* (L.)		Mangrove	Low	Abundant
35.	*Rhizophora racemosa* (R. Br.)		Red mangrove	Medium	"
36.	*Prunus africana* (Hook. f.)	Rosaceae	Bitter almond	High	Rare
37.	*Nauclea diderrichii* (De W. & Dur.)	Rubiace	Opepe, Bilinga	High	Rare
38.	*Pachystela brevipes* (Baker)	Sapotaceae	Azimomo, Udala	High	Rare
39.	*Synsepa lumafzelii* (Engl.)		Azimomo	High	Rare
40.	*Synsepa lumstipulatum* (Engl.)		Charcoal wood, Azimomo	High	Rare
41.	*Trema orientalis* (L.)	Ulmaceae	Charcoal Tree, Trema	High	Rare
Total	**41**	**13**			

**Preference Status **Abundant Status*

Twenty-one (21) trees were considered as highly preferred charcoal producing tree species by the respondents. Most of the species were considered rare in abundant by the charcoal producers. The said trees status and categories on the International Union for Conservation of Nature (IUCN) red list of threaten species is presented in Table 3.

Table 3: Charcoal Producing Trees with High Preference and their IUCN Status

S/No	Charcoal Producing Trees with High Preference	Status	* Category on IUCN Red List of Threaten Species
1.	*Brachystegia nigerica*	Decreasing	Vulnerable
2.	*Brachystegia spiciformis*	Stable	Least Concern
3.	*E. cylindricum*	Decreasing	Vulnerable
4.	*Erythrophleum ivorense*	Stable	Least Concern
5.	*Erythrophleum sauveolen*	Stable	"
6.	*Haplormosia monophylla*	Decreasing	Vulnerable
7.	*Khaya senegalensis*	Decreasing	"
8.	*Lophira alata*	Decreasing	"
9.	*Lophira lanceolata*	Stable	Least Concern
10.	*Milicia excelsa*	Lower Risk	Near threatened
11.	*Nauclea diderrichii*	Decreasing	Vulnerable
12.	*Pachystela brevipes*	Stable	Least concern
13.	*Pentaclethra macrophylla*	Stable	"
14.	*Piptadeniastrum africanum*	Stable	"
15.	*Prosopis africana*	Stable	"
16.	*Prunus africana*	Decreasing	Vulnerable
17.	*Pynanthus angolensis*	Stable	Least concern
18.	*Synsepalum afzelii*	Stable	"
19.	*Synsepalum stipulatum*	Stable	"
20.	*Syzgium guineense*	Stable	"
21.	*Trema orientalis*	Stable	"
			Source: www.iucnredlist.org

DISCUSSION

The understanding that hardwoods make good charcoal is widespread among the respondents, as they were able to identify the tree species by mere observation. Respondents less than 20 years were also familiar with the species used for charcoal production, an indication that socio-economic status was not entirely a prerequisite for knowledge on charcoal producing trees. Besides, the wealthiest among the respondents were the main producers of hardwood charcoal. While charcoal producing trees were categorizedinto high, medium and low preference levels,base on the quality of charcoal produced of them. Trees species that are members of the same family tends to exhibit similar properties, and this may account for the high preferential use of species belonging to a particular family for charcoal production.The highly preferred trees for charcoal were mainly hard wood. Such species contain incendiary substances, easy to light, and burn with even intense heat for a long time due toits high calorific value (Burnham and Johnson, 2004; Ihinmikaiye *et al*., 2019).

In the light of the foregoing, it is inferable to assert that members of Fabaceae family were the most prevalence tree species for charcoal production, and were in the categories of high and medium level of preference in Amukpe. Besides being hardwood, they are widely distributed in terms of species number. This is in line with the previous assertion of Burnham and Johnson (2004) who reported that Fabaceae is the dominant among tree families in tropical rainforests. Species preferred for charcoal production are increasingly becoming rare in abundant within the forest estate, advertence to increasing the risk factor for tree species diversity loss. Previous findings of Felton *et al*. (2019); Ihinmikaiye and Unanaonwi (2018); Kayode *et al*. (2019) asserted that the extraction pattern and use generally increases toward tree species with desired qualities, however if those were difficult

to find within the forest stand; then species use may drift towards taxa with low grade, being more readily available. Meanwhile 21 of the charcoal producing tree species were by the respondents' consensus considered as confirmed rare (Table 3), their status were in line with the International Union for Conservation of Nature (IUCN) red list of threaten species scale ranged from vulnerable to near extinction (IUCN 2019). Whereas, some were rated as 'list concern' or unrated altogether on the scale; but were alluded to as rare species by the charcoal producers, who were always incessant in their search for the species considered requisites for quality charcoal production.

Many plant species in the Niger Delta region lack extinction risk assessments, limiting the ability to identify conservation priorities (Stevart*et al*., 2019). Although charcoal production may not be considered a vehicle for tree species diversity loss on a global scale, yet it may be viewed as threat to indigenous tree species diversity, because trees extracted for charcoal reduce ecosystem integrity being at variance with the maintenance of ecological balance. Therefore, the continuous operation of charcoal industry is unsustainable ecologically, as charcoal production are species specific and usually results in the disappearance of choice trees, with a concomitant effect on forest structure and dynamics across space and time (Chiteculo and Surovy, 2018).Further compounding the problem is the dependent on indigenous trees for lumber and fire-wood production. At present, most of the tree species supplies to the site were of average and low ranks. When these are not available, makeshift is supplied since the usual charcoal species are now endangered.

CONCLUSION

Although charcoal use serves as cheap source of domestic energy for the masses; the act of harvesting specific trees for charcoal production creates sparse distribution of trees within the forest estate;because forest structure and dynamics are alteredmainly byanthropogenic disturbance and the level of interactions among species. This scenario affects the overall tree species diversity leaving a forest ecosystem characterized by herbaceous cover behind.Furthermore,many of the tree species status is in line with the IUCN red list of threaten species, confirming that selective logging of tree species for charcoal production in the Amukpe area reduces the abundant status of specific species to the point of local extinction. Thus,further research should focus on annual charcoal production curves and on the volume of charcoal produce from different tree species in the production site.

RECOMMENDATIONS

There is the need for sustainable use of forest trees in Amukpe area of Sapele and the entire Delta State. Therefore, conservation plans that would save the current situation are suggested thus: Government agencies and policy makers should see to the need for reduced risk associated with indiscriminate forest tree extraction, reforestation programs should be intensified, sawmill off cuts should rather be fostered for charcoal production, research and development of indigenous rare species should be prioritized by relevant government agents. On the whole, the government of Delta State should enforce strict measures to checkmate tree felling a major anthropogenic activity on the forest ecosystem in Amukpe area of Sapele, Delta State.

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Authors' contributions

Ihinmikaiye, S.O and Otoide, J.E carried out the field research and prepared the initial manuscript draft. Ochekwu, E.B. confirmed the timber species determination. The final manuscript was read and approved by the authors.The authors have no conflict of interest to declare, and did not received any monetary support.

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