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Use of *Acacia auriculiformis* fast-growing tree species for the mitigation of climate change

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TECHNOLOGY OF FOREST PRODUCTS

ABSTRACT

Background: In the face of increasing wood demand in climate change context, fast-growing species are considered as a current solution. However, the ability of fast-growing species in agroforestry systems to contribute to bridging the gap between wood demand and supply and climate change mitigation also depends on the properties of the species, which vary based on locality. The objective of this study was to evaluate the potential of *Acacia auriculiformis* A. Cunningham ex Benth. wood in Benin to contribute to climate change mitigation while sustainably supplying wood. Tissues proportion (Vessels, ray parenchyma, axial parenchyma, fibers), in the wood; fiber parameters (length, diameter and lumen width); organic carbon content and natural durability of *A. auriculiformis* wood to termite (*Macrotermes bellicosus)* were determined.

Results: The results indicate that the species has a high proportion of fibers (58%), which are quite long (1 mm to 4 mm), an organic carbon content of 35%, and is moderately durable to very durable against termite infestations.

Conclusion: The species, thus, has strong potential for wood (high fiber content, high fiber length, greater durability), renewable bioenergy (good fiber length) and pulp (high fiber content) and could be valued to supplement the wood supply from natural forest and contribute to mitigating the effect of climate change (carbon sequestration and limitation of pressure on natural forests).

Key words: Anatomical characteristics; natural durability; organic carbon content; sustainable wood demand, timber industry

HIGHLIGHTS

A. auriculiformis wood content 35% of organic carbon.
The species wood has a high proportion of fibers (58%), which are quite long (1 to 4 mm).
The wood is moderately durable to very durable against termite infestations.
A. auriculiformis, fast-growing species can contribute in climate change mitigation through REDD+, agroforestry, plantations, carbon sales.

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INTRODUCTION

Climate change is one of the current challenges in forest development and natural resource management (Leal Filho et al., 2021; Thuiller et al., 2011). The lack of monitoring implies unfavourable consequences on forest biodiversity such as the survival of certain species of natural forest (Jinga and Ashley, 2019). Mitigation actions involve all the processes aimed at reducing the impacts of climate change on the environment such as the protection of wooded areas, the reduction of the carbon rate in nature and the establishment of plantations to supply wood products (Guerra-De la Cruz and Galicia, 2017; Karoshi and Nadagoudar, 2012; Maiti et al., 2019) and therefore also increasing above- and belowground carbon pools. In the context of climate change, monospecific plantations might become an alternative to mitigate global warming; however, their contribution to the structural complexity, complementarity, and biodiversity of forests has not been addressed. Mixed forest plantations can ensure that objectives of climate change mitigation are met through carbon sequestration, while also delivering anticipated ecosystem services (e.g., nutrient cycling, erosion control, and wildlife habitat. Fast-growing tree species are one of the solution to resolve the diminishing wood resources and contribute to the mitigation of climate change effects (Liao et al., 2010; Zhang et al., 2021)using a meta-analysis approach, to quantify the differences in ecosystem C pools between plantations and their corresponding adjacent primary and secondary forests (naural forests).

For decades, fast growing tree species have been promising for sustainable forest use and, to reduce the gap between wood demand and supply (Adi et al., 2014; Dumitrascu et al., 2020). Several of them are multipurpose tree species with a high adaptation capability to wide ecological conditions, well-controlled silviculture, and high yield (Adi et al., 2014; Kiaei, 2011).

The ability of fast-growing tree species to both provide sustainable wood and effectively contribute to climate change mitigation varies between region and tree species (Adi et al., 2014). In the context of climate mitigation, one need to remove atmospheric carbon dioxide (CO_2) and, tree play an important role (Zeng and Hausmann, 2022). Trees absorb CO_2 from the atmosphere and store it in their biomass. Fast-growing trees have a higher rate of carbon sequestration compared to slow-growing trees, which means they can store more carbon in a shorter amount of time. Their contribution to carbon neutrality can be appreciated through the rate of carbon sequestered, the natural resistance of the wood against attacks, and the tree's ability to provide good wood quality (Adi et al., 2014; Jusoh et al., 2014; Karoshi and Nadagoudar, 2012).

Acacia auriculiformis is a fast-growing forest tree species used in plantations in Asia and West Africa countries including Benin, Ivory Coast, Togo and Nigeria. It is widely used in agroforestry systems and on degraded habitats to restore soil fertility, as well as to provide the necessary ecosystem services and wood for energy and construction (Fonton et al., 2002; Tonouéwa et al., 2019). *Acacia auriculiformis* wood is available (Tonouéwa et al., 2020a) and can be easily accessed in Benin (Tonouéwa et al., 2020a). The tree has a fast-growing rate of 2.4 cm/year in diameter at 6 years old (Tonouéwa et al., 2019) and high physico-mechanical characteristics (Tonouéwa et al., 2020b).

The anatomical properties of wood, mainly identified through the proportions of tissues, the characteristics of the fibers make it possible to predict the potential uses of *A. auriculiformis* as construction and furniture timber (Istikowati et al., 2016; Pereira et al., 2021; Pirralho et al., 2014). The fibers ensure the wood's rigidity. However, these properties are generally influenced by factors such as the age of the tree (Angélico et al., 2021). The present work is focused on the quantification of the level of carbon sequestered by this wood species, its resistance to termite attacks and its anatomical properties (tissue proportions, fiber parameters) in relation to plant age to better understand the capacity of the species to supply wood and the different scenarios of use that this wood can be destined. The research hypothesis is that: a high carbon rate, interesting anatomical properties and high natural durability of *A. auriculiformis* wood would allow the promotion of *A. auriculiformis* plantations to meet the demand for wood and for the mitigation of climate change.

MATERIAL AND METHODS

Study area and wood material

The *Acacia auriculiformis* woods tested in this study were selected from pure plantations of the species established in Southern Benin by firewood project phase I and II in Lama, Semè-kpodji, Pahou and Ouedo (PBF 1999; PBF2 2010a, 2010b, 2010c). The plantation is located between 6° 22'to 6° 54'N and 2°05'to 2° 43' E with 1100 mm mean annual precipitation and 27 °C average temperature. *Acacia auriculiformis* plantations from 4 to 29 years old were sampled. Table 1 presents the characteristics of the selected plantations. The wood samples were collected from the heartwood of the selected trees.

Table 1: Characteristics of *Acacia auriculiformis* plantations trees selected for the study.

	Young plantations					Middle-aged plantations			Aged plantations		
zone	**Ouedo**			**Pahou**	**Lama**	**Pahou**	**Lama**		**Pahou**	**Sèmè-Kpodji**	
Soil	**ferra**			**ferru**	**vertisol**	**ferru**	**vertisol**		**ferru**	**sandy**	
Age (years)	4	5	6	6	7	9	9	11	15	27	29
Tree (number)	3	3	3	3	3	3	3	3	3	3	3

ferra = ferralitic soil; ferru = ferruginous soil.

Wood properties of *A. auriculiformis* tree species

The wood properties assessed were the anatomical characteristics (tissues proportion and fibers parameters) (IAWA, 1989), natural durability against termites (Antwi-Boasiako et al., 2017), and carbon content (Heanes, 1984; Nelson and Sommers, 1983).

Tissues proportion

Preparation of three thin strips of wood for measurement of tissue proportion

A total of 24 small cubes (2cm) were cut from the heartwood of *A. auriculiformis* and placed in small jars filled with labelled water. The cubes were taken from trees aged between 6 and 29 years old (Table 1). The cubes stayed in the water for 21 days. The wooden cubes were put in a solution of 50% ethanol and 50% glycerol. Three to five thin sections measuring 15-25 µm were cut from the transverse/cross, radial and tangential sections of each cube using a microtome. The sections were prepared following the standardized process (Schweingruber, 2007; Tardif and Conciatori, 2015).

Measurements of Tissue proportion

The slides were observed under a microscope and micrographs were taken at 40 × magnification at a resolution of 1600 × 1200 pixels. Using image J software with 24 scale points (Area per point = $90000 \mu m^2$), the proportion of tissues was counted in each photo. The proportion of tissues (Vessels, ray parenchyma, axial parenchyma, fibers) in the wood was determined by counting the number of points per tissue (IAWA, 1989).

Fibers parameters

A total of 53 samples (sticks) taken from the heartwood of trees aged 4 to 29 years (Table 1) were used for the measurement of fiber parameters. The characteristics of the wood fibers were determined from macerated samples. A complete maceration was arrived by allowing matchstick sized samples to stand in Franklin's solution: 50% glacial acetic acid + 50% hydrogen peroxide followed by heating at 65 °C for 5 days. The macerated specimen was rinsed with distilled water and mildly teased apart in glycerine on a glass slide using fine needles. Some amount of fiber suspension was placed on a standard glass slide with a dropper. The length, diameter and lumen width of the fibers were measured using microscope with an AmScope digital camera connected to a laptop. The objective lens of 40x was used for measuring the fiber's diameter and the lumen's diameter. The fiber's length was determined with 10x lens. A total of 25 fibers were measured according to IAWA (1989) standard. The Runkel [1] and Slenderness ratio [2] of the fibers were also calculated.

$$\textit{Runkel ratio} = \frac{\text{fiber diameter} - \text{fiber lumen width}}{\text{fiber lumen width}} \qquad (1)$$

$$\textit{Slenderness ratio} = \frac{\text{fiber lenth}}{\text{fiber diameter}} \qquad (2)$$

Organic carbon content

The organic carbon content in the *A auriculiformis* wood was determined by Walkley – black wet oxidation method (Heanes 1984; Nelson and Sommers 1983). The wood samples (63 samples) from trees between 4 to 29 years old (Table 1) were used. The carbon content (% C) was determined from the following equation [3]. Where: M = Molarity of $FeSO_4$; V_{bl} = ml $FeSO_4$ of blank titration; V_s = ml $FeSO_4$ of sample titration = mass of sample taken in gram; 0.003 = milli-equivalent weight of C in grams (12/4000); 1.33 = correction factor used to convert the Wet combustion C value to the true C value since the Wet combustion method is about 75 % efficient in estimating C value, (i.e. 100/75 = 1.33).

$$\%C = \frac{M \times \langle V_{bl} - V_s \rangle \times 0\cdot 003 \times 1\cdot 33 \times 100}{g} \qquad (3)$$

Natural durability

The natural durability of *A. auriculiformis* wood was investigated through an accelerated field test for 6 months. The wood samples (400mm×40mm×20mm) were labelled and air-dried at 7% moisture content. These samples were buried near a termite mound (*Macrotermes bellicosus*). Half of the sample was sunk into the ground. The wood samples were arranged on the ground 50 cm apart using a completely randomized design (Figure 1a). The wood remained in the ground next to the termite mound under the effect of the weather (rain, temperature, wind, etc.) at the experimental station of the Faculty of Renewable Natural Resources / KNUST (Kumasi/Ghana). At this station, there is soil with a pH of 5 - 6.5, low organic matter content (25.3g/Kg), with altered water regimes (Nero and Anning, 2018; Owusu, 2009). The climate is humid and dry with relatively constant temperatures and rainfall (around 1400 mm/year with 2 rainy seasons: a longer season from March to July and a shorter one from September to November) throughout the year (Owusu, 2009). After six months of stay in the ground, the stakes were removed from the ground, and all debris and sand were removed. The wood was dried at 103 °C and then weighed (Figure 1b), to calculate the loss of mass (X). The equation [4] and [5] was used (BS EN 252, 2014). Where MSS= dry mass of the stakes before burial in the ground; MSF = dry mass after staying in the termite mound; X (%) was related to natural durability ratings: 41–100%= non-durable, 11–40% = moderate durable, 6–10% = durable, 0–5% = very durable (BS EN 252, 2014).

Figure 1: The stakes of *A. auriculiformis* wood in ground near to termite mound (a), the stakes removed from the ground and dried (b).

$$X = \frac{MSS - MSF}{MSS} \tag{4}$$

$$MSS = \frac{100 * Freshweight\ of\ sample}{100 + moisture\ content\ of\ sample} \tag{5}$$

(Antwi-Boasiako and Pitman)

Data analyses

The mean and standard deviation of tissue proportion, fibers parameters, and organic carbon content per age were calculated with the R 4.1 software. A mean comparison of data according to age was performed with a P-value of 1%. Then, a pairwise test was used for comparison of the mean (Tables 3 and 5). The P-value shows the significant difference between the wood characteristics of *A. auriculiformis* wood according to age (Pairwise comparison).

RESULTS

Tissues proportion of *Acacia auriculiformis* wood

Tissues proportion (vessels, fibers, axial parenchyma) of *Acacia auriculiformis* (Figure 2) slightly vary between ages (P-value = 0.01) (Table 2). The proportion of parenchyma rays is similar between ages (P-value = 0.303). Globally the tissue proportion of *A. auriculiformis* wood is on average of 12% for vessels (range 8 to 15%), 58% for fibers (range 54 to 64%), 18% for ray parenchyma (variation between 15 and 21%) and 12% of axial parenchyma (variation between 8 and 15%) (Table 2). Table 3 shows in general the absence of significant difference in tissues proportion of *A. auriculiformis* wood of different ages (P-value ≥0.05), although some minor variations are observed in fiber, vessel, and axial parenchyma proportions respectively between 11 and 15 years trees (P-value = 0.0067), 7 and 11 years trees (P-value = 0.043), and 15 and 27 years trees respectively (P-value = 0.0045) (Table 3).

Fiber parameters and organic carbon content of *A. auriculiformis* wood

The fibers observed with a microscope show a length between 1 mm to 4 mm with a mean of 2.5 mm (Figure 3). The fiber diameter varies from 19 to 209 µm (mean = 55 µm) and the lumen width is between 2 and 123 µm (mean = 28 µm).

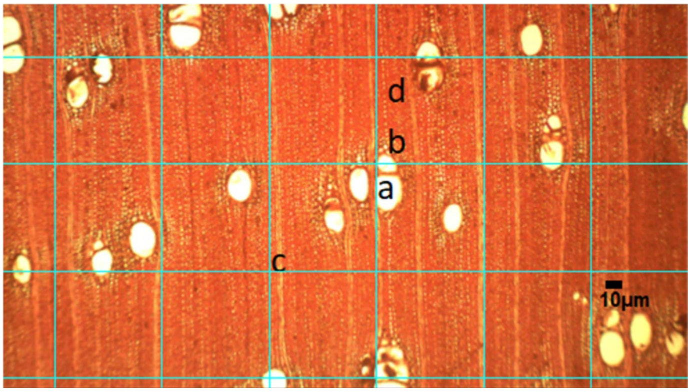

Figure 2: A micrograph (1771.3 µm x 1328.5µm) of *Acacia auriculiformis* used for tissue proportion determination. Vessel (a), axial parenchyma (b), parenchyma ray (c) and fiber (d) of *A. auriculiformis* wood: transversal section.

Table 2: Tissues proportion of *A. auriculiformis* wood according to age.

	Vessels (%)		Fibers (%)		Parenchyma Ray (%)		Axial parenchyma (%)	
Age (years)	**mean**	**sd**	**mean**	**sd**	**mean**	**sd**	**mean**	**sd**
6	11	7	58	8	18	9	13	7
7	8	8	59	10	18	9	13	9
9	11	8	59	9	18	10	11	6
11	15	8	54	12	21	10	11	6
15	13	7	64	10	15	11	8	6
27	10	10	54	17	18	11	15	6
29	10	7	60	14	19	13	11	7
P-value	0.01*		0.01*		0.303ns		0.01*	

sd = standard deviation, *Significant difference at the 5% level, ns=non-significant difference.

Table 3: Results of the pairwise comparison of the tissues proportion of *A. auriculiformis* wood of different ages.

	Age (years)	6	7	9	11	15	27
Fibers	7	1.0000	-	-	-	-	-
	9	1.0000	1.0000	-	-	-	-
	11	1.0000	1.0000	1.0000	-	-	-
	15	0.1582	0.7475	0.5058	0.0067	-	-
	27	1.0000	1.0000	1.0000	1.0000	0.1967	-
	29	1.0000	1.0000	1.0000	0.7457	1.0000	1.0000
Vessels	7	1.000	-	-	-	-	-
	9	1.000	1.000	-	-	-	-
	11	0.688	0.043	0.818	-	-	-
	15	1.000	0.584	1.000	1.000	-	-
	27	1.000	1.000	1.000	0.187	1.000	-
	29	1.000	1.000	1.000	0.129	0.911	1.000
Axial parenchyma	7	1.0000	-	-	-	-	-
	9	1.0000	1.0000	-	-	-	-
	11	1.0000	1.0000	1.0000	-	-	-
	15	0.1548	1.0000	1.0000	1.0000	-	-
	27	1.0000	1.0000	0.5555	0.1048	0.0045	-
	29	1.0000	1.0000	1.0000	1.0000	1.0000	0.6713

P-value ≥ 0.05, non-significant difference.

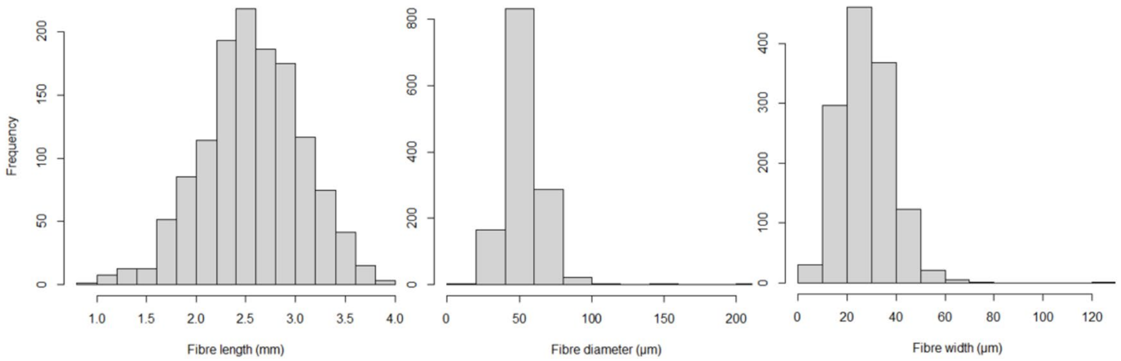

Figure 3: Fiber parameters (length, diameter and lumen width in µm) of *A. auriculiformis* wood.

The fiber parameters (fiber length, fiber diameter, fiber lumen width) and the derived indices (Runkel ratio, Slenderness ratio) of *A. auriculiformis* wood significantly increase with the tree's age (Table 4). At 7 years old, the fiber's length is already high. The fiber's length varies significantly between 4 and 7 years, but is similar between 7 and 29 years old (Table 5). The Runkel ratio and Slenderness ratio increase with the age of the wood. The Runkel ratio is between 0.87 to 1.55. It becomes higher (≥1.5) after 15 years old. Likewise, the slenderness ratio is between 38 and 61. It becomes very high from 15 years old (≥52) (Tables 4 and 5).

Table 4: Fiber parameters (length, diameter, lumen width) and organic carbon rate (per cent O.C) of *A. auriculiformis* wood as a function of tree age.

Age (years)	Length (mm)		Diameter (μm)		Width (μm)		Runkel ratio		Slenderness ratio		Per cent O.C (%)	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
4	2.0	0.4	57.1	20.9	32.5	13.7	0.87	0.57	38.13	12.81	34.2	3.5
5	2.3	0.4	50.2	10.8	26.2	9.5	1.09	0.72	47.40	14.09	37.3	2.0
6	2.4	0.5	53.5	11.2	29.5	9.9	1.09	1.73	46.99	12.73	35.7	1.3
7	2.7	0.5	56.8	10.1	32.1	8.5	0.84	0.35	49.88	15.35	34.7	1.2
9	2.7	0.4	53.9	11.7	29.6	10.3	0.99	0.64	51.66	13.27	34.3	2.2
11	2.7	0.4	56.1	10.4	29.4	9.3	1.16	1.28	49.12	11.90	34.6	2.3
15	2.9	0.4	50.8	11.8	24.7	10.3	1.34	0.90	60.90	15.19	36.0	1.4
27	2.7	0.4	49.1	11.1	22.3	9.4	1.51	1.28	58.08	15.12	35.2	1.1
29	2.6	0.3	50.9	9.1	21.7	7.0	1.55	0.89	53.38	10.87	33.7	2.2
P-value	0.000***		0.000***		0.000***		0.000***		0.000***		0.219ns	

sd = standard deviation, ***Significance difference at the 0.01% level, ns=non-significant difference.

Table 5: Results of the pairwise comparison of the fiber length, Runkel ratio and Slenderness ratio of *A. auriculiformis* wood.

	Age (years)	4	5	6	7	9	11	15	27
Fibers Length	5	6.5e-05	-	-	-	-	-	-	-
	6	8.8e-15	0.00913	-	-	-	-	-	-
	7	2.5e-15	2.6e-07	0.00017	-	-	-	-	-
	9	2,00E-16	7.6e-12	2.6e-05	0.89326	-	-	-	-
	11	2,00E-16	3.2e-11	2.3e-05	1.00000	1.00000	-	-	-
	15	2,00E-16	2E-16	2,00E-16	0.05520	4.7e-09	2.7e-07	-	-
	27	2,00E-16	1.1e-13	2.2e-08	1.00000	0.89326	1.00000	5.9e-05	-
	29	2,00E-16	2.1e-08	0.00246	0.85161	1.00000	1.00000	4.5e-06	1.00000
Runkel ratio	5	0.04261	-	-	-	-	-	-	-
	6	1.00000	0.10846	-	-	-	-	-	-
	7	1.00000	0.26898	1.00000	-	-	-	-	-
	9	0.66983	1.00000	1.00000	1.00000	-	-	-	-
	11	0.38873	1.00000	0.45299	1.00000	1.00000	-	-	-
	15	1.8e-07	0.34268	3.4e-07	3.4e-05	8.3e-05	0.00126	-	-
	27	3.1e-13	0.00037	1.4e-13	2.2e-09	1.9e-10	1.8e-07	0.49268	-
	29	1.6e-11	7.4e-05	2.5e-10	8.5e-10	5.3e-09	2.6e-07	0.07499	1.00000
Slenderness ratio	5	1.8e-05	-	-	-	-	-	-	-
	6	1.4e-09	1.00000	-	-	-	-	-	-
	7	5.8e-07	1.00000	1.00000	-	-	-	-	-
	9	2.9e-16	0.04321	0.00236	1.00000	-	-	-	-
	11	6.6e-12	0.77317	0.58722	1.00000	0.78319	-	-	-
	15	2E-16	9.5e-11	2E-16	5.4e-06	1.1e-06	2.5e-10	-	-
	27	2E-16	7.3e-09	2.9e-16	0.00020	0.00010	3.5e-08	1.00000	-
	29	4.1e-15	0.00285	0.00032	0.58722	1.00000	0.10857	0.00442	0.06406

P-value ≥ 0.05, non-significant difference.

There was no significant difference between the organic carbon content according to the wood age (Table 4). The average carbon content in *A. auriculiformis* wood is 35% (ranges between 33 and 37%).

Natural durability of *A. auriculiformis* wood to termite damages

There was no significant difference between the natural durability of *A. auriculiformis* wood of different ages (P-value = 0.4029). Even at a young age, the natural durability of *A. auriculiformis* wood is good. The proportion of very durable and durable wood is similar across age classes (Table 6). In total, 51%, 21% 10% and 18% of the wood samples studied present very high, high, moderate and low durability respectively (Table 6). *A. auriculiformis* wood samples studied have a median of natural durability of 4.9% (wood very durable) and a mean of 22.7% (moderately-durable).

Table 6: Variation in the proportion (%) of wood samples (very durable to non-durable) in relation with age of the wood (%).

Age class (years)	Very durable	Durable	Moderate durable	Non-durable
[6 -7]	25	37,5	12,5	25
[9 -11]	50	31,25	12,5	6,25
[15 -29]	66,67	0	6,67	26,67
All samples	51	21	10	18

DISCUSSION

Tissues proportion of *Acacia auriculiformis* wood

The similarity of tissue proportions in *A. auriculiformis* wood according to age explains the homogeneous growth of the species. A similarity in tissues proportion was previously obtained between different Australian provenances of the species established in India (Anoop et al., 2012), and also in other countries like Indonesia (Yahya et al., 2010). This demonstrates a certain homogeneity in the tissue proportion of the species. This proportion of fiber can always be improved through hybridization with *Acacia mangium* (Yahya et al., 2010).

Acacia auriculiformis has a high fiber proportion (58%) and a ray parenchyma proportion of 18%. This is comparable to that obtained in India (Anoop et al., 2012) and in Indonesia (Yahya et al., 2010). The tissues proportion in *Acacia auriculiformis* wood in Benin is similar to those of *Tectona grandis* (10 – 20 years old) in Ghana: (51 – 62% fibers, 7 – 10% vessels, 10 – 21% axial parenchyma and 15 – 19% ray parenchyma) (Amoah and Inyong, 2019). The high proportion of fiber in a wood indicates a high wood density, hardness and rigidity of that wood (Amoah and Inyong, 2019; Pirralho et al., 2014). This high fiber yield appears interesting for the various uses of solid wood, charcoal and pulp (Anoop et al., 2012; Pereira et al., 2021; Pirralho et al., 2014).

Fiber parameters of *A. auriculiformis* wood

Acacia auriculiformis wood in Benin has fiber characteristics twice more than that grown in Bangladesh. In Benin, the average fiber length at 11years old is 2.7 mm. In Bangladesh, the species has between 0.8 – 1.06 mm of fiber length at 11 years old (Chowdhury et al., 2009). Compared to *Tectona grandis* from Indonesia (1.42 mm of fiber length and 23.4 µm fiber diameter were obtained for 12 years old) (Hidayati et al., 2014), and Ghana : fibers with the following characteristics respectively 0.8 – 1.1 mm of fiber length, 11 - 17 µm of lumen width, 20 - 25 µm of fiber diameter for the trees 10 – 20 years old (Amoah and Inyong, 2019); *Acacia auriculiformis* in Benin has a high fiber length. This would be due to silvicultural treatments and differences in soil type in the different growing environments of the species (Lima et al., 2010; Pereira et al., 2011).

Woods with short fibers of the order of 1mm are often used for charcoal production (Pereira et al., 2021) and those with a Runkel coefficient of less than 1 and even more up to 1.5 are good for pulp (Boadu et al., 2020; Jusoh et al., 2014). The higher the Runkel ratio, the higher the stiffness of the fiber (Pirralho et al., 2014). On the other hand, the longer the fiber and the higher the Slenderness ratio the higher the compressive strength (Pirralho et al., 2014; Van Duong et al., 2019). Baar et al. (2016) added that woods with high fiber lengths have a high modulus of elasticity and better acoustic properties.

In sum, there is a positive relationship between fiber length, wood density, compressive strength, modulus of elasticity and acoustic properties of wood (Baar et al., 2016; Pirralho et al., 2014; Van Duong et al., 2019). The *Acacia auriculiformis* wood from Benin has a high fiber length at 7 years. This length is higher than that obtained from the same species in other regions of the world, and higher than that of teak. *Acacia auriculiformis*, therefore, presents anatomical aptitudes to be rigid, resistant with a high density. This explains the high density of wood obtained from the species in the region (Tonouéwa et al., 2020b). However, the Runkel ratio and Slenderness ratio are high from the age of 15, demonstrating anatomical maturation of the wood of the species at 15 years.

Organic carbon content of *A. auriculiformis* wood

The rate of carbon sequestered in wood is homogeneous with age, which is interesting for silvicultural improvements. Silvicultural practices aimed at rapid tree diameter and height growth will result in a high rate of carbon sequestration in *A. auriculiformis* wood. This sequestration rate is comparable to those of other acacias used for climate change mitigation (carbon sinks, renewable bioenergy, timber) in Mexico which have an equal proportion see increased by half (Maiti et al., 2019). The establishment of plantations of fast-growing species such as *Acacia auriculiformis* presents opportunities for carbon sale, wood supply and Reducing Emissions from Deforestation and forest Degradation (REDD+).

Natural durability of termite of *A. auriculiformis* wood

A. auriculiformis wood is moderately durable to very durable against termites (*Macrotermes bellicosus*). This parameter is very interesting for the use of wood of this species as timber for construction and furniture (Antwi-Boasiako et al., 2017). *Pterocarpus erinaceus* and *Milicia excelsa*, good timbers for construction, and other industrial uses also have a resistance to this termite. Extracts of wood from both species against *Macrotermes bellicosus* showed an 82% and 50% mortality of termites, respectively (Ajuziogu et al., 2019; Syofuna et al., 2012).

In short, the *A auriculiformis* wood has very suitable anatomical characteristics, organic carbon content and natural durability against termites. It can supply timber to meet demand for wood sustainably and be promoted for natural forests protection. In the context of global warming, large plantation of fast-growth tree species like *A auriculiformis* could considerably remove atmospheric CO_2 and significantly contribute to climate change mitigation.

CONCLUSIONS

The anatomical characteristics, organic carbon content and natural durability against termites of *A. auriculiformis* wood (tissues proportion, fibers parameters) show that the species has good properties despite being a fast-growing species. The high fiber yield of the species, high fiber length, high Runkel ratio and high Slenderness ratio suggest that the wood of *A. auriculiformis* could exhibit high stiffness and hardness. It is also homogeneous and resistant to termite attacks. However, the establishment of plantations over large areas and their monitoring and use for many years will allow a better understanding of its ability to meet all of these demands and contribute to the mitigation of climate change.

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