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Tissue Proportion, Fibre, and Vessel Characteristics of Young *Eucalyptus* Hybrid Grown as Exotic Hardwood for Wood Utilization

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Abstract – This study sought to determine selected anatomical properties of young *Eucalyptus* hybrid species (*E. grandis x E. urophylla*) grown in Ghana. Images of fibres from macerated wood, and micro–sections produced with microtome were analysed using a compound digital microscope associated with Motic Image Plus Software (MIPS), version 2.0, installed on a computer. Images were initially processed using ImageJ software. Study data were analysed using an R statistical package. The overall mean value for fibre length was 907.67 µm, whereas double fibre wall thickness was 7.76 µm. Both variables had higher mean values in sapwood than in heartwood. Nevertheless, the found values decreased from the butt to the top portion. Statistically, axial and radial positions had no influence on fibre characteristics. In a 1 mm^2 of the cross-section, the proportion of fibres was 38%, vessels were 19%, axial parenchyma were 22%, and radial parenchyma were 21% on average. Again, the radial and axial positions had no statistical influence on tissue proportion traits for the young eucalyptus wood. Mean value for vessel area was 9462.04 µm^2, whereas vessel frequency per mm^2 was about 14. Vessels were significantly larger in area (range 9982.50 – 13544.41 µm^2), yet reduced in frequency (range 6 – 17 per mm^2) for sapwood. In heartwood, vessel area was comparatively smaller (range 6321.15 – 7816.69 µm^2), whereas their frequency was high (range 15 – 18 vessels per mm^2). Axial and radial position had statistical influence on vessel frequency and area for the young *Eucalyptus* grown in a plantation in Ghana.

***Eucalyptus* / hybrid / fibre / tissue / parenchyma / vessel**

Kivonat – Fahasznosítás céljából termesztett *Eucalyptus* hibrid fajok fiatal egyedeinek szöveti szerkezete, rost– és edényjellemzői. Ez a cikk a Ghánában termesztett *Eucalyptus* hibrid fajok (*E. grandis x E. urophylla*) fiatal egyedeinek egyes anatómiai tulajdonságait írja le. A macerációval elkülönített farostok fotóit, ill. mikrotómmal készített anatómiai metszetek mikroszkopikus részleteit elemeztük egy összetett digitális mikroszkóppal, amely a számítógépre telepített Motic Image Plus Software (MIPS) 2.0 verziójához kapcsolódott. A képeket eredetileg ImageJ szoftverrel dolgoztuk fel. A nyert adatokat R statisztikai szoftvercsomag segítségével elemeztük. A rosthossz átlagértéke 907,67 µm, míg a kettős sejtfalfalvastagság 7,76 µm volt. Megállapítottuk, hogy a szijács hosszabb farostokat

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tartalmaz, melyeknek kettős falvastagsága is nagyobb a gesztben mért értékekhez viszonyítva, ugyanakkor a különbségek statisztikailag nem szignifikánsak. Az említett értékek a tő felől a csúcs irányában csökkenő értékeket mutattak, de statisztikailag nem volt igazolható az eltérés. Statisztikailag tehát az axiális és radiális helyzetek nem befolyásolták a farostok jellemzőit. 1 mm^2 keresztmetszetet vizsgálva a farostok aránya 38%, az edényeké 19%, az axiális parenchimáké 22%, míg a bélsugár parenchimáké 21%. A radiális és axiális helyzetnek nincs statisztikai hatása a fiatal eukaliptusz faegyedekben a vizsgált sejttípusok arányára. Az edényterület átlagos értéke 9462,04 μm^2 volt, míg az edények darabszáma 14 körüli érték volt 1 mm^2–re vetítve. A szijácsban az edények területe a 9982,50 – 13544,41 μm^2 tartományban, mozgott, de darabszámuk kisebb volt a geszthez viszonyítva (6 – 17 db/mm^2). A gesztben az edények területe kisebb értéket adott (6321,15 – 7816,69 μm^2), míg darabszámuk nagyobb volt (15 – 18 db/mm^2). Vizsgálatainkkal megállapítottuk, hogy a ghánai ültetvényen termesztett fiatal *Eucalyptus* egyedek esetén az axiális és a radiális helyzet statisztikailag befolyásolta az edények mennyiségét (számát) és méretét (területét).

Eukapliptusz / hibrid / farost / szöveti szerkezet / parenchyma / edény

1 INTRODUCTION

Wildfires, illegal logging, overexploitation to meet domestic and foreign wood demand, and other factors put continuous pressure on natural forests in tropical timber producing countries. Experts have predicted that the raw material base for wood will soon shift from natural to plantation timber. Efforts to guarantee a sustainable future supply of wood include the introduction of fast-growing exotic species like *Tectona grandis*, *Cedrela odorata*, and *Eucalyptus* species. The genus *Eucalyptus* comprises fast-growing species that are able to adapt well to marginal soils in diverse climatic conditions (Willan 1951, Woods – Peseta 1996). These characteristics make *Eucalyptus* a suitable candidate genus for commercial timber plantations that can meet the increasing wood demand as well as mitigate some alarming climate change effects. Eucalyptus plantations are found currently in tropical, subtropical, and temperate areas. They amount to 8% of planted forests globally (Harwood 2011).

Wood from *Eucalyptus* species are useful for pulp and paper, solid wood products, veneer, fuelwood, posts, etc. In Kenya, eucalyptus is the third most grown genus after pine and cypress. It was originally introduced in Kenya to provide biomass for powering railway steam engines (Githiomi – Kariuki 2010). Until recently, eucalyptus was only planted in small scale research plot sizes and on private lands in Ghana, primarily for shade and ornamental purposes. Admittedly, general information on original eucalyptus species has been published; however, specific research on young stems is scarce. Presently, MIRO Forestry Ghana Limited, a private organisation, has adopted a breeding technology program for *Eucalyptus grandis* and *Eucalyptus urophylla*. The goal is to create a hybrid species for an improved tree form and enhanced growth. Nonetheless, little research focusing on the wood properties has been completed on bred *Eucalyptus* species.

As is the case with other tree species, silvicultural management, age, genetics, and growing sites influence the formation and quality of the woody biomass of eucalyptus (Zobel – van Buijtenen 1989, Savidge 2003, Roque 2004). In addition, wood quality can also vary with an individual tree and between trees of same species growing under same conditions (Plomion et al. 2001, Wimmer et al. 2002, Monteoliva et al. 2005, Quilhó et al., 2006, Sharma et al. 2015).

Generally, it has been argued that timber species that are fast-growing and less than ten years old produce mostly juvenile, inferior quality wood (Zobel – Sprague 1998, Moore – Cown 2017). Accordingly, properties of young eucalyptus wood need to be investigated for efficient utilization. The anatomical structure and characteristics of wood are known to influence the most important properties, which include density, drying characteristics, shrinkage, permeability for preservation treatment, pulp yield, paper strength, etc. (Fujiwara et al. 1991, Ofori – Brentuo 2005, Bhat et al. 2007, Yahya et al. 2010, Zanuncio et al. 2016). Moglia et al. (2008), reported that fibre and vessel length significantly varied radially within a tree, whereas tissue proportion differed considerably between trees of same species. Amidon (1981) and Barauna et al. (2014) found that vessel frequency and diameter size greatly affected papermaking properties and wood permeability. The present study aimed to establish the anatomical properties that are fundamental to enhancing the utilisation potential of hybrid *Eucalyptus* species grown in Ghana. Specific anatomical properties considered for the present study were fibre characteristics (length, diameter, lumen width, and wall thickness), tissue proportion (fibre, vessel, axial and radial parenchyma), and vessel characteristics (frequency and area). These variables could influence utilisation properties of the young wood considerably.

2 MATERIALS AND METHODS

2.1 Study site

The study was conducted with materials from a plantation site owned by MIRO Forestry Ghana Limited located near Agogo in Asante Akyem North district of the Ashanti region of Ghana (*Figure 1*). The land is a degraded forest reserve forming part of the forest transition zone of Ghana. Between 2013 and 2018, the district, which is located on latitude 6º 37' 5" N and longitude 1º 12' 36" W, recorded monthly rainfall between 120 mm and 150 mm. The mean temperature ranged between 26ºC and 30ºC (MOFA 2018). Total plot size was 50 hectares.

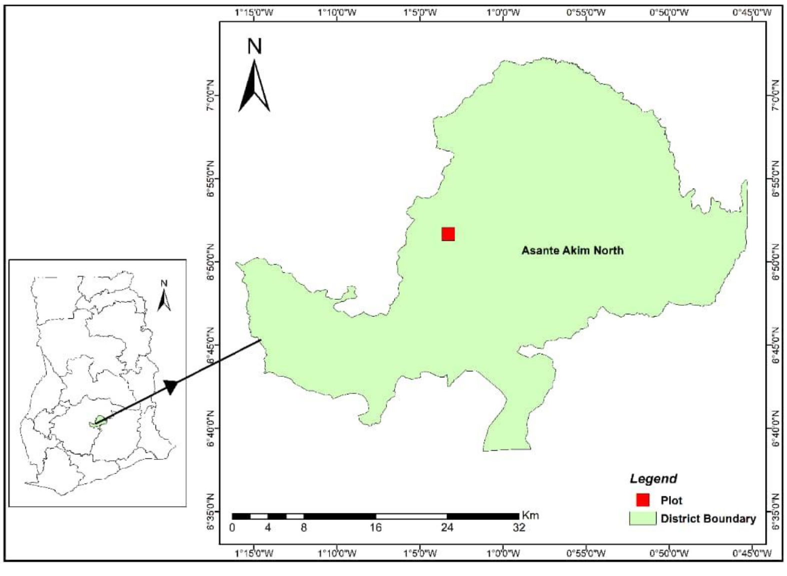

Figure 1. A map highlighting the Eucalyptus plot and Asante Akyem North District in the Ashanti region of Ghana.

2.2 Measurement of trees morphological features

The *Eucalyptus* hybrid (*E. grandis* and *E. urophylla*) trees were four years old, planted with 2.5 x 3m spacing, and were nurtured with MIRO's thorough silvicultural management and protection from annual wildfires. Fifty trees were randomly selected for height and diameter measurement. Diameter tape was used to measure stem diameters for the trees at breast height position of 1.3 m. Tree heights were measured using a linear tape after the trees had been harvested close to the ground with a chainsaw. Respective stump heights were also added.

2.3 Sampling of wood materials

Six trees were randomly selected from the 50 harvested trees. MIRO donated only six trees for this destructive study. The trees were crosscut into three axial portions representing the butt, middle, and top position of tree. One 2 cm-wide wood disc was collected from the different stem height levels (butt, middle, and top) of all six trees. Eighteen (18) wood discs were labelled accordingly. Each disc was packaged in a sealed polythene and transported to the Wood Anatomy Laboratory within the Council for Scientific and Industrial Research's Forestry Research Institute of Ghana (CSIR–FORIG). The idea behind sampling from the axial position was to address any inherent variability that had naturally developed during growth of each tree. Again, there was a sharp visible distinction between sapwood and heartwood on the butt and middle discs. Therefore, one sample from heartwood and one from sapwood were taken from either side of the disc (Cherelli 2015). A total of 72 sub-samples were studied (4 sub–samples x 18 discs).

2.4 Fibre characteristics

Matchstick-sized wood pieces were taken from all sub-samples. These were placed in labelled vials and macerated using a solution of equal parts of hydrogen peroxide and glacial acetic acid. The vials containing the wood material were kept in a N53C-Genlab Oven at 60°C and monitored every 12 hours until the maceration was complete. The macerate was repeatedly washed with distilled water to guarantee total removal of acetic acid (Franklin 1945). A drop of glycerol was placed unto the macerate, and the fibres were put on a specimen slide where they were separated apart with a pin (*Figure 2*). The slides were studied under a digital Compound Microscope (National) operated alongside a Motic Image Plus software (MIPS). Images with X40 magnification (*Figure 2*) were employed for the measurement of fibre length, whereas images with X400 magnification (*Figure 3*) were used for diameter, lumen width, and wall thickness. Twenty-five (25) straight and unbroken fibres were measured for each sub-sample. This resulted in 50 fibres for sapwood and 50 fibres for heartwood, for a total of 100 fibres per disc.

2.5 Tissue proportion and vessel characteristics

Wood samples of approximately 2 cm in all dimensions were taken through a softening process following published protocols (Schweingruber 2007). After being softened, each sample was mounted on a sledge Microtome (HM 400, Microm, Walldorf, Germany) to cut microsections of about 10 – 20 μm from the cross-sectional surface (*Figure 4*). The thin sections were stained with safranin solution and further submitted to a gradual dehydration process. This was achieved by transferring the stained microsections from water through ethanol solution of 30 %, 50 %, 70 %, 90 %, and absolute ethanol. Furthermore, the sections were permanently mounted with Canada balsam and oven–dried at 60 °C (Schweingruber 2007, Tardif – Conciatori 2015). The best-mounted sections were selected, at least 3 slides per sub-sample, and studied under the microscope associated with MIPS to capture images. In ImageJ, the software scale is set using the scale of an individual image. Afterwards, a scale grid of 1 mm^2 was superimposed, at least 10 times, on original images representing a sub-sample. The individual tissue elements (fibre, vessel, axial parenchyma, radial parenchyma) within the 1 mm^2 area were counted at each placement and equated to 20.

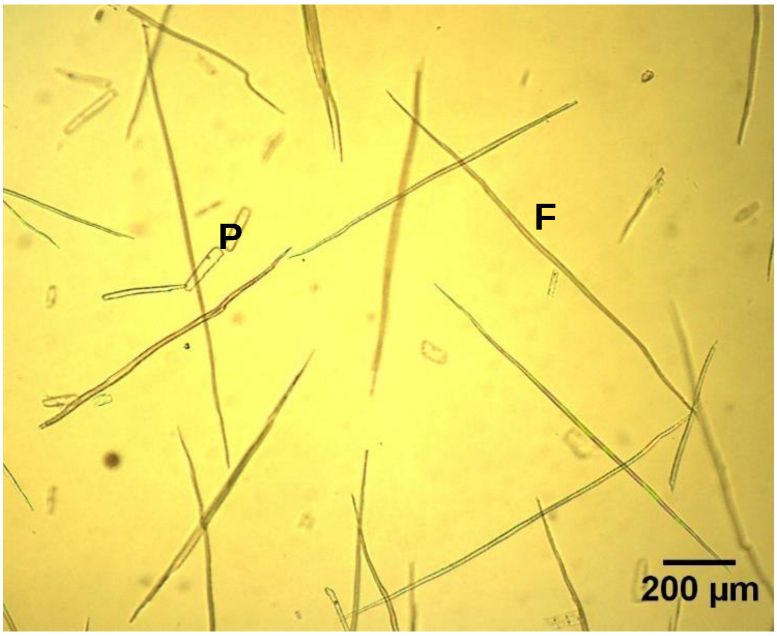

Figure 2. Fibres (F) and parenchyma cells (P) from macerated wood from 4-year-old Eucalyptus hybrid species grown in Ghana.

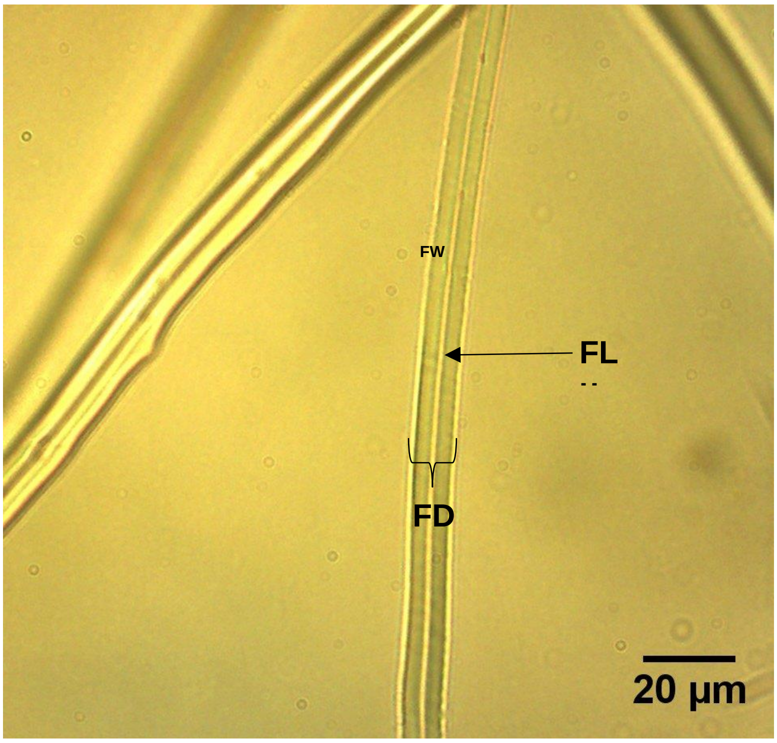

Figure 3. A magnified fibre from macerated wood from a 4-year-old Eucalyptus hybrid species. (FW): Fibre wall; (FD): Fibre diameter; (Flu): Fibre lumen.

For instance, if vessels are 3 out 20 spots, the proportional means are reported as percentages as (3/20)·100. Regarding vessel characteristics measurement, ImageJ software was used to analyse the same images captured to represent the sub-samples (Abràmoff et al. 2004). For vessel area, the images were converted into 8-bit format, inverted, and threshold set activated to convert all vessels into black dots. Using a feature called 'analyse particle' within ImageJ, dot circularity was set between 0.75-1.00. Furthermore, the desired dot area was set above a pre-determined area of the smallest vessel. This excludes the many smaller dots representing cells such as axial parenchyma. Vessels were analysed as particles to estimate their area (*Figures 4* and *5*). A minimum of 45 vessels from three different images were feasible for area measurement for each sub-sample. Vessel frequencies were completed manually on the same-sized images.

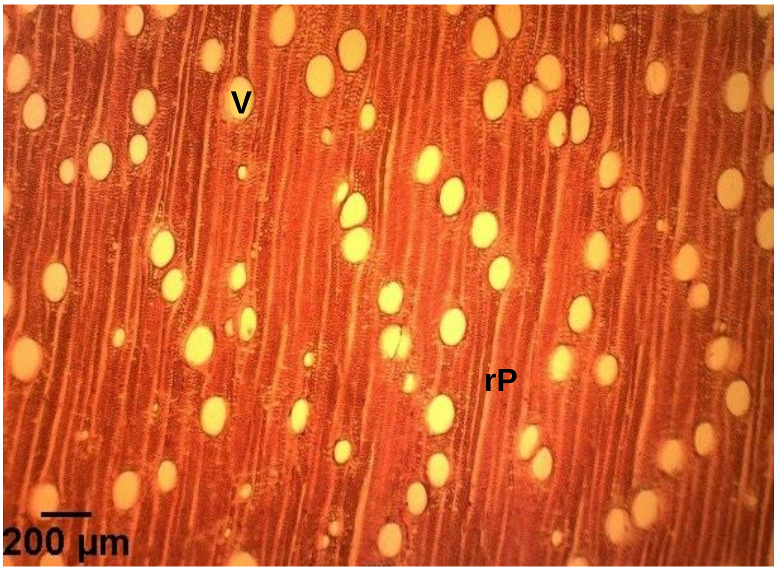

Figure 4. Cross-sectional image of wood from a 4-year-old Eucalyptus hybrid grown in Ghana. Image is at X40 magnification. V = vessel, rP = radial parenchyma

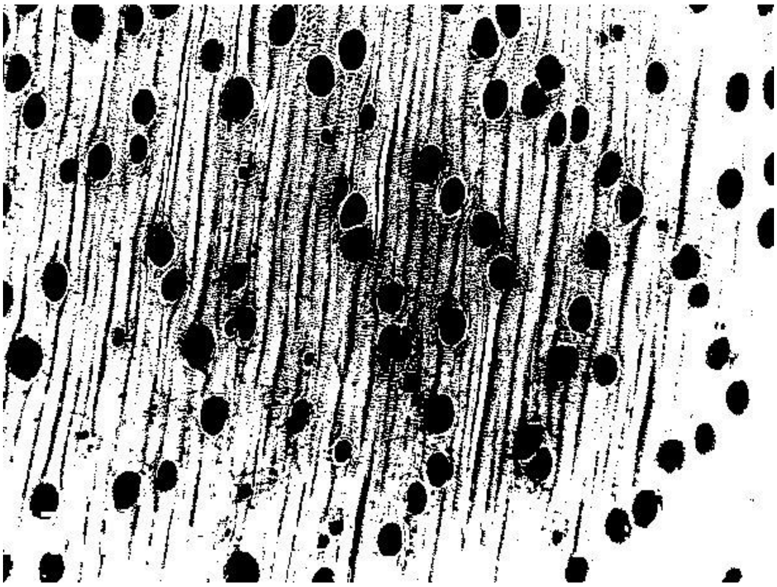

Figure 5. A processed image of a cross-section of wood from 4–year–old Eucalyptus hybrid species grown in Ghana. The vessels in the original image (Figure 4) are now seen as dark particles. Radial parenchyma now seen as black stripes.

2.6 Data analysis

The data generated from the study was organized with an Excel spreadsheet (Microsoft 365), and analysed using the R statistical package (Team 2014). The mean values and their corresponding standard deviations are reported in *Tables 2-4*. A one-way analysis of variance

(ANOVA) was employed to test if differences observed in the mean values were statistically significant. *P*-values from ANOVA outputs are included in the Tables presented above. Tukey's Honest Significant Difference was implemented to compare mean values with statistically significant differences, especially for variables with more than two categories.

3 RESULTS AND DISCUSSION

In general, the study results of morphological features, tissue proportion, fibre and vessel traits were comparable among the axial and radial positions as well as to values reported in the literature.

3.1 Morphological features

Mean merchantable height was 14.26 m, whereas the mean diameter at the butt section was 31.42 cm (*Table 1*). The mean height and diameters the present study found for eucalyptus trees grown in Ghana correspond with those reported in literature. In Brazil, Brito et al. (2019) reported a diameter at breast height (dbh) of 16.19 cm and a height of 17.07 m for clone materials of the same age. Likewise, Ramalho et al. (2019) reported a dbh range of 7.4-14.11 cm. Quilho et al. (2006) found an average dbh of 11.5 cm and an average commercial height of 17.8 m for 5-year-old *Eucalyptus urograndis* hybrid trees. The study results indicate that the hybrid eucalyptus trees have positively adapted to their growth conditions. It also suggests that *Eucalyptus* hybrid trees have sufficient crown development to provide adequate useful area for the trees (Miranda et al. 2009). The morphological findings reported in *Table 1* are important when considering the utilization of 4-year-old materials for solid wood applications such as utility poles. The impregnation of preservatives and their retention are influenced by the sapwood portion (Valle et al. 2013).

Table 1. Some morphological properties for 4-year-old Eucalyptus hybrid trees (E. grandis x E. urophylla) grown in Ghana. (Max): Maximum; (Min): Minimum; (Stdv): Standard Deviation. Total samples trees (n) = 50.

Variable	Min	Max	Mean	Stdv
Merchantable length (m)	11.55	16.87	14.26	2.20
Butt diameter (cm)	28.65	34.70	31.42	2.36
Top diameter (cm)	9.23	13.37	11.14	1.55
Sapwood width at butt (mm)	15	95	56	2.34
Sapwood width 3m from butt (mm)	37	76	53.50	1.58
Sapwood width at mid-length (mm)	40	60	47.83	0.78

3.2 Fibre biometry

The mean fibre length for the eucalyptus hybrid trees was 907 µm. The found value falls within the length range (800 to 1300 µm) reported in an earlier study and the InsideWood database (Wheeler 2011, Brito et al. 2021). Fibre length decreased from tree butt to the top portion (938.81 to 862.69 µm) as shown in *Table 2*.

The observed longitudinal variation agrees with other studies (Quilhó et al. 2006, Bhat et al. 2007). However, the abovementioned authors observed an initial increase in fibre length to about breast height before the decrease to the top portion. In the present study, the middle portion was at exactly the 50% mark of merchantable height reported in Table 1. Clearly, the middle portion was beyond the breast height of 1.3 m. Bamber (1985) reported a similar observation. Quilhó et al. (2006) studied eucalyptus hybrids (*E. grandis* and *E.*

urophylla) and reported 820 – 1040 µm for fibre length for trees from seed origin and 1010-1110 µm for five-and-half-year-old clones. Regarding the same hybrid grown in India, Sharma et al. (2015) reported 910-1140 µm for fibre length. Radially, the sapwood had longer mean fibre length (949.55 µm) than heartwood (862.77 µm). The differences between mean values for fibre length, for both axial and radial positions, were statistically insignificant.

Table 2. Mean values of fibre characteristics for 4-year-old eucalyptus hybrid (E. grandis x E. urophylla) grown in Ghana. (FL): Fibre Length; (FD): Fibre Diameter; (FLW): Fibre Lumen Width; (FDWT): Fibre Double Wall Thickness.

Positions	Levels	FL (µm)	FD (µm)	FLW (µm)	FDWT (µm)
Axial	Top	862.69 (81.85)	16.85 (1.82)	9.67 (1.11)	7.18 (1.07)
	Middle	923.26 (69.83)	16.49 (1.13)	8.77 (1.06)	7.72 (0.83)
	Butt	938.81 (77.86)	17.98 (1.51)	9.56 (1.33)	8.42 (1.92)
P–value		0.22	0.24	0.38	0.31
Overall mean		907.67 (40.25)	17.11 (0.78)	9.33 (0.49)	7.77 (0.62)
Radial	Heartwood	862.77 (82.86)	17.71 (1.33)	10.23 (1.50)	7.49 (1.16)
	Sapwood	949.55 (52.97)	16.49 (1.69)	8.48 (0.88)	8.00 (1.14)
P–value		0.06	0.19	0.034	0.45
Overall mean		906.16 (61.36)	17.10 (0.86)	9.36 (1.24)	7.76 (0.36)

The P–values for each variable are from a one–way ANOVA run at 95% confidence interval. In parenthesis are the standard deviation of the mean values. Total sampled trees (n) = 6.

Regarding fibre diameter (width), the mean value was 17.11 µm. This variable decreased from the butt to the middle, but slightly increased from the middle to the top portion (*Table 2*). The study finding on fibre diameter correlates with values reported in the literature. Carvalho and Nahuz (2001) reported 17.1 µm; Rao et al. (2002) reported 14.5 – 16.9 µm; Quilhó et al. (2006) reported 20 µm; Sharma et al. (2015) reported 14.3 – 16.8 µm. Across radial position, fibre diameter was higher in heartwood. The mean values for fibre diameter found by this study were not statistically different in either axial or radial directions.

The mean value of fibre double wall thickness (width) was 7.76 µm. The pattern for double wall thickness also decreased from the butt to the top, as with the fibre length. Radially, double wall thickness for fibres from sapwood were thicker than double wall thickness for fibres from heartwood. However, the reported mean values are comparable to those reported by Sharma et al. (2015) for 6-year-old *Eucalyptus* hybrid trees. The fibre double wall thickness exhibited mean values that were not statistically different.

This study revealed that fibre length and double wall thickness were comparatively higher in sapwood than in heartwood. This observation suggests that sapwood could be denser than heartwood in young wood. Similar observations have been reported in literature for both young and older *Eucalyptus species*; 6.5-year-old trees (Pillai et al. 2013), 10-year-old trees (Tomazello 1987), 15-year-old trees (Carrillo et al. 2015), 18-year-old trees (Trevisan et al. 2013) and 37-year-old trees (Melo et al. 2018). The authors attributed their observation to cambial age as particularly related *Eucalyptus* species.

3.3 Tissue proportion

Fibre carried a proportion of 37.54% and vessel elements carried 18.60%. Axial and radial parenchyma proportion were about 22% and 21% respectively (Table 3). Axial and radial variation in tissue proportion was recorded within trees. Study findings are compatible with studies on similar *Eucalyptus* hybrid species (Hu et al. 2008) and a 4.5-year-old

Eucalyptus tereticornis (Rao et al. 2002). However, the differences reported in the present study were statistically insignificant. Generally, the radial variation, though insignificant, was a little pronounced, but only at the butt section for the tissue proportional traits. Practically, the findings suggest that the studied wood materials may be utilized irrespective of its portion on the stem. Meanwhile, the service life of the young wood could be compromised as described in Brischke et al. (2006); a direct decay-influencing factor, among others, is a material natural resistance.

3.4 Vessel characteristics

Generally, vessels were exclusively solitary with a diffuse porous arrangement. Vessel characteristics affect the papermaking properties of wood and other technologies like impregnability (Amidon 1981, Barauna et al. 2014, Anupam et al. 2016). The mean values for vessel area, based on cross sectional view, for the 4-year-old *Eucalyptus* hybrid wood is 9462 μm^2 (*Table 4*). Vessel area was larger in sapwood than in heartwood. Same variable increased from the butt to the middle portion of the tree before a slight decrease at the top portion. Regarding vessel quantity, the estimated mean value was approximately 14 per mm^2. The top portions had highest vessel frequency followed by the butt before the middle portion. Statistically, the effect of axial and radial position on vessel quantity and size was highly significant. Practically, the results suggest that positions are important when considering the young wood for application. For instance, in cases where impregnation of preservatives is required, different portions of the stem would give different outputs.

Table 3. Mean tissue element proportion (%), based on cross section area, for 4-year-old Eucalyptus hybrid (E. grandis x E. urophylla) grown in Ghana.

Variable	Position	Heartwood	Sapwood	*P*–value
	Top	–	35.13 (8.31)	
Fibre (%)	Middle	38.67 (9.00)	38.33 (10.47)	0.60910
	Butt	37.00 (12.07)	41.00 (8.97)	
Overall mean		*37.54 (2.34)*		
	Top	–	20.43 (5.50)	
Vessel (%)	Middle	18.00 (6.90)	17.33 (7.76)	0.32011
	Butt	19.67 (6.94)	15.75 (5.68)	
Overall mean		*18.60 (1.90)*		
Axial parenchyma (%)	Top	–	23.40 (7.35)	
	Middle	21.00 (7.59)	22.33 (6.51)	0.2456
	Butt	21.67 (7.24)	23.25 (7.30)	
Overall mean		*22.51 (1.43)*		
	Top	–	21.05 (7.27)	
Radial parenchyma (%)	Middle	22.33 (6.66)	22.00 (8.82)	0.8270
	Butt	21.67 (11.75)	20.50 (8.72)	
Overall mean		*21.43(0.77)*		

The P–values for each variable are from a two–way ANOVA run at 95% confidence interval. In parenthesis are the standard deviation of the mean values. – is used because the top portion had not developed heartwood yet. Total sampled trees (n) = 6.

Tukey's Honest Significant Difference was employed to test where the significant difference existed among the axial positions. Regarding vessel area, the butt portion contributed greatly compared to the middle and the top. Conversely, for vessel frequency, the top portion contributes greatly when compared to both butt and middle. The pattern of vessel characteristics in this study conforms to earlier reports ((Taylor 1973, McKimm – Ilic 1987, Leal et al. 2003). The axial and radial variations observed in this study for vessel characteristics can be attributed to cambial age as related to eucalyptus species, and reported in literature (Leal et al. 2003, Ramírez et al. 2009, Carrillo et al. 2015).

Table 4. Mean vessel frequency per mm^2 and area (µm^2) for 4-year-old Eucalyptus hybrid (E. grandis x E. urophylla) grown in Ghana. (VA): Vessel Area; (VF): Vessel Frequency.

Variable	Axial position	Heartwood	Sapwood	*P*–value
	Top	–	9503.73 (3573.25)	
VA (µm^2)	Middle	7816.69 (3993.39)	13544.41 (5955.02)	1.188e–05
	Butt	6321.15 (2729.22)	9982.50 (5037.37)	
Overall mean		*9462.04 (2717.98)*		
	Top	–	17.70 (1.93)	
VF/mm^2	Middle	15.00 (2.36)	6.60 (1.51)	1.371e–06
	Butt	15.50 (2.12)	11.40 (1.65)	
Overall mean		*13.98(4.31)*		

The P–values for each variable are from two-way ANOVA run at 95% confidence interval. In parenthesis are the standard deviations of the mean values. – is used because the top portion had not developed heartwood yet. Total sampled trees (n) = 6.

4 CONCLUSIONS

This study contributes to addressing the scarce scientific literature on eucalyptus in Africa. The focus on selected anatomical properties and morphological features is an important start for the resilient species. The height, diameters, and other morphological traits identified for the 4-year-old eucalyptus hybrid wood suggest that the hybrid species could qualify for numerous applications and further related tests. The axial and radial positions within the trees had no significant effect on fibre dimensions and tissue proportions. On the contrary, axial and radial positions had significant effect on vessel frequency and area. Meanwhile, the mean values found for all variables agreed with reported values of eucalyptus species grown through seed and clones in both native and cultivated lands. Comparatively, vessels were larger in area, but fewer by frequency in sapwood than in heartwood. Additionally, both vessel area and frequency increased from butt to top portion. The findings of this study highlight some of the fundamental information needed to support efficient utilization of eucalyptus wood, especially in Ghana. In this regard, it would be helpful to conduct further research to establish the effect of age, planting distances, etc., on wood properties of the *Eucalyptus* hybrid species in Ghana.

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