Advances in Research

14(2): 1-11, 2018; Article no.AIR.39024
ISSN: 2348-0394, NLM ID: 101666096

Planing and Turning Characteristics of *Gmelina arborea* Grown in Two Ecological Zones in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SJM, MAM and FWO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author RO managed the analyses and literature searches of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2018/39024
Editor(s):
(1) Paola Deligios, Department of Agriculture, University of Sassari, Italy.
Reviewers:
(1) Fellah Mamoun, Abbes Laghrour University & Annaba University, Algeria.
(2) I. Gede Bawa Susana, Mataram University, Indonesia.
(3) Atria Pradityana, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia.
(4) Obiekea Kenneth Nnamdi, Ahmadu Bello University Zaria, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/23911

Original Research Article

Received 19th November 2017
Accepted 29th January 2018
Published 31st March 2018

ABSTRACT

Gmelina arborea grown in Ghana has not been promoted for its efficient use by the wood industry due to the limited technical information available and is therefore classified as a lesser-used timber species. This paper presents research findings on the planning and turning properties of *Gmelina arborea* cultivated in two ecological zones in Ghana. Samples of logs from six trees of the species were obtained from Daboase and Abofour in the Wet Evergreen and Dry Semi-Deciduous Forest zones of Ghana. These were crosscut into top, middle and butt sections using a chainsaw. An LT 15 Wood-Mizer bandsaw was used to saw each log into 2.6 cm-thick boards; these were then stacked for air drying. Planning and turning tests were conducted following the American Society for Testing and Materials International D1666-87-2004 method to determine the machining characteristics of

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the wood. The results of the study indicate that *Gmelina arborea* is a medium-density species and that irrespective of where it is grown, the best planing performance is obtained at a feed speed of 6 m/min using a cutting angle of 30°. The results also indicate that the turning characteristics of *Gmelina arborea* obtained from the two ecological zones were best at spindle speeds of 1850 rpm and 2500 rpm. At the 5% level of significance, the spindle speed and the interaction between location and spindle speed, tree section and spindle speed and location, tree section and spindle speed had a significant effect on the surface quality of the turned specimen. It is therefore found that *Gmelina arborea* cultivated in Ghana has good planing and turning characteristics.

Keywords: Feed speed; Gmelina arborea; species density; spindle speed; surface quality.

1. INTRODUCTION

To sustain the dwindling timber industry in Ghana due to over-exploitation of the primary timber species, researchers have focused on the efficient utilisation of timber and the promotion of lesser-used timber species (LUS) and lesser-known timber species (LKS) in developing sustainable forest management. Currently in Ghana, most timber species are not being used because their properties are not well known [1]. Useful scientific information on LUS and LKS is essential for their promotion and efficient utilisation as substitutes for endangered timber species that are in short supply and that are very expensive. LUS and LKS are readily available and are comparatively cheaper than the original species. Additionally, the use of LUS and LKS expands species utilisation, thus reducing the pressure on dwindling timber species.

Previous studies by [2] on some machining qualities of selected LUS and LKS in Ghana have indicated that most of the species investigated have promising boring, turning and shaping characteristics to justify their use in the furniture and construction industries. Additionally, studies conducted by [3] on some machining properties of four LKS grown in Turkey have revealed that the species studied had excellent performance for all machining processes.

The surface quality of wood is the degree of roughness of the surface. Studies by [4] and [5] have indicated that surface roughness plays an important role in determining the quality of a machined product. The factors that most affect surface roughness during machining processes include the non-uniformity of cutting conditions, such as depth of cut, cutting speed and feed rate [6-8] and [9]. Other factors are moisture content, density, number of cutters/knives per cutter head, blunt cutters and the cutting angle [10] and [11]. According to [12], the surface quality of wood is better when the wood species is dense, hard and dry. Furthermore, the machining performance for hardwoods improves with the increasing speed of rotation [13].

It is also reported that the frequency of tool dulling increases with increasing density [14], which has an adverse effect on wood machining. Defects such as raised grain, torn grain, chipped grain and chip marks are common in wood machining [15]. Two different methods for measuring the roughness of wood surfaces, visual inspection and stylus profilometer, have been reported by [16,17]. The stylus profilometer method is the most common and involves passing a stylus tip over the wood surface, which has limitations for industrial use because it is slow and the results are difficult to interpret [17].

Gmelina arborea, an exotic species found in the Indo-Burma region of South-East Asia, is a potential source of raw material for the wood industry [18]. It is a deciduous tree and grows to 12–30 m in height and 60–100 cm in diameter. According to [19], *Gmelina arborea* is fast-growing and prefers moist fertile valleys with 450–750 mm rainfall. It does not thrive in ill-drained soil and remains stunted in dry, sandy or poor soil. *Gmelina arborea* is a medium-density timber species and has excellent strength properties [19]. Studies show that *Gmelina arborea* wood is suitable for use as plywood, particleboard, mining props and telecommunication transmission poles. It is also used as a fuel source [19].

In Ghana, over 5,000 hectares of *Gmelina arborea* plantations have been established. Of these, 2,000 hectares are cultivated by Subri Industrial Plantations Limited (SIPL) at Daboase near Sekondi-Takoradi [18]. The Daboase *Gmelina arborea* plantation was originally cultivated to serve as a wood resource base for a proposed paper-processing factory in Ghana. However, the factory was never established and the plantation was left unused. It was later

realised that *Gmelina arborea* could be used as timber in various applications. Despite this, it is not common on the local timber market due to a lack of scientific information on the species. *Gmelina arborea* is among the 10 species the Forestry Commission in Ghana has selected for plantation.

The aim of this study is to determine some of the machining characteristics of *Gmelina arborea*. The outcome of this study will provide scientific information on the potential use of *Gmelina arborea* wood for the manufacture of furniture and other wood products.

2. MATERIALS AND METHODS

2.1 Material Selection

One group of three *Gmelina arborea* trees was obtained from the plantation in Daboase, western Ghana that was established in 1977. Daboase is located in the Wet Evergreen Forest Zone, which has an average annual rainfall of 1500 mm. Another group of three *Gmelina arborea* trees was obtained from the plantation in Abofour in the Ashanti region of Ghana that was established in 1975. Abofour is in the Dry Semi-Deciduous Forest Zone, which has an average annual rainfall of 1400 mm. In both cases, trees with a breast-height diameter of 40–60 cm were sampled for the study.

2.2 Material Preparation

The trees from both plantations were crosscut into three sections—top, middle and butt—using a chainsaw. Each section measured 2.5 m and was labelled accordingly. Next, a narrow Wood-Mizer bandsaw was used to saw each of the logs into 2.6 cm-thick boards. The boards were stacked in a drying shed to air dry (Fig. 1). The moisture content of the lumber was checked at regular intervals with a moisture meter until 15%–16% moisture content was attained.

The air-dried samples were then rip sawn into dimensions of 20 mm x 100 mm x 900 mm in accordance with [20], with some modification, for planing and turning tests.

2.3 Moisture Content

Before the planing and turning tests, the boards were randomly sampled to determine the moisture content using the oven-dry method, in accordance with [21]. Fifteen *Gmelina arborea* boards with dimensions of 20 mm x 20 mm x 30 mm were weighed and placed in a laboratory oven at a temperature of 103°C. The samples were dried until the difference in mass between two successive weighings separated by an interval of two hours was 0.01 g or less. The moisture content of the specimens was then computed as follows:

$$\text{Moisture content (\%)db} = \frac{M_1 - M_0}{M_0} \times 100,$$

where M_1 and M_0 are the masses (g) of the specimens before drying and after oven drying, respectively.

Fig. 1. *Gmelina arborea* boards air drying in a drying shed

2.4 Density of *Gmelina arborea*

The densities of the samples were determined in accordance with [22]. Fifteen samples with dimensions of 20 mm x 20 mm x 30 mm were randomly sampled for the planing and turning tests. The sampled boards represented the tree sections and the ecological zones from which the trees were harvested. The oven-dried masses of the specimens were determined using an analytical balance with accuracy of 0.0001 g. Thereafter, they were dipped one after another in paraffin wax and placed in a desiccator. The volume displacement method using a Eureka can and a measuring cylinder were employed to determine the volumes of the specimens. The density of each specimen was then computed as:

$$Density = \frac{Mass\ of\ Specimen}{Volume\ of\ Specimen}.$$

The average density of the samples from each ecological zone was determined.

2.5 Planing Quality Test

The planing test was conducted in accordance with [20]. A 610 x 230 mm DAA surfacing and thickness planer was used. The dimensions of the samples were 20 mm x 100 mm x 900 mm. Three feed speeds (F1 = 6 m/min, F2 = 9 m/min and F3 = 14 m/min) and a cutting angle of 30^{o} were used. The planer knife was set to remove 2 mm of wood shavings (chippings) from the face of each test specimen. Fifteen specimens for each tree section were selected for each feed speed. The total number of specimens planed for each ecological zone was 135 (15 x 3 x 3 = 135). Finally, the surfaces of the planed specimens were visually evaluated and graded on a scale of 1–5. The percentage of excellent and good specimens was then estimated.

2.6 Turning Quality Test

The turning test was also conducted in accordance with [20]. A Minimax T124 lathe machine was used for this test. The dimensions of the test specimens were 20 mm x 20 mm x 125 mm. The lathe had a maximum spindle speed of 2500 rpm, and three turning speeds of 1000 rpm, 1850 rpm and 2500 rpm were used. Feeding of the turning tool was done by hand. Fifteen specimens of each of the tree sections—the top, middle and butt—were turned using each of the spindle speeds. In all, 135 specimens were prepared from logs harvested from each ecological zone. Turned specimens were visually graded and evaluated on a scale of 1–5. The percentage of excellent and good specimens was then estimated.

2.7 Grading of Specimens

The test specimens were examined, evaluated and graded visually after each of the two machining operations in accordance with [20], with some modification. The grading of both the planing and turning tests was done using a numerical scale of 1–5, as follows: grade 1 = excellent (defect-free); grade 2 = good (slight defects that can easily be rectified by sanding); grade 3 = fair (medium defects that can be removed by sanding but with slight difficulty); grade 4 = poor (severe defects that can be removed with difficulty); and grade 5 = reject/poorest (fibre tear outs and broken corners). For both tests, the percentage grades—1 and 2 (excellent and good)—were used as the performance criteria.

2.8 Data Analysis

After visual examination and grading, the data resulting from the planing and turning tests were transformed using log transformation to convert the data into continuous data prior to statistical analysis. Version 9 of the SAS statistical software program was used to perform the statistical analysis.

3. RESULTS AND DISCUSSION

3.1 Density of *Gmelina arborea*

Table 1 shows the density of *Gmelina arborea* harvested from Daboase in the Wet Evergreen Forest Zone (Western region of Ghana) and from Abofour in the Dry Semi-Deciduous Forest Zone (Ashanti region of Ghana). The average oven-dry density of the top, middle and butt portions of *Gmelina arborea* obtained from the Daboase plantation was 515 kg/m^3, with a range of 413 kg/m^3–599 kg/m^3. The average oven-dry density of the top, middle and butt portions of *Gmelina arborea* obtained from the Abofour plantation was 455 kg/m^3, with a range of 390 kg/m^3–500 kg/m^3. Although the samples obtained from Daboase and Abofour were of the same species, those obtained from Daboase had a higher density than those obtained from Abofour.

The difference in the density of *Gmelina arborea* obtained from the two ecological zones could be attributed to differences in the climatic conditions and soil types. Daboase lies in the Wet Evergreen Forest Zone of Ghana with an average annual rainfall of 1500 mm, whilst Abofour lies in the Dry Semi-Deciduous Forest Zone with an average annual rainfall of 1400 mm. Furthermore, the soil type at Daboase is classified as Nta-Ofin series (Gleyic Arenosol) and that of Abofour is classified as Kumasi series (Haplic Lixisol) [23,24].

Wood density has long been considered the most important wood quality attribute. To a large extent, it helps determine the suitability of a species for a specific end use, and it correlates with lumber strength, particularly stiffness [2] and [25]. It also relates to the boring, turning and shaping qualities of the wood [2,25]. The species studied can be classified as medium density and can be compared with other well-known commercial timber species, such as *Lovoa klaineana* (African walnut; 520 kg/m^3, 12–15% moisture content) and *Khaya ivorensis* (African

mahogany; 500 kg/m^3, 12–15% moisture content), which are used for high-quality joinery, furniture, mouldings, doors, carving and frames [26].

3.2 Moisture Content of *Gmelina arborea*

Wood moisture content has a significant effect on wood machining. On average, the moisture content of the samples before the machining test was 15.5%. Previous studies indicated the best wood machining results could be obtained at 6% moisture content and the poorest at 20%+ moisture content [27]. Therefore, the moisture content of the samples in this study can be considered adequate.

3.3 Planing Characteristics of *Gmelina arborea*

Planed surface characteristics of solid wood are a function of machining quality, which is directly related to cutter head speed [28]. Discussions on planed surfaces usually centre on different quality aspects, such as surface roughness and dimensional accuracy [29]. In this study, we are particularly interested in surface roughness. Table 2 indicates the percentage grades of planed specimens of *Gmelina arborea* harvested from the Wet Evergreen Forest Zone of Ghana (Daboase). The highest surface quality grade (93.3%) was obtained for the middle section of the tree when the feed speed was 6 m/min. The lowest surface quality grade (20.0%) was obtained for the middle section of the tree when the feed speed was 14 m/min.

Generally, the planing performance of *Gmelina arborea* obtained from the Daboase plantation decreased with increasing feed speed for all tree sections, with a feed speed of 6 m/min exhibiting the best performance. This is in accordance with [27] and [30] in that surface quality increases with decreasing feed speed. The highest surface quality of planed specimens for the top, middle and butt sections was 66.7%, 93.3% and 86.6%.

Table 1. Mean densities of *Gmelina arborea* from two ecological zones

Location	Tree section	Replicates	Density (kg/m^3)	Range (kg/m^3)
Daboase	Top	15	537	479–599
	Middle	15	432	413–557
	Butt	15	577	536–599
Abofour	Top	15	471	448–500
	Middle	15	412	390–439
	Butt	15	483	458–501

Table 2. Surface quality grade of planed lumber of *Gmelina arborea* harvested from Daboase plantation

Location	Tree Section	Surface Grades	Feed speed		
			6 m/min	9 m/min	14 m/min
Daboase	Top	Grade 1	36.7	26.7	-
		Grade 2	30.0	20.0	33.3
		Grade 3	33.3	53.3	46.7
		Grade 4	-	-	20.0
		Grade 5	-	-	-
		Grades 1 & 2	66.7	46.7	33.3
	Middle	Grade 1	63.3	16.7	-
		Grade 2	30.0	43.3	20.0
		Grade 3	6.7	40.0	80.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	93.3	60.0	20.0
	Butt	Grade 1	73.3	26.7	20.0
		Grade 2	13.3	33.3	10.0
		Grade 3	13.4	36.7	70.0
		Grade 4	-	3.3	-
		Grade 5	-	-	-
		Grades 1 & 2	86.6	60.0	30.0

Legend: Cutting angle of cutting knife = 30°

Table 3 shows a summary of percentage grades of planed specimens of *Gmelina arborea* harvested from the Abofour plantation in the Dry Semi-Deciduous Forest Zone of Ghana. The highest surface quality grade was obtained for the top section (100%) at a feed speed of 6 m/min. For all sections, the best performance was obtained at a feed speed of 6 m/min.

The planing performance results show a trend similar to that obtained for the Daboase plantation. That is, the planing performance of *Gmelina arborea* obtained from the Abofour plantation also decreased with increasing feed speed for all tree sections, with a feed speed of 6 m/min exhibiting the best performance. The highest surface quality performance of planed specimens for the top, middle and butt sections were 100%, 96.7% and 96.6%, respectively.

Comparing the results obtained from the two plantations, it can be seen that, generally, for every tree section and feed speed, the specimens obtained from the Abofour plantation showed higher rates of performance in terms of surface quality than Daboase specimens. A feed speed of 6 m/min consistently produced the highest surface quality grade for every tree section obtained from both the Daboase and Abofour plantations. This observation is consistent with [7,27,31] and [32], who reported that low feed speeds generally result in better surface quality during machining than high feed speeds. The results of the study also suggest that, among other things, the Dry Semi-Deciduous Forest Zone where the Abofour plantation is located can be considered when selecting a site for future *Gmelina arborea* plantations, as samples obtained from this area had the best planing characteristics.

Table 4 shows the ANOVA of the effect of ecological zone or geographical location, tree section and feed speed on the surface quality of planed specimens. The ecological zone from where the samples were obtained and feed speed both had a significant effect on the quality of the planed surface (5% level of significance). Previous studies by [7] and [33] indicated that better machining performance results were obtained with decreasing feed speed, which confirms the trend in this study.

It can also be seen from Table 4 that the interaction between the location from which the samples were taken and tree section and the interaction between the location from which the samples were taken and feed speed have significant effects on the surface quality of planed specimens.

Table 3. Surface quality grade of planed lumber of *Gmelina arborea* harvested from the Abofour plantation

Location	Tree section	Surface grades	Feed speed		
			6 m/min	9 m/min	14 m/min
Abofour	Top	Grade 1	50.0	10.0	3.3
		Grade 2	50.0	80.0	73.3
		Grade 3	-	10.0	23.3
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	100.0	90.0	76.6
	Middle	Grade 1	60.0	16.7	13.3
		Grade 2	36.7	66.6	46.7
		Grade 3	3.3	16.7	40.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	96.7	83.3	60.0
	Butt	Grade 1	23.3	20.0	33.3
		Grade 2	73.3	33.3	26.7
		Grade 3	3.4	46.7	40.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	96.6	53.3	60.0

Legend: Cutting angle of cutting knife = 30°

3.4 Turning Characteristics of *Gmelina arborea*

Wood turning is the craft of using a lathe with hand-held tools to cut a shape that is symmetrical around the axis of rotation. In evaluating turned wood (for example, in the form of tool handles, sporting goods and furniture parts), the quality of the surface is of ultimate importance [12]. Table 5 shows the turning test results for *Gmelina arborea* harvested from Daboase in the Wet Evergreen Forest Zone of Ghana. The turning grade ranged from 33.3% (top section, 1000 rpm spindle speed) to 80% (middle section, 1850 rpm spindle speed).

The turning grade for all three sections improved at a spindle speed of 1000 rpm–1850 rpm and then decreased at a spindle speed of 2500 rpm. It can be inferred from the results that a spindle speed of 1850 rpm can produce the best turning characteristics for *Gmelina arborea* harvested from the Wet Evergreen Forest Zone (Daboase). Even though from turning speeds of 1000 rpm to 1850 rpm the results obtained conform with those of [12] in that "the surface roughness decreases with increasing cutting speed", the surface roughness obtained between 1850 rpm and 2500 rpm was not consistent with the assertion that surface roughness of wood decreases with increasing spindle speed.

Table 4. ANOVA of effect of location, tree section and feed speed on the surface quality of planed lumber

Source	DF	ANOVA SS	Mean square	F – Ratio	p-value
Location	1	7.3500	7.3500	15.44	0.0001*
TS	2	1.2704	0.6352	1.33	0.2644†
FS	2	68.9600	34.4796	72.41	0.0001*
Location x TS	2	5.4111	2.7056	5.68	0.0036*
Location x FS	2	6.8111	3.4056	7.15	0.0009*
TS x FS	4	4.2852	1.0713	2.25	0.0627†
Location x TS x FS	4	1.8778	0.4694	0.99	0.4148†
Error	493	234.7574	0.4762		

Statistically significant at 0.05 level of significance; †Not statistically significant at 0.05 level of significance
Legend: TS = Tree section; FS = Feed speed

Table 5. Surface quality grade of turned specimens of *Gmelina arborea* harvested from the daboase plantation

Location	Tree section	Surface grades	Spindle speed		
			1000 rpm	1850 rpm	2500 rpm
Daboase	Top	Grade 1	-	-	-
		Grade 2	33.3	66.7	60.0
		Grade 3	66.7	33.3	40.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	33.3	66.7	60.0
	Middle	Grade 1	-	-	-
		Grade 2	40.0	80.0	60.0
		Grade 3	60.0	20.0	40.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	40.0	80.0	60.0
	Butt	Grade 1	-	-	-
		Grade 2	40.0	60.0	53.3
		Grade 3	60.0	40.0	46.7
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	40.0	60.0	53.3

Table 6 shows the results of the turning test on *Gmelina arborea* obtained from the Abofour plantation in the Dry Semi-Deciduous Forest Zone. The grades of this turning operation ranged from 20% (top section, 1000 rpm spindle speed) to 80% (all sections, 2500 rpm spindle speed). The results indicate that for all tree sections, the grade improved with increasing spindle speed, with a speed of 2500 rpm producing a higher surface quality grade of 80%.

Comparing the turning characteristics of the *Gmelina arborea* from the two ecological zones, that from Daboase had the highest surface quality grades at a spindle speed 1850 rpm, whilst specimens from Abofour had the highest surface quality grades at 2500 rpm. Abofour specimens generally performed better in the turning operation than those from Daboase. The most common defect in both cases was fuzzy grain. It can therefore be concluded that spindle speeds of 1850 rpm and 2500 rpm are suitable for turning *Gmelina arborea*.

Table 7, which shows the analysis of variance (ANOVA) of the surface quality of turned specimens, indicates that at 5% level of significance spindle speed and the interaction

Table 6. Surface quality grade of turned specimens of *Gmelina arborea* harvested from the Abofour plantation

Location	Tree section	Surface grades	Spindle speed		
			1000 rpm	1850 rpm	2500 rpm
Abofour	Top	Grade 1	-	-	33.3
		Grade 2	20.0	40.0	46.7
		Grade 3	80.0	46.7	20.0
		Grade 4	-	13.3	-
		Grade 5	-	-	-
		Grades 1 & 2	20.0	40.0	80.0
	Middle	Grade 1	-	-	-
		Grade 2	66.7	73.3	80.0
		Grade 3	33.3	26.7	20.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	66.7	73.3	80.0
	Butt	Grade 1	-	-	-
		Grade 2	60.0	66.7	80.0
		Grade 3	40.0	33.3	20.0
		Grade 4	-	-	-
		Grade 5	-	-	-
		Grades 1 & 2	60.0	66.7	80.0

Table 7. Location based ANOVA trials of tree sections and spindle speed over the surface quality on turned specimens

Source	DF	ANOVA SS	Mean Square	F - Ratio	p –value
Location	1	0.0930	0.0930	2.28	0.1326†
Tree section	2	0.0304	0.0152	0.37	0.6900†
Spindle speed	2	0.4195	0.2097	5.14	0.0065*
Location x TS	2	0.0777	0.0389	0.95	0.3876†
Location x SS	2	0.6582	0.3291	8.06	0.0004*
TS x SS	4	0.5401	0.1350	3.31	0.0116*
Location x TS x SS	4	0.5376	0.1344	3.29	0.0119*
Error	238	9.7189	0.0408		

**Statistically significant at 0.05 level of significance; †Not statistically significant at 0.05 level of significance*
Legend: TS = Tree section; SS = Spindle speed

between location and spindle speed, tree section and spindle speed and location, tree section and spindle speed have significant effects on the surface quality of turned specimens.

These results are similar to those of studies conducted by [27] and [34], which indicated that spindle and feed speeds have a significant effect on the turning and shaping qualities of the two timber species studied and that spindle speeds of 2,800 rpm and 6,000 rpm for turning and shaping tests, respectively, generated Grade I surface quality samples for Khaya and Mahogany.

4. CONCLUSION

The machining characteristics of wood significantly affect its efficient utilisation. This paper, which is part of a more extensive study, has focused on the planing and turning characteristics of *Gmelina arborea* cultivated in the Wet Evergreen and the Dry Semi-Deciduous Forest Zones in Ghana. The study showed that *Gmelina arborea* is a medium-density species and can therefore be used in various applications, such as high-quality joinery, furniture, mouldings, doors, carving and frames. The study further revealed that irrespective of the geographical location in Ghana where *Gmelina arborea* is cultivated, a feed speed of 6 m/min at a 30° cutting angle produces the best planing performance. *Gmelina arborea* cultivated in the Dry Semi-Deciduous Forest Zone performed better in planing than that cultivated in the Wet Evergreen Forest Zone. Furthermore, at the 5% level of significance, spindle speed and the interaction between location and spindle speed, tree section and spindle speed and finally location, tree section and spindle speed had significant effects on the surface quality of turned specimens. Therefore, it is recommended that a feed speed of 6 m/min at a 30° cutting angle should be used for planing *Gmelina arborea* lumber and that the Dry Semi-Deciduous Forest Zone should be considered the most suitable ecological zone for establishing *Gmelina arborea* plantations in the future. The turning test indicated that *Gmelina arborea* from Daboase in the Wet Evergreen Forest Zone and from Abofour in the Dry Semi-Deciduous Forest Zone had the best surface quality grade at spindle speeds of 1850 rpm and 2500 rpm, respectively. These spindle speeds should therefore be most suitable for turning *Gmelina arborea*. It is recommended that further studies be conducted on the mechanical and durability properties of *Gmelina arborea* cultivated in Ghana to better promote its utilisation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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