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Anatomical Properties of *Lonchocarpus sericeus,* Poir. A Lesser Utilized Timber Species in Nigeria

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ABSTRACT

Declining availability of the prime economic species in Nigeria timber market has led to the introduction of Lesser-Used-Species (LUS) as an alternative. Their acceptability demands information on their wood technical properties. The aim of this study is to investigate anatomical properties of *Lonchocarpus sericeus* which is a lesser used timber in Nigeria with a view to provide information on its anatomical structure and hence relate them to its utilization for various end-uses. Three matured trees of *Lonchocarpus sericeus* were selected from a free forest area of Longe village in Ibadan, Oyo State, Nigeria. Samples from the harvested trees were collected at base (10%), middle (50%) and top (90%) along the sampling heights and further partitioned into innerwood, centrewood and outerwood across the sampling radial position. Fibre characteristics namely:fibre length, fibre diameter and lumen width were investigated Microscopy was performed using a stage micrometer and an eye piece micrometer on a Reichert light microscope at 80 x. Analysis of variance (ANOVA) was conducted using R-Software and all statistical analyses were conducted as a 3 x 3 factorial experiment in a completely randomized design (CRD).Average values of fibre length, fibre diameter, fibre lumen width and fibre cell wall thickness of *Lonchocarpus sericeus* were1.29mm, 14.3 mm, 7.75 mm and 3.09 mm respectively. The cell wall thickness, Slenderness Ratio (SR), Flexibility Coefficient (FC), Runkel Ratio (RR), Rigidity Coefficient (RC), Luce`s Shape Factor (LSF) and Solid Factor (SF) were computed from the measured fibre dimension. The slenderness ratio ranging between 89.99 and 71.67increased from the base to the top and from the innerwood to the outerwood.The flexibility coefficient of *Lonchocarpus sericeus* showed inconsistent pattern of variations along the sampling heights and across the radial sampling positions. The Runkel ratios of *Lonchocarpus sericeus*was observed to be less than 1. Conclusively, the slenderness ratio, flexibility coefficient, Runkel ratio, Rigidity coefficient, Luce`s shape factor and solid factor values obtained, all supported the suitability of *Lonchocarpus sericeus* for pulp and paper production.

Keywords: Fiber Characterization, Lesser Used, Utilization, Pulp and Paper.

Introduction

Wood is a natural material with anisotropic structure. Its properties depend on the wood species and its related anatomical structure. A characteristic feature of wood, which distinguishes it from other uniform materials, is its diversity of properties, even within one species. As a raw material for construction, fuel wood and agricultural tools, wood has been overexploited as a result of increase in the world population which led to an increase in demand for wood and wood products. In order to meet the increasing demand, overexploitation of the forest has been done over the year for wood and its product for the teeming population. Some favoured timber species have become scarce while others have become extinct in certain ecological zones as a result of over exploitation (Fuwape, 2000). According to Okojie and Akande (1995), the annual consumption of wood in Nigeria has exceeded the allowable cut by about 3 million m^3 for industrial wood and about 10 million m^3 for fuel wood. The areas of constituted forests and woodland in Nigeria have declined progressively since the country independence in 1960 (Akande, 2003). From the forest industry perspective, this situation is disheartening as Nigeria grossly falls short of the internationally recommended forest cover per unit area of land. In order to meet the wood and wood products need of the population on sustained yield basis, wood supplied from the natural forest need to be supplemented with wood raised in plantation. It has been estimated that there are currently more than 50,000 plant species worldwide. Astonishingly, only about 1000 different tree species are utilized globally while the other are either under-utilized, not utilized, or used inappropriately (FAO, 2006). The present human population, estimated at approximately 6.5 billion in 2005 (Aktuell, 2007), has wood consumption needs within the range of 0.3 to 0.6 m3/year/habitant. As a result, the annual wood and wood based products consumption have been calculated to be around 3.5 billion m3, approximately 66% of which are hardwoods used mainly as fuel and the rest are softwoods used principally in industry (Youngquist, 1999). Many tree plants including *Lonchocarpus sericeus* are found to be under this categorises, which are under-utilized or used inappropriately.

Lonchocarpus sericeus is an evergreen tree with a roundish crown. It grows from 4 – 20 metres tall with a straight, cylindrical bole 30 - 70cm in diameter. The trees are harvested from the wild for local use as fuel and timber. An ornamental tree, especially when flowering, it is used in urban planting schemes. *Lonchocarpus* is a plant genus in the legume family (Fabaceae). The species is called lancepods due to their fruit resembling an ornate lance tip or a few beads on a string. It flowers with dense hanging racemes of purple flowers, mainly when leafless, which makes it perfect for display purposes. It is frequently planted in villages as shade tree and in gardens. The wood is clear yellow, sometimes marbled, with heart-wood and olive-green.

This study investigated the histological features of Nigerian *Lonchocarpus sericeus* with a view to provide information on its anatomical structure and hence relates them to its utilization for various end-uses. This is necessary because anatomical structure of wood species determines to a large extent its utilization for various purposes. For instance, thick walled fibres are able to transmit more stress, but are difficult for adhesive to penetrate; the small lumen, thick walls and narrow pit openings between fibres, all restrict adhesive flow into the wood and usually results in adhesive penetration only one or two fibres deep. On the other hand, wood with very thin fibre wall and wide lumen (for example *Ceiba pentandra, Bombax bounopozense* and *Ricinodendron heudeloti*) usually have their specific gravity about 0.25-0.5 and are very light(Adeniyi *et al*. 2013).

Materials and Methods

The *L. sericeus* trees were gotten from free forest area called Longe village, Busogbooro along Ibadan/Ijebu Ode road in Oluyole local Government area in Ibadan, Oyo State. *Lonchocarpus sericeus* wood samples were selected for this research based on their availability in the timber market aslittle or nothing is known about its wood properties. The trees were felled and their merchantable heights were measured. Samples from the base (10%), the middle (50%) and the top (90%) of the merchantable length were processed into test samples as showed in Fig. 1.

Anatomical characteristics examinations were carried out in accordance with the ASTM D 1413-61 (2007) at the Wood Anatomy section, Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan. Wood samples were macerated inside equal solution of hydrogen peroxide and acetic acid at 100^{o}C. Sectioning of wood samples into 20 microns thick was performed using a Reitchert sledge microtome.

Samples were prepared into three planes namely transverse, tangential and radial sections. The sections were later covered with safarin stain for two minutes after which series of concentrations ethanol were used for dehydrate. Clearing was done using a vegetable oil (Adeniyi *et al*. 2016). The specimens were embedded with Canadan balsam on microscopic slide and examined under a light microscope. Fibre characteristics such as fibre length, fibre diameter and lumen were measured using a stagemicrometer and an eye piece micrometer. Cell wall thickness, Slenderness Ratio (SR), Flexibility Coefficient (FC), Runkel Ratio (RR), Rigidity Coefficient (RC), Luce`s Shape Factor (LSF) and Solid Factor (SF) were derived and computed from the measured fibre dimension using equation 1to 7.

$$Cell\ wall\ Thickness = \frac{\text{Fibre Diameter}-\text{Lumen Width}}{2} \ldots\ldots 1$$

$$Slenderness\ Ratio = \frac{\text{Fibre Length}}{\text{Fibre Diameter}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$Flexibility\ Coefficient = \frac{\text{Lumen Diameter}}{\text{Fibre Diameter}} \ldots\ldots\ldots\ldots\ldots\ldots 3$$

$$Runkel\ Ratio = 2\text{x}\frac{\text{Cell Wall Thickness}}{\text{Lumen Diameter}} \ldots\ldots\ldots\ldots 4$$

$$Rigidity\ Coefficient = 2\text{x}\frac{\text{Cell Wall Thickness}}{\text{Fibre Diameter}} \ldots\ldots\ldots\ldots 5$$

$$Luce`s\ Shape\ Factor = \frac{Fibre\ Diameter^2 - Lumen\ Diameter^2}{Fibre\ Diameter^2 + Lumen\ Diameter^2} \ldots\ldots\ldots 6$$

$$Solid\ Factor = Fibre\ Diameter^2 - Lumen\ Diameter^2\ x\ Fibre\ Length \ldots\ldots 7$$

Analysis of variance (ANOVA) was conducted using R-Software.All statistical analyses were conducted as a 3 x 3 factorial experiment in a completely randomized design (CRD) to determine significant differences among treatment means. Separation of treatment means was carried out using Duncan multiple range test (DMRT). This was completed to know the differences between means and to choose the best treatment combination from the factors considered.

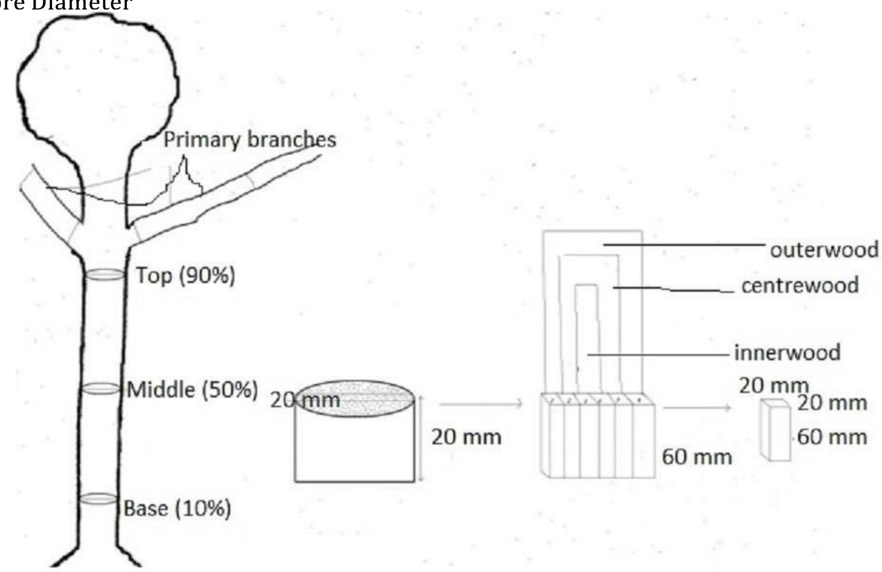

Fig 1: Schematic Sampling Procedure for obtaining the test samples

Results and Discussions

The results showed that average values of fibre length, fibre diameter, fibre lumen width and fibre cell wall thickness of *Lonchocarpus sericeus* were1.29mm, 14.3 mm, 7.75 mm and 3.09 mm, respectively.

Fibre Length

The longest fibre length in this study was recorded at the outer wood of the middle portion of *L. sericeus*, while the inner wood of the base portion had the shortestfibre length (Table1).

Generally, average fibre length in conifers ranges from 1.18mm to 7.39mmwhile that hardwood ranges from 0.5mm to 2.6mm (Panshin and Dezeeuw, 1980).The average fibre length of 1.29 mm obtained for*Lonchocarpus sericeus* in this study was the same with what was obtained in the findings of Roger *et al*. (2007) for *Gmelina arborea* but higher than the findings of Hindi *et al*. (2010) for *Leucaena leucocephala* (1.13mm), *Azadirachta indica* (1.04mm) and *Simmondsiachinens* (0.50mm), Ogunkunle (2010) for *G. arborea* (1.28mm) and Anguruwa (2018) for *Ficus exasperate* (1.07 mm). However, the fibre length of *Lonchocarpus sericeus* obtained in this study was lesser than 1.35 mm of *Triplochiton scleroxylon* (Ogunsanwo, 2000) and 1.36 mm of *Ricinodendron heudelotti* (Ogunleye, 2014)

It was observed that the fibre length of *L. sericeus* decreased from innerwood to the outerwood, this pattern of variation is in line with the findings of Rulliaty and America (1995) on *Swietennia macrophylla*, Ogunsanwo (2000) on *Triplochiton scleroxylon*, Izekor (2010) on *Tectonagrandi*, Ogunleye (2014) on *R. heudolotii* and Anguruwa (2018) on *Ficus exasperata*. The decrease in the fibre length of *Lonchocarpus sericeus* from the innerwood to the outerwood agrees with the reports of Onilude *et al.* (1988) on selected savannah tree species, Ogunsanwo (2000) on *Triplochiton scleroxylon*, Osadare (2001) on *Pinus caribaea*, Adejoba (2008) on *Ficus mucuso*, Izekor (2010) on *Tectona grandis*, Ogunleye (2014) on *R. heudolotii* and Anguruwa 2018) on *Ficus exasperata*. The observed variation may be as a result of geographical and environmental factors (Adejoba, 2008). Bamber and Burley (1983) confirmed that the sum total of factors influencing fibre length includes age, height in tree, season and cardinal points round the stem, rate of growth, silvicultural practices and defects in wood. Fibre length greatly affects the quality and the strength of the pulp and paper produced.

Fibre Diameter

The widest fibre diameter was recorded at the inner wood of the top portion of *Lonchocarpus sericeus*, while the outer wood of the base portion had the narrowest fibre diameter (Table 1 and Fig.3). The observed values of fibre diameter of *Lonchocarpus sericeus* falls between 14.10µm and 15.04µm which are lower to 14.0 – 16.0µm reported by Plant Protection Research Institute PPRI, (2011) for *Eucalyptus*, although the value of 14.5µmrecorded in this study is less than 30.67µm reported by Roger *et al* (2007) for *Gmelinaarborea*, 17.4µm, 29.3µm, 23.6µm 28.2µm, 37.5µm recorded by Adeniyi *et al.* (2013) for *Diospyros mespiliformis*, *Nauclea diderrichii*, *Afzelia Africana* and *Mansonia altissima* respectivelyand for those recorded by Ogunkunle (2010), and Emerhi (2011). Kaur and Dutt (2013) reported that greater value of fibre diameter increases the volume of forms of a coarse-surfaced paper sheet. With this result of fibre diameter, it shows that *Lonchocarpus sericeus* can be considered for pulp and paper production. Fibre diameter of *Lonchocarpus sericeus* decreased from the base to the top (Fig.2). The decrease in Fibre diameter of *Lonchocarpus sericeus* along the sampling height agrees with the findings of Izekor (2010) on *Tectona grandis* and Ogunleye (2014) on *R heudelotii*. This variation pattern along the sampling height could be due to the fact that minimum net photosynthate for cell development at the top caused by competition for leaf and branch development lead to better cells production at the base (Anguruwa, 2018). The fibre diameter of *Lonchocarpus sericeus* decreased from the innerwood to the outerwood. This pattern of variation across the radial sampling positions agrees with the findings of Kandeel and Bensend (1969) on Silver maple. Akachuku (1980) and Onilude and Ifju (1992) found a gradual decreasing trend from the pith to bark in *Gmelina arborea* and plantation grown cotton wood.

Fibre Lumen Width

The widest fibre lumen width was observed at the inner wood of the top portion of *Lonchocarpus sericeus*, while the inner wood of the base portion had the narrowest fibre lumen (Table 1 and Fig.4). The fibre lumen width was observed to be within the range of 7.75µm and 12.49µm. The lumen width decreased from the base to the top and increased from the innerwood to the centrewood then decreased towards the outerwood. The decrease of lumen width of *Lonchocarpus sericeus* from the base to the top agrees with the findings of Adejoba (2008), Izekor (2010), Ogunleye (2014) and Anguruwa (2018) on *Ficus mucuso*, *Tectona grandis*, *R heudelotii* and *Ficus exasperata* respectively while the inconsistent pattern of variation in anatomical properties of *L. sericeus* across the radial sampling positions negate the findings of Adejoba (2008) on *Ficus mucuso*, Izekor (2010) on *Tectona grandis*, Ogunleye (2014) on *R heudelotii* and Anguruwa (2018) on *Ficus exasperate.*

Cell wall thickness

The thickest cell wall was recorded at the inner wood of the top portion of *L. sericeus*, while the inner wood of the top portion had the thinnest fibre lumen width (Table 1). The cell wall thickness of *Lonchocarpus sericeus* wood was observed to be within the range of 3.09µm and 3.97µm. These values fall within the range of 1.94 – 4.99µm reported by Ogunkunle (2010) for *Ficus species*, higher than 2.82µm reported for *Gmelina arborea* by Ogunkunle (2010), 2.90µm for *Leucaena leucocephala* by Oluwadare and Ashimiyu (2007) and lower than 5.47µm reported for *Ficus exasperata* by Anguruwa (2018). The cell wall thickness of *Lonchocarpus sericeus* increases from the base to the top in line with the reports of Izekor (2010), Ogunleye(2014) and Anguruwa (2018) on *Tectona grandis, R heudelotii* and *Ficus exasperate* respectively; however, inconsistent pattern of variations was observed across the radial positions of *Lonchocarpus sericeus* which is contrary to the reports of Adejoba (2008), Izekor (2010) and Ogunleye (2014) on *Ficus mucuso*, *Tectona* and *grandis, R heudelotii*. This may likely be due to the level of development of the secondary cell wall which is a function of the age of the fibre. Cell wall thickness is important for fibre dimensions because of its effect on the rigidity and strength of the paper made from the fibre (Akpakpan *et al.*, 2012). Syed *et al.* (2016) reported that large fibres with thin walls give a positive effect as they tend to form non-porous tightly bonded paper sheet that is easily collapse and flexible. The light cell wall observed in this study confirms the suitability of *Lonchocarpus sericeus* as a raw material for pulp and paper making.

Table 1: Summary of mean values of Anatomical properties of *Lonchocarpus sericeus*

		Sampling height			
Property	**Radial**	**Base**	**Middle**	**Top**	**Pooled**
Fibre length	Innerwood	1.28±0.10	1.26±0.06	1.23±0.42	**1.26±0.25[b]**
(mm)	Centrewood	1.32±0.19	1.26±0.14	1.29±0.16	**1.29±0.16[b]**
	Outerwood	1.32±0.17	1.35±0.19	1.29±0.21	**1.32±0.19[a]**
	Pooled Mean	**1.31±0.16**	**1.29±0.14**	**1.27±0.28**	**1.29±0.20**
Fibre diameter	Innerwood	16.05±2.40	14.38±2.11	14.24±3.55	**14.89±2.82[a]**

(µm)	Centrewood	15.00±2.00	14.50±1.50	14.31±0.80	**14.60±1.50^{b}**
	Outerwood	14.08±1.13	14.48±1.52	13.76±1.10	**14.11±1.27^{c}**
	Pooled Mean	**15.04±2.03^{a}**	**14.46±1.69^{b}**	**14.10±2.16^{c}**	**14.53±1.99**
Lumen width	Innerwood	8.84±1.88	7.21±1.41	6.54±0.96	**7.53±1.73**
(µm)	Centrewood	7.95±1.19	8.73±2.53	7.73±0.81	**8.14±1.70**
	Outerwood	7.65±1.06	8.07±2.47	7.03±0.79	**7.58±1.64**
	Pooled Mean	**8.15±1.48^{a}**	**8.00±2.24^{a}**	**7.10±0.96^{b}**	**7.75±1.70**
Cell wall Thickness	Innerwood	2.47±0.90	2.79±0.45	3.85±1.56	**3.04±1.21**
(µm)	Centrewood	3.12±0.29	3.02±0.68	2.86±0.78	**3.00±0.61**
	Outerwood	3.15±0.31	3.21±0.29	3.37±0.21	**3.24±0.28**
	Pooled Mean	**2.92±0.65^{b}**	**3.01±0.52^{b}**	**3.36±1.07^{a}**	**3.09±0.80**

Mean with same superscript in the same column are not significantly different (p<0.05)

Slenderness Ratio of *Lonchocarpus sericeus*

The slenderness ratio of *L. sericeus is* 89.99 as showed in Table 2. This increased from the base to the top and also from the innerwood to the outerwood. This pattern of variation agrees with the reports of Ogunleye (2014) on *R heudelotii* and Anguruwa (2018) on *Ficus exasperata*. The slenderness ratio, also referred to as felting power of this species is higher than 50.06 reported for *G arborea* by Ogunkunle (2010), 39.1 for *G. arborea* by Sharma *et al* (2013), 35.85 for *R heudelotii* by Ogunleye (2014), 42 for *Leucaena leucocephala* by Oluwadare and Sotannde (2007), 44 for *Eucalyptus camaldulensis* by Manahil and Abdelazim (2015) and 50.57 for *Ficus exasperate* by Anguruwa (2018) but very close to 71.99 reported for different *Ficus species* by Ogunkunle (2010). Akgul (2009), reported that slenderness ratio is one of the criterions that control the suitability of wood material for paper production which is determined by comparing the fibre length to fibre diameter. The measure of tearing, bursting and breaking off properties in paper making is determined from fibre length and fibre diameter. Sharma *et al*., (2013) and also Xu*et al*., (2006) reported that slenderness ration of greater than 33 is the best suitable for pulp and paper production. Low slenderness ratio means production of weak paper; hence both *Lonchocarpus sericeus* with high slenderness ratio of 89.99 will produce a very strong paper with higher rate of tear resistance compared to *Gmelina arborea*.

Flexibility Coefficient of *Lonchocarpus* sericeus

The flexibility coefficient of *L. sericeus*is 0.54. This values less than 0.73 and 0.63 to 0.79 reported by Ogunkunle (2010) for *G. arborea* and *Ficus species* respectively. This species showed inconsistent pattern of variations along the sampling heights and across the radial sampling positions as showed in Table 2 and this maybe as a result of unavoidable defects on the wood samples used in lumen diameter and fibre diameter determination since flexibility coefficient is the ratio of lumen diameter to fibre diameter. This inconsistent variation pattern was also reported by Ogunleye (2014) on *R heudelotii*. Flexibility coefficient is one of the important derived indices to determine strength properties of paper and is governed by lumen diameter and fibre diameter (Ogunleye, 2014). It determines the degree of fibre bonding in paper sheet. Smook (1997) reported that 0.55 – 0.70 and 0.75 flexibility coefficient values for hardwood and softwood respectively. Bektas *et al.* (1999) also reported that fibre having flexibility coefficient more than 0.75 and between 0.50 – 0.75 are considered as highly elastic and elastic and elastic fibres. Therefore, *Lonchocarpus sericeus* fall within the range of elastic fibres which mean that the species is flexible and satisfy the requirement for their suitability for pulp and paper production.

Runkel Ratio of *Lonchocarpus sericeus*

The Runkel ratio of *L.sericeus*is0.93 respectively. The Runkel ratio of *Lonchocarpus sericeus* remained constant from the base to the middle then a slight increase to the top while it decreases from the innerwood to the centrewood then increases to the outerwood. Runkel ratio measures the proportion of cell-wall thickness in relation to the lumen width of the fibre. The fibres with Runkel ratios less than 1 are considered as good for paper making because the fibres are flexible easily collapse and form a paper with large bonded area while the fibres with Runkel ratios above 1 are considered thick-walled fibres which are stiffer, less flexible and form bulky paper sheet of lower bonded area (Dutt *et al*., 2009). Ona *et al*. (2001) reported that Runkel ratio is related to paper conformability, pulp yield and fibre density. The Runkel ratio of *L. sericeus* is less than 1. Hence, the species can be considered suitable for pulp and paper production.

Luce`s Shape factor of *Lonchocarpus sericeus*

The Luce`s Shape factor (LSF) of *L. sericeus is* 0.55. The species showed inconsistent pattern of variation from the base to the top along the sampling height and LSF of *Lonchocarpus sericeus* decreases from the innerwood to the centrewood then slightly increased to the outerwood. LSF is directly related to paper sheet density (Ogunleye, 2014). It is an important fibre index and derived from fibre diameter and lumen diameter. Ona *et al*. (2001) stated that LSF and solids factor were found to be related to paper sheet density and could be significantly correlated to breaking length of paper. The LSF of *L. sericeus* obtained in this study compared well with the reports of Ogunkunle (2010) on *G arborea*, Oluwadare (2007) on *Afzelia Africana*, Ogunleye (2014) on *R heudelotii* and Anguruwa (2018) on *Ficus exasperata* which means that the species is suitable wood for pulp and paper production.

Solid factor of *Lonchocarpus sericeus*

The solid factor of *L. sericeus*is 198.40. The species showed inconsistent pattern of variation from the base to the top along the sampling height. Across the radial sapling positions, *Lonchocarpus sericeus* decreases from the innerwood to the outerwood.

Rigidity Coefficient of *Lonchocarpus sericeus*

The rigidity coefficient of *L. sericeus* is 0.46. The species exhibited inconsistent pattern of variation along the sampling height and across the radial sampling positions as showed in Table 2. Rigidity coefficient is a major index that governs flexibility and coarseness of the fibre. It is expresses the fraction of the cell-wall thickness in the fibre diameter (Anguruwa, 2018). Increasing fibre rigidity results to decrease in fibre bonding which results into stiffer, less flexible and form bulkier paper with lower bonded area, coarse surfaced and contained a large amount of void volume (Dutt and Tyagi, 2011). This implies that fibres with low rigidity coefficient give higher degree of conformability within the sheet, which results in sheet of lower bulk or higher density. Paper made from such fibres will be bright, physical strong with low porosity and could be said to be perfect for printing, writing , wrapping and packaging purposes.

Table 2: Summary of mean values of derived Anatomical properties of *Lonchocarpus sericeus*

		Sampling height			
Property	**Radial position**	**Base (10%)**	**Middle (50%)**	**Top (90%)**	**Pooled Mean**

Slenderness ratio	Innerwood	81.93±17.35	89.66±15.13	87.34±27.45	**86.31±20.47**^{b}
	Centrewood	90.46±20.48	87.93±10.67	90.34±10.65	**89.58±14.39**^{b}
	Outerwood	94.08±12.19	93.88±17.23	94.29±16.22	**94.08±15.01**^{a}
	Pooled Mean	**88.83±17.41**	**90.49±14.49**	**90.66±19.18**	**89.99±17.03**
Flexibility coefficient	Innerwood	0.57±0.17	0.51±0.10	0.47±0.09	**0.52±0.13**
	Centrewood	0.54±0.08	0.60±0.14	0.54±0.05	**0.56±0.10**
	Outerwood	0.54±0.07	0.55±0.11	0.51±0.02	**0.54±0.08**
	Pooled Mean	**0.55±0.11**	**0.55±1.12**	**0.51±0.06**	**0.54±0.11**
Runkel ratio	Innerwood	0.91±0.57	1.05±0.43	1.18±0.42	**1.05±0.48**^{a}
	Centrewood	0.92±0.37	0.75±0.38	0.87±0.20	**0.85±0.33**^{b}
	Outerwood	0.87±0.25	0.89±0.40	0.97±0.09	**0.91±0.28**^{b}
	Pooled Mean	**0.90±0.41**	**0.90±0.41**	**1.00±0.30**	**0.93±0.38**
Luce`s shape factor	Innerwood	0.51±0.21	0.59±0.12	0.63±0.11	**0.58±0.16**
	Centrewood	0.55±0.11	0.47±0.17	0.55±0.07	**0.52±0.13**
	Outerwood	0.54±0.09	0.53±0.14	0.59±0.03	**0.55±0.10**
	Pooled Mean	**0.54±0.14**	**0.53±0.15**	**0.59±0.08**	**0.55±0.13**
Solid factor	Innerwood	227.74±111.48	197.22±72.45	243.17±201.53	**222.56±137.54**^{a}
	Centrewood	210.30±60.79	163.13±63.17	188.31±39.25	**187.25±57.58**^{b}
	Outerwood	185.62±53.46	189.53±47.37	181.00±40.25	**185.38±46.38**^{b}
	Pooled Mean	**207.89±79.61**	**183.29±62.22**	**204.16±121.31**	**198.40±46.38**
Rigidity coefficient	Innerwood	**0.43**±0.17	**0.49**±0.10	**0.53**±0.10	**0.48±0.13**
	Centrewood	0.46±0.08	0.40±0.14	0.44±0.06	**0.44±0.10**
	Outerwood	0.46±0.07	0.45±0.11	0.49±0.02	**0.46±0.08**
	Pooled Mean	**0.45±0.11**	**0.45±0.12**	**0.49±0.06**	**0.46±0.11**

Mean with same superscript in the same column are not significantly different ($p<0.05$)

Conclusion

This research work has provided fundamental information on the anatomical properties of *Lonchocarpus sericeus* as a lesser utilized wood species found in Nigeria with the provision of information in the area of possible end utilization. The fibre length obtained for *Lonchocarpus sericeus* is an indication that if used for paper can give a good resistance to tearing, and this can play a crucial role in reducing the cost of pulp fibre to paper industry importation in Nigeria. The large fibres with thin walls obtained in this study for *Lonchocarpus sericeus* gives a positive effect as they tend to form non-porous tightly bonded paper sheet that is easily collapse and flexible. Moreover, the slenderness ratio, flexibility coefficient, Runkel ratio (which is less than 1), rigidity coefficient, Luce`s shape factor and solid factor values obtained all supported the suitability of *Lonchocarpus sericeus* for pulp and paper production.

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