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COMPARATIVE WOOD ANATOMY OF SOME MEMBERS OF THE GENUS *CAESALPINIA* (LINN.) SW

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ABSTRACT

The wood anatomy of two varieties of *Caesalpinia bonduc* (L.) Roxb., that is the staminate and pistillate plants and four varieties of *Caesalpinia pulcherrima* (Linn).Sw, namely, Red, Yellow, Off-white and Pink petal plants were studied in search of wood anatomical characters that may be useful in the taxonomy of the *Caesalpinia* genus. Transverse, tangential longitudinal and radial longitudinal sections of the woods were made and some other parts of the woods were macerated. Qualitative and quantitative characters were observed and measured respectively, in all the taxa. The data were subjected to Duncan multiple range test (DMRT), principal components analysis (PCA) and single linkage cluster analysis (SLCA). The results revealed that growth ring is absent in all the taxa studied. They all have diffuse porous woods with heterogenous, uniseriate rays and solitary vessels. Pistillate plant of *C. bonduc* is the only taxa with multiple ray cells. Apotracheal axial parenchyma type was unique to the staminate plant of *C. bonduc* while paratracheal type was unique to *C. bonduc* pistillate. All the varieties of *C. pulcherrima* lack axial parenchyma. Tylose was absent in the pistillate plant of *C. bonduc* var. female and *C. pulcherrima* var. pink but present in all the other taxa. The first three components of the PCA accounted for 95.73% of the total variation among the taxa. It was concluded that quantitative and qualitative wood anatomical characters can be employed in differentiating the species and varieties of *Caesalpinia* studied.

Keywords: Axial parenchyma, *Caesalpinia*, Fibres, Tylose, Vessels, Wood anatomy.

INTRODUCTION

The genus *Caesalpinia* Linn. belongs to the family Fabaceae, subfamily Caesalpinioideae and tribe Caesalpinieae Benth. (Polhill *et al*., 1981; Lewis, 2005). *Caesalpinia* is a Pantropical genus of woody species in Africa, Asia, and America. They are represented by about 140 species of trees, shrubs and lianas usually with thorns, bipinnate compound leaves and other great morphological variations which have been variously described (Lewis, 1998; Chen *et al.,* 2010). Many species are important as ornamentals, medicinal plants, or as timber producing plants (Burkart, 1952).

According to Burkhill (1985), three species of *Caesalpinia* (*C. bonduc* (Linn.) Roxb., *C. decapetala* (Roth) Alston and *C. pulcherrima* (Linn.) Sw) are found in West Africa and in Nigeria. However, only two species (*C. pulcherrima* and *C. bonduc*) were identified on the Campus of Obafemi Awolowo University, Ile-Ife, South Western Nigeria. *Caesalpinia pulcherrima* varieties were found with inflorescences of four different colours on different plant stands. There were plant stands with red petals and yellow margins, yellow petals, off-white petals and pink petals. These arrays of flowers of *C. pulcherrima* had been confirmed by Roach *et al.* (2003). On the other hand, according to Tomlinson (1986), *C. bonduc* plants are either pistillate (having flowers with the female part only) or staminate (having flowers with the male part only).

A detailed morphological description of *C. bonduc* and *C. pulcherrima* had been reported (Harden, 2002; Roach *et al*., 2003; Kannur *et al*., 2012). The medicinal uses of various parts of these two species have also been described (Ragasa *et al.,* 2002; Chiang *et al.,* 2003; Islam *et al.,* 2003; Srinvas *et al.,* 2003; Gupta *et al*., 2005; Sudhakar *et al.,* 2006; Kannur *et al*., 2012). Phytochemical studies have been carried out on some members of the genus *Caesalpinia* as reported by Zanin *et al.* (2012). *C. pulcherrima* is usually cultivated as an ornamental plant while *C. bonduc* contributes to the biodiversity of the forests where it grows, helps protect the soil, and furnishes cover for wildlife. Chromosome number reported for the genus by Rodrigues *et al.* (2012) is 2n = 24.

The purpose of this work is therefore to explore and identify the wood anatomical characters that can be useful in the identification and delimitation of the varieties of *Caesalpinia bonduc* and *C. pulcherrima* in addition to their unique floral morphological characters.

MATERIALS AND METHODS

The species and varieties studied were the two sexual forms of *Caesalpinia bonduc* (Linn.) Roxb (Staminate and Pistillate) and the four varieties of *Caesalpinia pulcherrima* Linn. (red petal, yellow petal, off-white petal and pink petal). Matured wood samples were collected from these six taxa on Obafemi Awolowo University campus (N07º31.252' E004º31.307'), Ile-Ife, Osun State, Nigeria.

Small blocks of wood were sliced into match-stick like sizes using a sharp knife and placed in a Petri-dish containing Schultz's fluid. The Schultz's fluid was prepared by mixing equal volume of 10% of chromic acid (1 g of potassium dichromate in 50 ml concentrated nitric acid) and 5 ml of nitric acid. The Petri-dishes were placed in the oven for about six hours to aid softening of the wood, for maceration. The macerates were afterwards rinsed thoroughly and stained with Safranin O for 3 minutes prior to microscopic examination.

For wood sectioning, blocks of wood were boiled in water for several hours to soften the tissues. Transverse section (T.S.), tangential longitudinal section, (T.L.S.) and radial longitudinal section, (R.L.S.) of the woods of each of the *Caesalpinia* taxa were cut at 10 microns thickness using a sledge microtome. The sections were stained with Safranin O and counter-stained in Alcian blue, after which they were made to pass through different concentrations (50%, 70%, 80%, 90% and 100%) of ethanol for differentiation and dehydration. They were then mounted on glass slides for microscopic examination.

Both qualitative and quantitative wood anatomical characters were observed in all the taxa. The qualitative characters studied include the distribution of axial parenchyma and their relationship with the vessel, the type of vessels and their distribution, the ray cells as well as types of vessel perforation and inter vascular pitting. The features of the fibres were also observed and noted. The quantitative characters measured are vessel diameter, vessel length, fibre length, and ray length. The distribution of solitary and multiple (radial multiple and pores clusters) vessels, were noted and their percentages were also calculated. All measurements were made with an ocular micrometer and the final figures were obtained with the ocular constant. The qualitative data observed were coded, merged with the quantitative data and all were subjected to principal components analysis (PCA) and single linkage cluster analysis (SLCA). Means were compared using Duncan multiple range test (DMRT). Photomicrographs of the macerates and sections were made using AmScope camera attached to the microscope.

RESULTS

The results of the wood anatomical character of the six taxa of *Caesalpinia* studied are as described below. Table 1 shows the summary of the qualitative wood anatomical characters of the taxa, table 2 shows the summary of their vessel attributes, table 3 shows the summary of their quantitative wood anatomical characters while table 4 shows the Eigenvalue and the percentage of total variation accounted for by the first three components axes of ordination of the taxa. Figure 1 shows the graph of the principal components analysis of the taxa based on components 1 and 2 while figure 2 shows the graph of the principal components analysis of the taxa based on components 1 and 3. Figure 3 is the dendrogram of the *Caesalpinia* taxa based on the qualitative and the quantitative wood anatomical characters while the photomicrographs of the taxa are shown in figures 4 – 7.

Caesalpinia bonduc **Staminate**

Wood is diffuse porous and growth rings are absent. The vessel pores vary from spherical or circular to elliptic in shape with tylose. Very few vessel pores are in radial multiple ranging from 2-8, pore cluster vessels range from 3-6, solitary vessels are present (Figure 4A). Mean pore diameter is 108.92 ± 3.50 μm. Percentage of solitary vessels ranges from 45.8 to 65.2% while that of multiple vessels range from 34.78 to 54.17%. The axial parenchyma is apotracheal.

Vascular ray cells are uniseriate non-storied (Figure 5A) and mean ray length is 52.08 ± 4.79 μm. Rays are heterogeneous or heterocellular, consisting of both procumbent and upright cells (Figure 6A). Macerates show fibres that are non-septate and non-storied with an average length of 677.67 ± 21.85 μm. Vessel perforation simple, vessels have simple pitting, some of the vessels have tail at one end. Vessels end mostly oblique and the mean vessel length is 320.67 ± 12.23 μm (Tables 1, 2 & 3, Figure 7A).

Caesalpinia bonduc **Pistillate**
Wood is diffuse porous and growth rings are absent. The vessel pores vary from spherical or circular to elliptic in shape without tylose. Vessel pores are in radial multiple ranging from 2-6, pore clusters absent, solitary vessels are present (Figure 4B). Mean pore diameter is 105.75 ± 3.38 μm. Percentage of solitary vessels ranges from 60 to 100% while that of multiple vessels ranges from 8.3 to 40%. Axial parenchyma is paratracheal (vasicentric). Vascular ray cells are compound and uniseriate, non-storied (Figure 5B) with mean length of 48.58 ± 2.36 μm. Ray cells are heterogeneous or heterocellular consisting of procumbent and upright cells (Figure 6B). Macerates show fibres that are non-septate and non-storied with an average length of 794.67 ± 24.12 μm. Vessel perforation simple, vessels have simple pitting, some of the vessels have tail at one end. Vessels end oblique. Mean vessel length is 345.33 ± 17.24 μm (Tables 1, 2 & 3, Figure 7B).

Caesalpinia pulcherrima **var. red**
Wood is diffuse porous and growth rings are absent. The vessel pores vary from spherical or circular to elliptic in shape with tylose. Very few vessel pores are in radial multiple ranging from 2-5, pore clusters 3-4, solitary vessels are present (Figure 4C). Mean pore diameter is 67.50 ± 1.72 μm. Percentage of solitary vessels ranges from 75.47 to 92.11% while that of multiple vessels range from 7.89 to 10.90%. Axial parenchyma is absent. Vascular ray cells are uniseriate and non-storied (Figure 5C) with a mean length of 35.92 ± 1.48 μm. Ray cells are heterogeneous or heterocellular comprising of procumbent and upright cells (Figure 6C). Macerates show fibres that are non-septate and non-storied with mean length of 614.00 ± 18.77 μm. Vessels perforation is simple. Vessels have tail at one end. Mean vessel length 225.33 ± 9.56 μm (Tables 1, 2 & 3, Figure 7C).

Caesalpinia pulcherrima **var. yellow**
Wood is diffuse porous and growth rings are absent. The vessel pores vary from elliptic to circular in shape with tylose. Vessels are in radial multiple of 2-3 pores, pore clusters 3-6, and solitary vessels are present also (Figure 4D). Mean pore diameter is 70.00 ± 1.58 μm. Percentage of solitary vessels ranges from 79.17 to 96% while that of multiple vessels range from 4.0 to 20.83%. Axial parenchyma is absent. Vascular ray cells are uniseriate and non-storied (Figure 5D) with a mean length of 37.50 ± 1.23 μm. Ray cells are heterogeneous or heterocellular comprising of upright and procumbent cells (Figure 6D). Macerates show fibres that are non-storied and non-septate with mean length of 641.00 ± 13.88 μm. Vessel perforation is simple. Vessels have no tail. Mean vessel length is 222.00 ± 9.53 μm (Tables 1, 2 & 3, Figure 7D).

Caesalpinia pulcherrima **var. off-white**
Wood is diffuse porous and growth rings are absent. The vessel pores vary from elliptic to circular in shape with tylose. Vessel pores are in radial multiple ranging from 2-6, pore clusters 3-6, and solitary vessels are present also (Figure 4E). Mean pore diameter is 68.83 ± 1.43 μm. Percentage of solitary vessels ranges from 62.58 to 90.41% while that of multiple vessels ranges from 12.32 to 37.5%. Axial parenchyma is absent. Vascular ray cells are uniseriate and non-storied (Figure 5E) with a mean length of 37.58 ± 1.89 μm. Ray cells are heterogeneous or heterocellular comprising of upright and procumbent cells (Figure 6E). Macerates show fibres that are non-storied and non-septate with mean length of 569.00 ± 16.13 μm. Vessel perforation is simple. Vessels have no tail. Mean vessel length is 253.67 ± 5.88 μm (Tables 1, 2 & 3, Figure 7E).

Caesalpinia pulcherrima **var. pink**
Wood is diffuse porous and growth rings are absent. The vessel pores vary from spherical or circular to elliptic in shape without tylose. Vessel pores are in radial multiple ranging from 2-4, pore clusters 3-6. Solitary vessels are present also (Figure 4F). Mean pore diameter is 74.42 ± 1.79

μm. Percentage of solitary vessels ranges from 70.83 to 75% while that of multiple vessels ranges from 25 to 29.17%. Axial parenchyma is absent. Vascular ray cells are uniseriate, biseriate and non-storied (Figure 5F) with a mean length of 38.33 ± 1.25 μm. Ray cells are heterogenous or heterocellular comprising of procumbent and upright cells (Figure 6F). Macerates show fibres are non-storied and non-septate with mean length of 584.67 ± 10.89 μm. Vessel perforation is simple. Vessels have no tail. Mean vessel length is 251.33 ± 7.22 μm (Tables 1, 2& 3, Figure 7F).

Table 1: Summary of qualitative wood anatomical characters of the species and varieties of *Caesalpinia* studied

	Wood Character				
Species	**Wood porosity**	**Growth ring**	**Vascular ray type**	**Axial parenchyma**	**Tylose**
C. bonduc staminate	Diffuse porous	Absent	Heterogenous, Uniseriate	Apotracheal (banded)	Present
C. bonduc pistillate	Diffuse porous	Absent	Heterogenous, Multiseriate, Uniseriate	Paratracheal (vasicentric)	Absent
C. pulcherrima var. red	Diffuse porous	Absent	Heterogenous, Uniseriate	Absent	Present
C. pulcherrima var. yellow	Diffuse porous	Absent	Heterogenous, Uniseriate	Absent	Present
C. pulcherrima var. off-white	Diffuse porous	Absent	Heterogenous, Uniseriate	Absent	Present
C. pulcherrima var. pink	Diffuse porous	Absent	Heterogenous, Uniseriate, Biseriate	Absent	Absent

Table 2: Summary of the vessel attributes of the species and varieties of *Caesalpinia* studied

	Wood Character (Vessel)				
Species	**Radial Multiple**	**Pore Cluster**	**Vessel tail**	**Solitary vessels (%)**	**Multiple vessels (%)**
C. bonduc staminate	2 - 8	3 - 6	Present	45.8 - 65.2	34.8 - 54.2
C. bonduc pistillate	2 - 6	-	Present	60.0 - 100.0	8.3 - 40.0
C. pulcherrima var. red	2 - 5	3 - 4	Present	75.5 - 92.1	7.9 - 10.9
C. pulcherrima var. yellow	2 - 3	3 - 6	Absent	79.2 - 96.0	4.0 - 20.8
C. pulcherrima var. off-white	2 - 6	3 - 6	Absent	62.6 - 90.4	12.3 - 37.5
C. pulcherrima var. pink	2 - 4	3 - 6	Absent	70.8 - 75.0	25.0 - 29.2

Table 3: Summary of quantitative wood anatomical characters of the species and varieties of *Caesalpinia* studied

Species	Wood Character				
	Vessel Length (µm)	**Vessel Breadth (µm)**	**Ray Length (µm)**	**Fibre Length (µm)**	**Pore Diameter (µm)**
C. bonduc Male	320.67±12.23^{A}	140.75±7.02^{A}	52.08±4.79^{A}	677.67±21.85^{B}	108.92±3.50^{A}
C. bonduc Female	345.33±17.24^{A}	120.75±6.79^{B}	48.58±2.36^{A}	794.67±24.12^{A}	105.75±3.38^{A}
C. pulcherrima Red	225.33±9.56^{B}	83.08±4.11^{D}	35.92±1.48^{B}	614.00±18.77^{CD}	67.50±1.72^{B}
C. pulcherrima Yellow	222.00±9.53^{B}	86.50±3.09^{D}	37.50±1.23^{B}	641.00±13.88^{CB}	70.00±1.58^{B}
C. pulcherrima Off-white	253.67±5.88^{B}	96.00±3.06^{CD}	37.58±1.89^{B}	569.00±16.13^{D}	68.83±1.43^{B}
C. pulcherrima Pink	251.33±7.22^{B}	109.75±3.90^{CB}	38.33±1.25^{B}	584.67±10.89^{D}	74.42±1.79^{B}

** Means with the same letter along columns are not significantly different at $P \leq 0.05$.

Table 4: Eigenvalue and the percentage of total variation accounted for by the first three components axes of ordination of the *Caesalpinia* species and varieties.

Principal components axis	Eigenvalue	Percentage of total variation	Cummulative percentage
I	1.9954	57.01	57.01
II	0.9643	27.55	84.56
III	0.3910	11.17	95.73

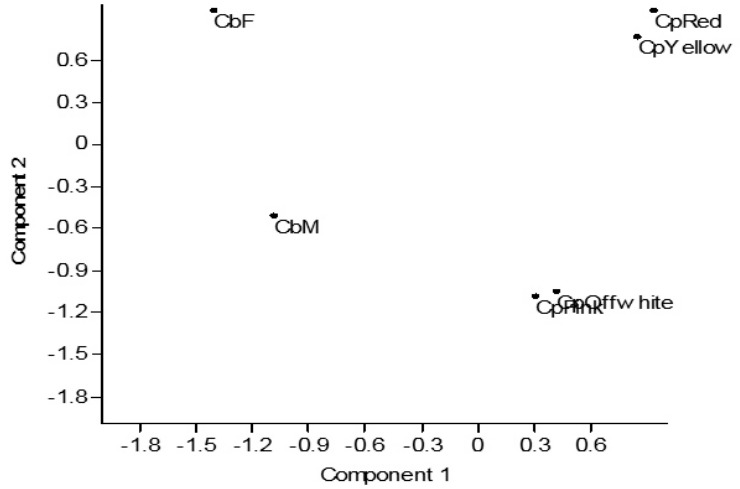

Figure 1: Principal component analysis showing the relationship of *Caesalpinia* species and varieties based on their wood anatomical characters.

Legend: CbF – *Caesalpinia bonduc* pistillate; CbM - *Caesalpinia bonduc* staminate; CpRed – *Caesalpinia pulcherrima* var. red; CpYellow – *Caesalpinia pulcherrima* var. yellow; CpOffwhite - *Caesalpinia pulcherrima* var. off-white; CpPink - *Caesalpinia pulcherrima* var. pink

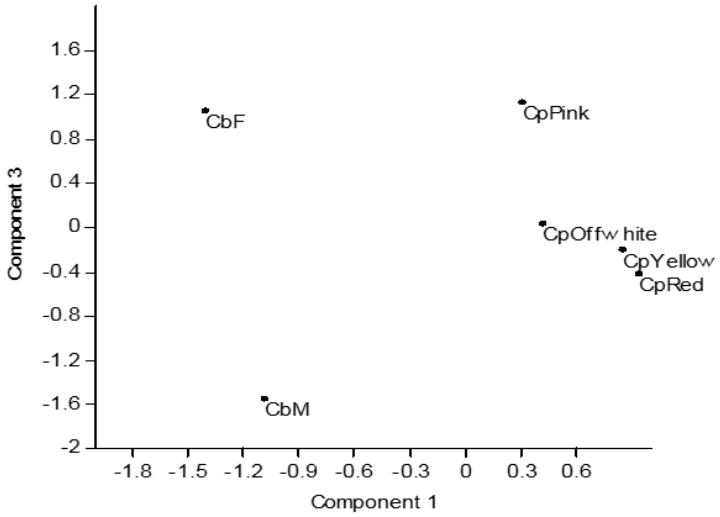

Figure 2: Principal component analysis showing the relationship of *Caesalpinia* species and varieties based on their wood anatomical characters.

Legend: CbF – *Caesalpinia bonduc* pistillate; CbM - *Caesalpinia bonduc* staminate; CpRed – *Caesalpinia pulcherrima* var. red; CpYellow – *Caesalpinia pulcherrima* var. yellow; CpOffwhite - *Caesalpinia pulcherrima* var. off-white; CpPink - *Caesalpinia pulcherrima* var. pink

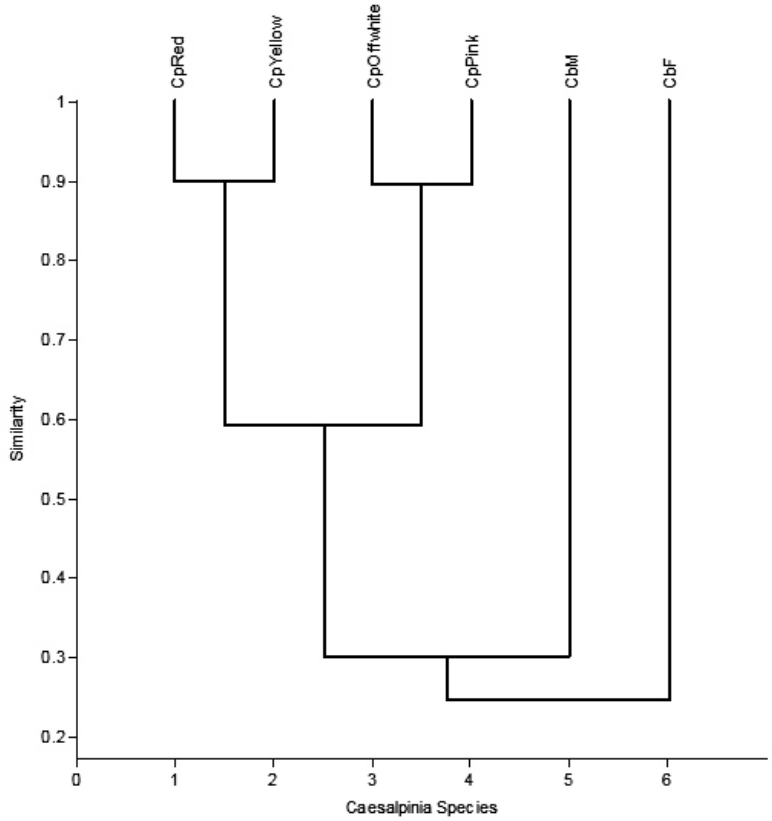

Figure 3: Dendrogram of *Caesalpinia* species and varieties based on the qualitative and quantitative wood anatomical characters.
CbF – *Caesalpinia bonduc* pistillate
CbM - *Caesalpinia bonduc* staminate
CpRed – *Caesalpinia pulcherrima* var. red
CpYellow – *Caesalpinia pulcherrima* var. yellow
CpOffwhite - *Caesalpinia pulcherrima* var. off-white
CpPink - *Caesalpinia pulcherrima* var. pink

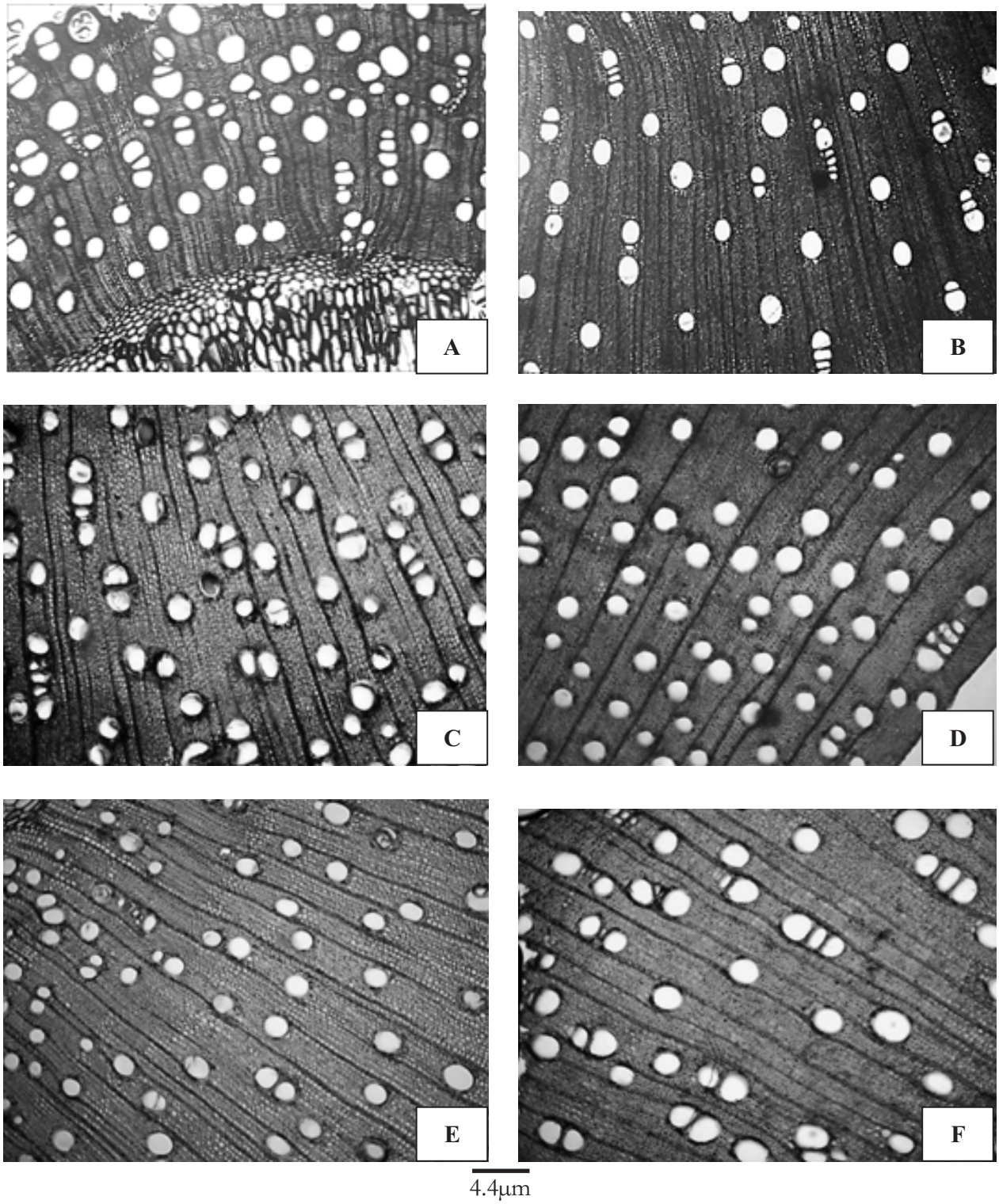

Figure 4: Transverse section of the *Caesalpinia* species and varieties.
A – *C. bonduc* staminate, B – *C. bonduc* pistillate, C – *C. pulcherrima* var. red, D – *C. pulcherrima* var. yellow, E – *C. pulcherrima* var. off-white, F – *C. pulcherrima* var. pink.

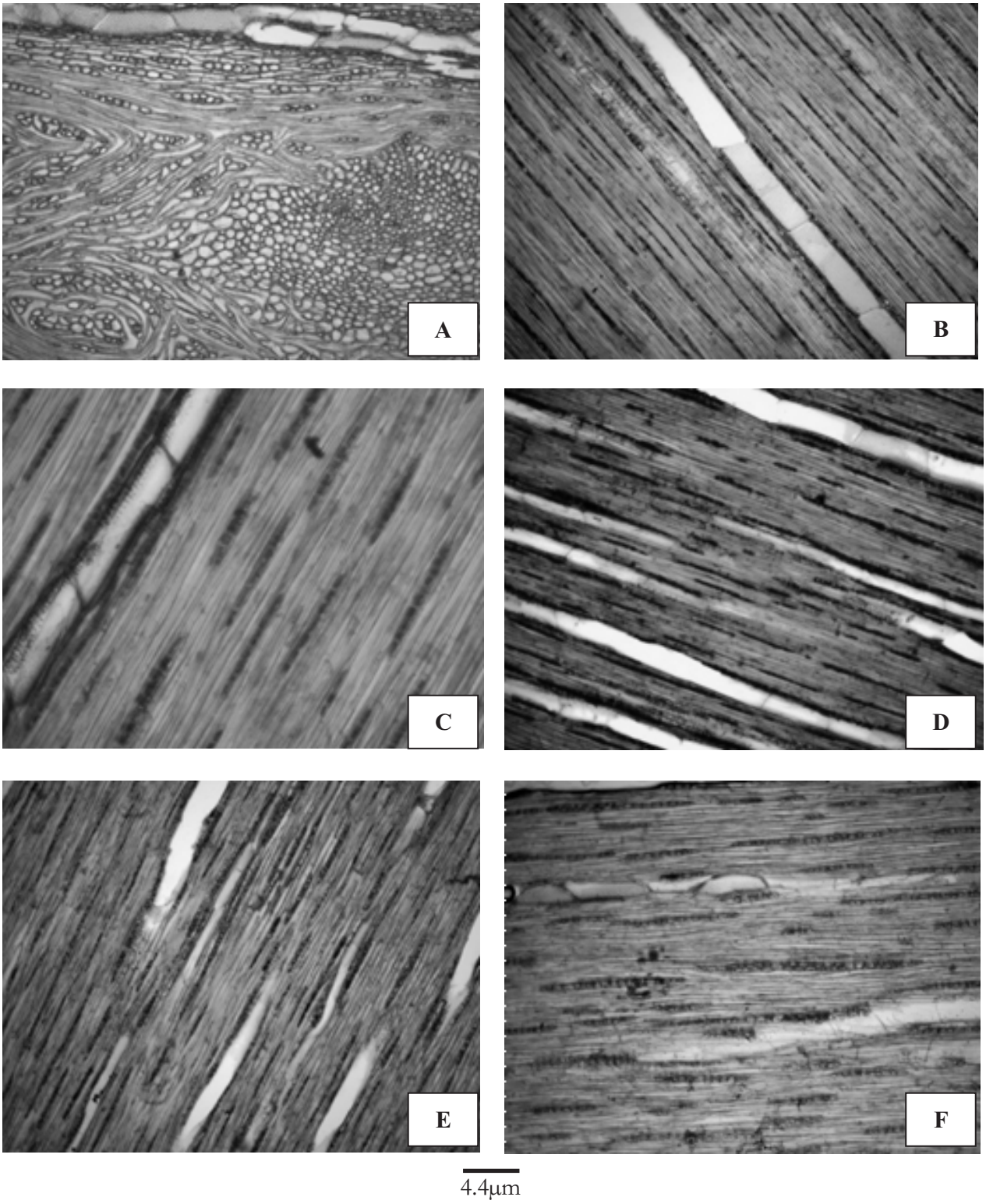

Figure 5: Tangential longitudinal section of the *Caesalpinia* species and varieties.
A – *C. bonduc* staminate, B – *C. bonduc* pistillate, C – *C. pulcherrima* var. red, D – *C. pulcherrima* var. yellow, E – *C. pulcherrima* var. off-white, F – *C. pulcherrima* var. pink.

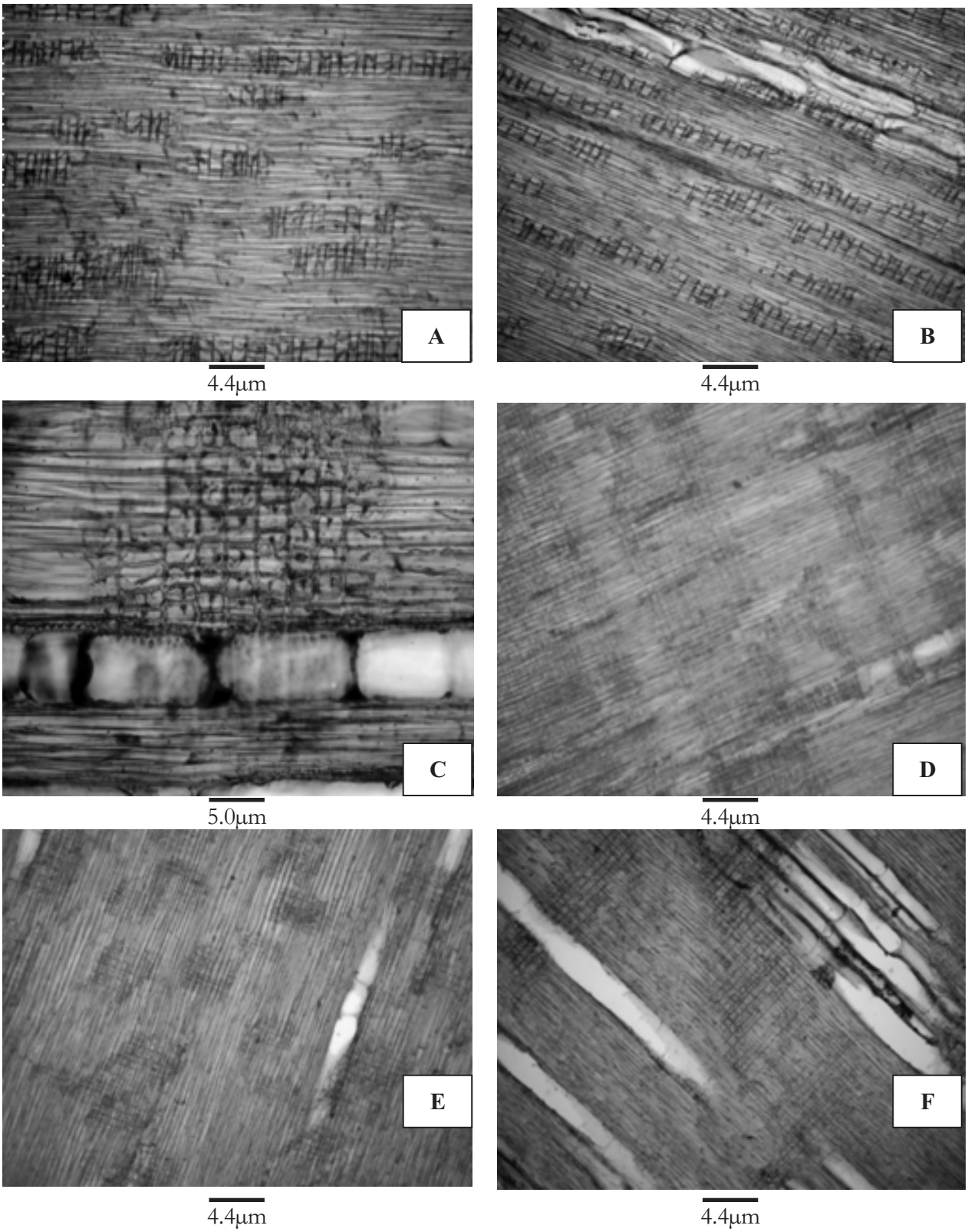

Figure 6: Radial longitudinal section of *Caesalpinia* species and varieties.
A – *C. bonduc* staminate, B – *C. bonduc* pistillate, C – *C. pulcherrima* var. red, D – *C. pulcherrima* var. yellow, E – *C. pulcherrima* var. off-white, F – *C. pulcherrima* var. pink.

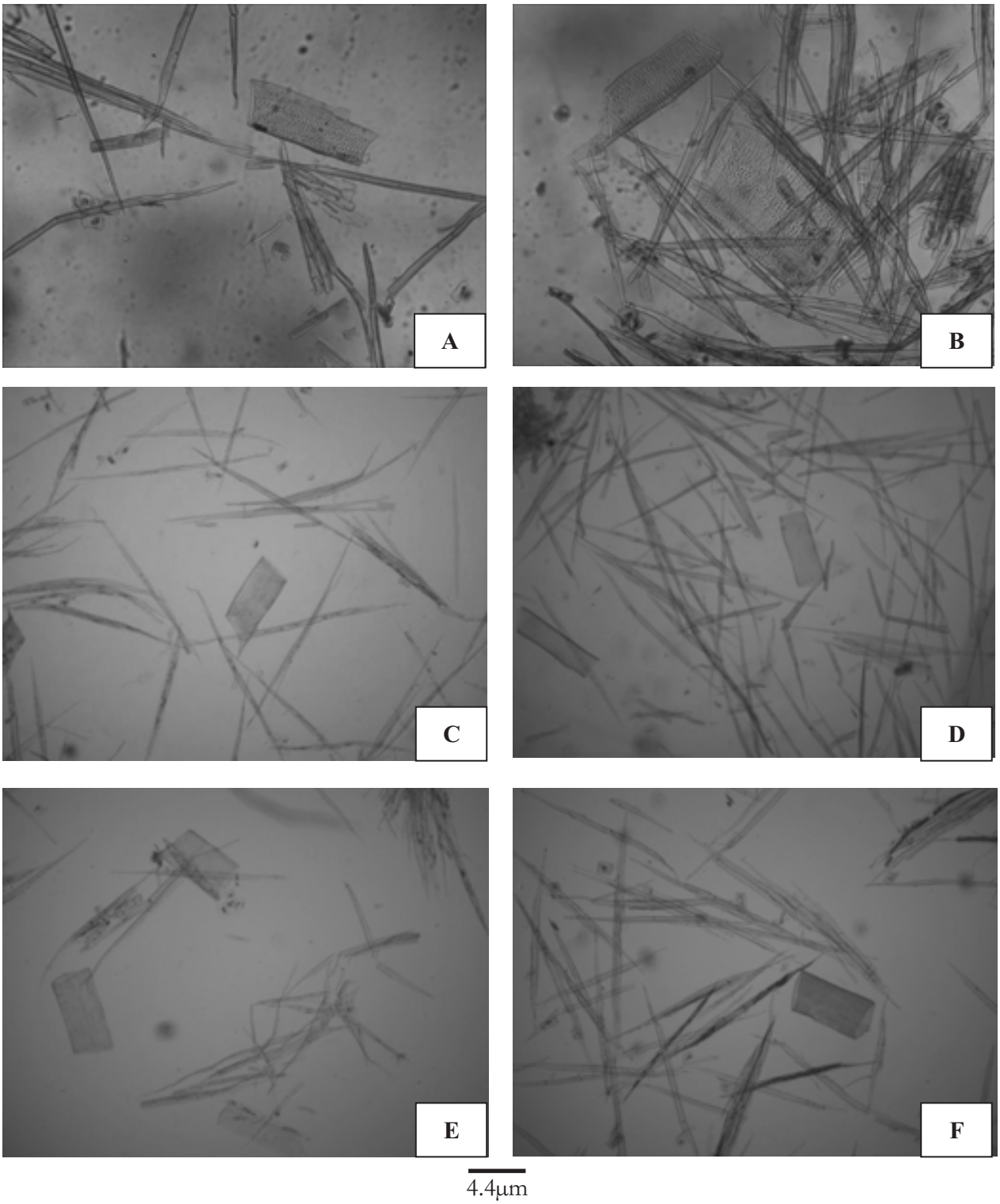

Figure 7: Macerates of *Caesalpinia* species and varieties.
A – *C. bonduc* staminate, B – *C. bonduc* pistillate, C – *C. pulcherrima* var. red, D – *C. pulcherrima* var. yellow, E – *C. pulcherrima* var. off-white, F – *C. pulcherrima* var. pink.

DISCUSSION AND CONCLUSION

The importance of wood anatomical characters cannot be overemphasized because they have great significance in the taxonomy of angiosperms and in interpreting inter-relationship among different species and varieties of plants. These characters have also being reported to determine the type and value of products the wood will yield (Zobel and Jett, 1995). Wood anatomical characters of taxonomic and phylogenetic importance which include but not limited to wood porosity, growth ring, characteristics of the fibre and vessels, vessel distribution pattern, presence of tylose, type of axial parenchyma, presence of solitary vessels, presence of resin ducts and vascular ray type have been reported by several authors among whom are Carlquist (1961); Wickremasinghe and Herat (2006); Simpson (2010); Akinloye *et al.* (2012); Mudasiru *et al.* (2016) and Oladipo *et al.* (2016).

The six *Caesalpinia* taxa studied have common generic wood anatomical characters as well as specific delimiting characters. Characters that are generic include diffuse porosity of their woods, the absence of growth ring and the presence of uniseriate and heterogenous vascular ray cells. The presence of solitary vessels in all the taxa is an indication of primitiveness in the genus (Dehgan and Webster, 1979; Oladipo and Oyaniran, 2013). Pistillate *C. bonduc* has the highest number of solitary vessels when compared to the other taxa suggesting that it is the most primitive of all the taxa.

The taxa in the study can be delimited or separated based on some other anatomical characters of their wood. Multicellular vascular ray type was only encountered in the pistillate of *C. bonduc* and absent in the staminate variety and all the *C. pulcherrima* varieties. The occurrence of biseriate vascular ray type distinguishes *C. pulcherrima* var. pink from the other varieties of *C. pulcherrima* and *C. bonduc*. Ray type is therefore an important tool in the identification of *C. bonduc* var. female and *C. pulcherrima* var. pink. This is quite diagnostic and it further confirms the primitiveness of *C. bonduc* pistillate and *C. pulcherrima* var. pink. According to Metcalfe and Chalk (1989), the presence of uniseriate rays in certain taxa is a mark that they are phylogenetically advanced compared to the other taxa in the genus with biseriate or multiseriate ray cells. Oladipo and Oyaniran (2013) also separated some members of the genus *Ocimum* based on their vascular ray type.

Much taxonomic significance is attached to the type and distribution of axial parenchyma in angiosperms (Fahn, 1974). Axial parenchyma type in the taxa studied is classificatory and diagnostic. Banded apotracheal parenchyma being unique to *C. bonduc* staminate delimits it from its pistillate variety which has a vasicentric paratracheal type and these clearly delimit them from the varieties of *C. pulcherrima* which lack any form of axial parenchyma. The presence of tylose in some of the taxa in this study is also diagnostic. Tylose was present in *C. bonduc* var. male, *C. pulcherrima* varieties red, yellow and off-white while *C. bonduc* var. female and *C. pulcherrima* var. pink do not have tylose.

The fibres of all the taxa are libriform, non-septate and non-storied. Fibre length is also diagnostic in the genus. The highest fibre length was observed in *C. bonduc* var. female and the least length in *C. pulcherrima* var. off-white, although the value is not significantly different from that of *C. pulcherrima* var. pink. According to the classification of wood fibres by Metcalfe and Chalk (1989), all the *Caesalpinia* wood studied fall in the group of short fibres. Specifically, the fibres of *C. bonduc* var. female are moderately short while those of the other taxa are very short.

The vessel lengths of the two varieties of *C. bonduc* are not significantly different from each other at $p < 0.05$. Those of the *C. pulcherrima* varieties are also not significantly different from one another at the same probability, although they are significantly different from those of *C. bonduc*. This affirms their specific distribution. Vessel breadths however, show significant differences in all the taxa except in *C. pulcherrima* var. red and *C. pulcherrima* var. yellow. Based on their dimensions, the vessels of the two varieties of *C. bonduc* and *C. pulcherrima* var. pink are medium sized while those of *C. pulcherrima* varieties red, yellow and off-white are moderately small (Metcalfe and Chalk, 1989). Solitary and radial multiple pores were found in all the taxa. Pore clusters were also found in all the taxa except in *C. bonduc* var. female where they are

completely absent. This clearly delimits *C. bonduc* var. female from the other taxa of *Caesalpinia* in this study.

The graph of the principal components analysis (PCA) based on the qualitative and quantitative wood anatomical data grouped the taxa into three when components 1 and 2 were used. The two varieties of *C. bonduc* were grouped together, *C. pulcherrima* varieties red and yellow were also grouped together in another cluster while the other two varieties of *C. pulcherrima*, pink and off-white were grouped together in another cluster. When components 1 and 3 were used, the two species were clearly separated, that is, the two varieties of *C. bonduc* were grouped together while the four varieties of *C. pulcherrima* were also grouped together. The first three components of the PCA accounted for 95.73% of the variation among the taxa studied. From the PCA loadings, it can be gathered that the characters responsible for the separation of the taxa studied from component one are the vessel length, pore diameter and axial parenchyma, those of component two are vessel breadth, ray length, and fibre length while those of component three are the presence of tylose and percentage of solitary pores.

The result of the single linkage cluster analysis grouped the taxa into four. *C. bonduc* var. female was separated from the other five taxa in the first main grouping; *C. bonduc* var. male was also separated from the varieties of *C. pulcherrima* in the second main grouping. In the third grouping and at a higher similarity level, *C. pulcherrima* varieties pink and off-white were clustered together on one side while *C. pulcherrima* varieties red and yellow were also clustered together on the other side.

In conclusion, it is evident that there is homogeneity of wood anatomical character among the species and varieties of *Caesalpinia* in this study and few diagnostic characters which include the ray type, distribution of axial parenchyma, presence of tylose and the dimensions of the vessels, ray and fibre cells. Therefore, the taxa of *Caesalpinia* in this study can be separated based on their qualitative and quantitative wood anatomical characters.

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