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Colorimetry And Anatomical Characterization of Commercial Wood Species From The Brazilian Amazon

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Abstract

The purpose of this study was to characterize wood species from Tauari (*Couratari oblongifolia* Ducke & Kunth), Jatoba (*Hymenaea courbaril* L.), Angelim-vermelho (*Diniziaexcelsa* Ducke), Ipe-verde (*Handroanthus serratifolius* (A.H. Gentry) S .Grose) and Abiurana (*Pouteria egregia* Sandwith) trees, all of with are largely commercialized in Brazil and the international market, by utilizing techniques of colorimetry, macroscopy, microscopy and fiber measurement, so as to expand the use of these techniques in the technological characterization of wood and the best use of these species the timber market. IMEQ / MT Institute of Metrology and Quality of the State of Mato Grosso provided the wooden planks and the specimen preparation was determined by COPANT (1972). 20 specimens were made with measurements of 2cm x 2cm x 30cm (width, thickness and length), for use in ascertaining the woods color (colorimetry - performed using the colorimetric parameters of the CIELAB system 1976). While another 20 specimens, measuring 2cm x 2cm x 5cm, were used in the tests image analysis to study anatomical properties. The *Couratari oblongifolia* species and *Pouteria egregia* were lighter in color, respectively, greyish white and pink. While the *Hymenaea courbaril* and *Dinizia excelsa* species have brownish yellow color, *Handroanthus serratifolius* possessed an olive brown color. The anatomical description and fiber measurements of these Amazonian species show singular characteristics of their wood, differentiating their peculiarities, attributes that identifies the wood, providing different application options and increasing trade value. The work also demonstrated that quantitative colorimetry is an efficient tool to classify wood coloration and to differentiate the radial and tangential sections of a wood species.

Key words: Amazonian species, Colorimetric, tangential and radial faces, anatomical identification, Fibers

INTRODUCTION

Brazil, with approximately one third of the remaining tropical forests is one of the most important repositories of global biodiversity(Silva, Matos and Ferreira, 2008). Natural forests present great global importance due to their heterogenic nature, territorial expanse, endemic species, genetics and diverse ecosystems of their biomes(Assunção and Felfili, 2004). In this sense, the legal Amazon, which includes the Amazonian Biome, areas from the Cerrado and natural fields, is the biggest vegetation expanse in Brazil, with more than five million square kilometers and encompassing 59% of the Brazilian territory (Pereira *et al.*, 2010).

The Brazilian Amazon is one of the biggest producers of tropical forest wood in the world, the extraction and industrialization of wood is among the main economic activities. In the year 2009, 14.2 million m³ of wood logs were extracted from the Legal Amazon, the equivalent of 3.5 million trees, the states of Pará, Mato Grosso and Rondônia being the biggest producers with 91% of the total production(Veríssimo *et al.*, 2006; Pereira *et al.*, 2010).

The state of Mato Grosso has been consolidating itself in both national and international markets as a large producer of wood from native forests, between the years of 2010 and 2014, approximately 32.2 million m³ of *in natura*, sawed and industrialized/milled wood were commercialized(Cipem, 2014). In a diagnose conducted by Ribeiro (2013), the state has commercialized around 411 species of forest species in a seven year period (2004-2010), showing the biomes great species diversity.

The purpose of this study is to identify the main species of milled wood commercialized by the state of Mato Grosso through techniques such as Colorimetry, Macroscopy and Microscopy.

MATERIALS AND METHODS

This research was conducted in the wood technology laboratory at the department of Forestry Engineering at the University of Brasília – UnB, in collaboration with the forestry products laboratory LPF/SFB – Brazilian Forestry Service – Brasília DF.

1.1. Timber:

Studied species were selected according to the need for technological characterization and identification of commercialized woods in the state of Mato Grosso-Brazil: Tauari (*Couratari oblongifolia* Ducke&Kunth) Lecythidaceae family, Jatobá(*Hymenaea courbaril* L.) Fabaceae family, Angelim-vermelho (*Dinizia excelsa* Ducke) Fabaceae family, Ipê-verde (*Handroanthus serratifolius* (A.H.Gentry) S.Grose) Bignoniaceae family and Abiurana (*Pouteria egregia* Sand with) Sapotaceae family.

The wooden planks were made available by Imeq/MT-"*Instituto de Metrologia e Qualidade*" of the state of Mato Grosso in the industrial district of Cuiabá, and the test samples were cut according to the Copant standard(Copant, 1972). From the wood planks, 20 test samples of heartwood were cut, in the longitudinal, radial and tangential planes, measuring 46 cm x 2 cm x 2cm, 100 test samples for all five species, in total. These samples were further divided into smaller samples of 2 cm x 2 cm x 30 cm, for colorimetry tests, and samples of 2 cm x 2 cm x 5 cm, for macroscopic, microscopic characterization and fiber measurement.

1.2. Colorimetry:

For the execution of these tests, a *ColorEye*® XTH gretagmacbeth spectrocolorimeter was utilized connected to a microcomputer with the Color iControl software, with a *Pulsed Xenon D65* lamps at a 10° angle at room temperature. The methodology proposed by(Gonçalez, 1993)based on the Cielab system (1976) was used for defining the colorymetric parameters L (clarity), coordinates "a" and "b", C (saturation) and "h" (paint angle). For identification of each species color, a table described by(Camargos and Gonçalez, 2001)was utilized.

10 test samples of each species were utilized, conducting 20 measurements on each facet (radial and tangencial), totalizing 40 measurements per sample, for a total of 400 measurements per species(Lima *et al.*, 2013).

1.3. Macroscopy:

For macroscopic analysis, the 2 cm x 2 cm x 5 cm test samples were polished in transversal sections with water sandpaper, with grit sizes of 40, 180, 320, 600 and 1200, removing any roughness. Characteristics of the wood were left visible to the naked eye, or with the use of a stereoscope with 20x amplification, according to the methodology described in the(Copant, 1974), (Coradin and Muniz, 1992)and (IAWA Commitee, 1989)standards.

Macroscopic characteristics were photographed in the radial, tangential and transversal sections with the use of a SZX7 Olympus steroscopical microscope, with images captured with a DP25 model Olympus digital camera and analysed with a software application DP2-BSW® (Olympus), with ocular lense 10x2, twenty-time increase, with a 1mm scale. The main observed characteristics were; heartwood/sapwood, coloration, growth rings, shine, smell, cutting resistance, grain, texture, figure and macroscopic characteristics – axial parenchyma (vessels/pores), visibility, types, diameter, porosity frequency, clustering, radial multiples, vessel arrangement, transversal section form, perforation plates, vessel obstructions, tyloses or deposits. Radial parenchyma (rings) – visibility, contrast, width, height, frequency, thus illustrating the difference between species.

1.4. Microscopy:

For preparation of permanent slides, samples were immersed in water until complete saturation, and afterwards placed into boiling water for softening(Burger and Richter, 1991). Histological cuts were made in radial, transversal and tangential sections utilizing a Leica SM 2000R sliding microtome, equipped with type C or D razors, with cut slices thickness between 18 and 30 µm. The wood slides were clarified utilizing Sodium Hypochlorite (50%) and dyed with alcoholic Safranin (50%) 1:1 and Astra Blue Alcoholic Solution (50%) 1:1, treated with alcohol solutions of 20%, 30%, 40%, 60%, 70%, 80% and 100%. Slices were placed on glass slides showing all three section planes on each slide, Elettan® synthetic resin was used to secure slices in place(Johansen, 1940).

Macroscopic characteristics were photographed in the radial, tangential and transversal sections with the use of a BH-2 Olympus microscope, with images captured using a DP25 model Olympus digital camera, and analysed with DP2-BSW® (Olympus) software, according to the methodology described in the (Copant, 1974), (Coradin and Muniz, 1992) and (IAWA Commitee, 1989) standards.

1.5. Fibers:

Fiber characterization was conducted with dissociated material, in the wood anatomy sector of the forestry product laboratory LPF/SBF. In the maceration process, small wood shaving from the studied species were transferred to test tubes with distilled water and afterwards immersed in a maceration solution (hydrogen peroxide 120 vol. and glacial acetic acid) then taken to a drying oven (50°, for 48h). For morphological analysis and measurement analysis, the dissociated material was dyed with Safranin and mounted on semi-permanent slides with glycerine and water. The microscopic anatomical description was conducted according to the(Copant, 1974) and (IAWA Commitee, 1989) standards.

Fiber characterization was conducted by image analysis, utilizing a Olympus BH-2 microscope with images captures through a Olympus DP25 digital camera (1.3 objective/0,1 ocular and 40 objective/0,65 ocular) with a scale of 1mm and 20µm (figure 1.7) and analysed with DP2 – BSW® (Olynpus) software. Fiber images were taken and measurements for length (C), total width (L), fiber diameter (DL) and wall thickness (EP) of 25 fibers per slide, as per the(IAWA Commitee, 1989) standards. The wall thickness was obtained through use of the equation 1.

$$EP = \frac{\mathrm{L-DL}}{2} \tag{1}$$

In which: EP = Wall thickness; L = total width; DL= fiber diameter.

1.6. Statistical Analysis:

For the colorimetric analysis, a Completely Randomized Design was used, with 2 treatments (radial and tangential) and 10 repetitions. Data obtained was submitted to a variance analysis (ANOVA) and Tukey test, to 95% probability utilizing the ASSISTAT software, version 7.7 beta. Normalcy of data was verified through use of the Shapiro-Wilk test(Silva and Azevedo, 2002; Lima *et al.*, 2016).

In anatomical characterization, descriptive statistics was used: mean, maximum, minimum, variance, standard deviation, coefficient of variation. The Genes statistical software was utilized for data analysis (Cruz, 2006; Lima *et al.*, 2015).

RESULTS AND DISCUSSION

1.7. Colorimetry:

Wood coloration is an indispensable element in species identification and can be characterized qualitatively and quantitatively through the colorimetric parameters L*, a*, b*, C and h*, according to the CIELAB system. This property, in practice, has been increasingly used for commercialization and use of wood. The mean values of colorimetric parameters and classification of the color for studied species are presented on Table 1.

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Table1: Average values of colorimetric parameters and classification of the color for the studied species

Speciess	L*	a*	b*	C	h*	Color Classification
Courataríoblongifolia	74.17	4.23	22.50	22.91	79.44	Grayish White
Hymenaeacourbaril	51.74	14.03	24.37	28.16	59.98	BrownishYellow
Dinizia excelsa	50.40	16.06	24.47	29.29	56.75	BrownishYellow
Handroanthus serratifolius	49.08	9.42	25.50	27.26	69.45	Olive Brown
Pouteriaegregia	59.33	14.53	26.40	30.14	61.18	Pink

Color classification according to the wood color table proposed byCamargos and Gonçalez(2001).

According to (Camargos and Gonçalez, 2001), species that showt values of L* parameters (clarity) greater than 56 are considered light colored and species with L* parameters (clarity) bellow 56 are considered dark colored woods. Therefore, according to Table 1, the color of the wood species *Couratari oblongifolia* and *Pouteria egregia* were classified as light colored and *Hymenaea courbaril*, *Diniziaexcelsa* and *Handroanthus serratifolius*s pecies were classified as dark colored.(Costa *et al.*, 2011)obtained similar results for wood species of *Couratari oblongifolia* and *Hymenaea courbaril*. Color variation in wood from the same species can occur, for according toGonçalez (1993),many factors influence color, such as anatomical characteristic, chemical makeup, forestry treatment, sample position from the tree, environment, diameter, height and age of the tree, as well as genetic factors inherent to the species.

Colorimetric parameters for the studied wood on tangential and radial sections are presented onTable 2.

Table 2: Mean values for colorimetric parameters for radial sections (RD) and tangential sections (TG) for studied species.

SPECIES		L*	a*	b*	C	h*
CourataríoblongifoliaDucke&Kunth	RD	75.09a	3.99a	22.69a	23.04a	80.07a
	TG	73.24b	4.46a	22.32a	22.77a	78.81a
SPECIES		L*	a*	b*	C	h*
Hymenaeacourbaril L.	RD	51.56a	14.21a	24.59a	28.43a	59.90a
	TG	50.92a	13.86a	24.15a	27.88a	60.05a
SPECIES		L*	a*	b*	C	h*
Dinizia excelsa Ducke	RD	50.25a	16.42a	25.15a	30.05a	56.88a
	TG	50.54a	15.69b	23.78b	28.52b	56.63a
SPECIES		L*	a*	b*	C	h*
Handroanthus serratifolius (A.H.Gentry) S.Grose	RD	49.55a	9.08a	25.80a	27.45a	70.19a
	TG	48.60a	9.77a	25.20a	27.08a	68.71a
SPECIES		L*	a*	b*	C	h*
PouteriaegregiaSandwith	RD	59.13a	14.87a	26.92a	30.76a	61.09a
	TG	59.51a	14.19a	25.88b	29.52b	61.27a

Mean values for each species in columns, for each colorimetric parameter, followed by the same letter, do not possess statistical deviation of 5% probability by the Tukey test..

Analysing table II, it can be observed that parameter L* (Clarity), does not show significant statistical difference between radial (RD) and tangential (TG) sections in each species, except for *Couratari oblongifolia* wood. In this case, the radial section is a lighter color than the tangential. Probably, even though no statistical difference was detected for coordinate a* in this species, this was the main factor responsible for the color difference between facets, due to the higher value of this parameter leading to a darker color in the tangential section.

All five species are strongly influenced by the coordinate b*, situated in the first quadrant of the CIELAB system, which is responsible for the color yellow. Higher values of this parameter, when compared to coordinate a* (responsible for red coloring), will determine the color of the species. The low value of coordinate a* on *Couratari oblongifolia* wood alongside high values of b* leads to this species having the lighter color amongst studied species. The value of parameter h* corroborates this statement, approximating the paint angle to coordinate b*.

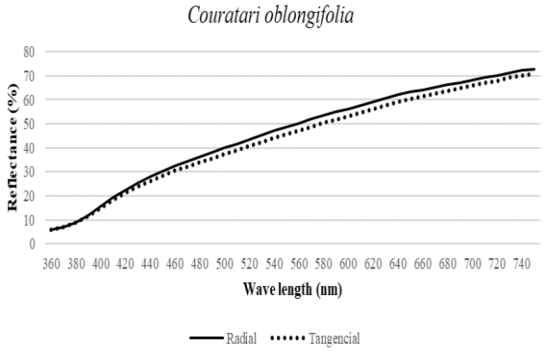
It can also be observed that *Hymenaea courbaril* and *Dinizia excels* present similar coloration, due to the colorimetric parameters of these species being similar to one another. The anatomical structure of both species may present visual differences in their wood, leading to coloration distortion, at first sight giving the impression that they are quite distinct from one another. Thanks to the CIELAB technique, they can be grouped together and perhaps even sold commercially in bundles when only the color factor is considered.

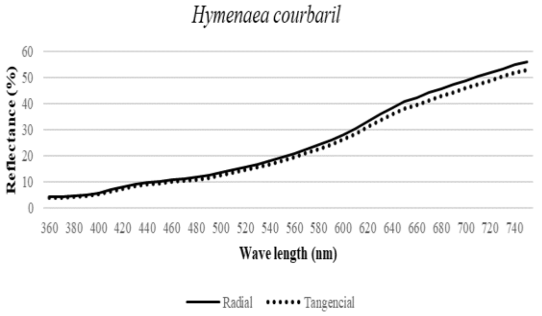
This same behavior was observed by(Autran and Gonçalez, 2006), for the Amazonian species *Hevea Brasiliensis* (seringueira), where there were no significant differences between the radial and tangential sections for all colorimetric parameters.

For the *Pouteria egregia wood* the b* and C parameters of the radial section were superior to the tangential section, yet there was no statistical influence in clarity values (L*) of the wood.

Various studies are found in literature(Nishino *et al.*, 1998; Zerbini, 2008; Barros, Muniz and Matos, 2014; Silva *et al.*, 2015; Paula, 2016), that show the differences between the sections of wood in Amazonian species, in which each species may possess distinctive behaviors.

The spectral signatures or reflectance curves of each studies species, for both radial and tangential sections, are presented in Figures 1.





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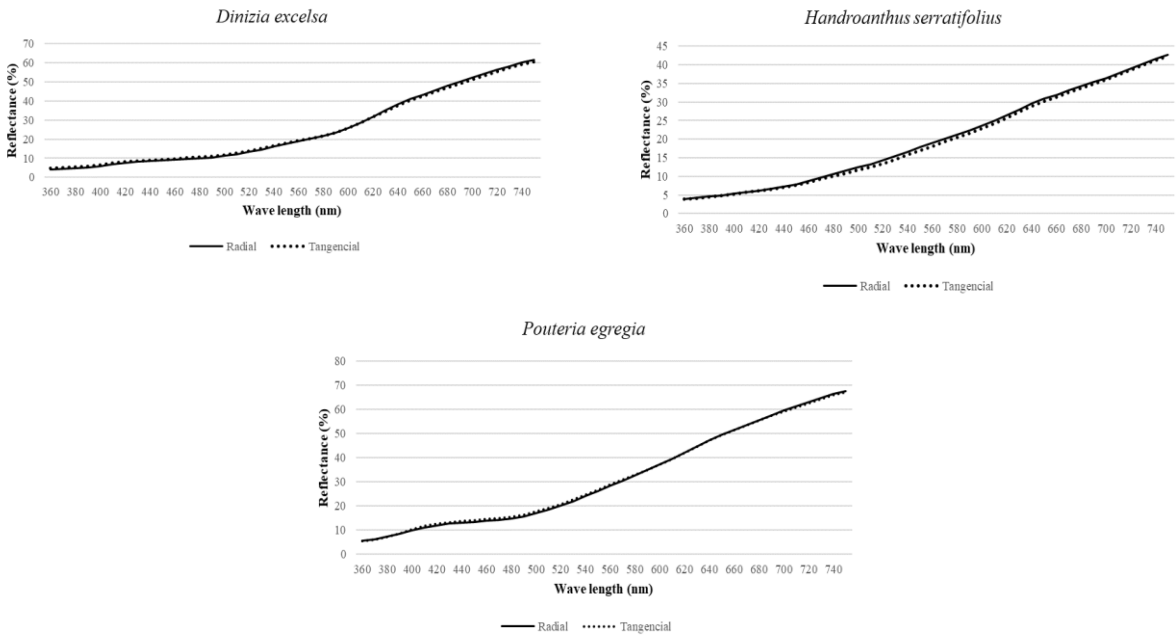

Fig. 1: Reflectance curve of studied species, in relation to wave length.

In Figure 1 it is evident that the mean between tangential and radial sections was close, except for the *Couratari oblongifolia* species, in accordance to values found in Table II. It can also be noted that *Couratari oblongifolia* and *Pouteriaegrégia* reflect more light in all wave lengths than other species.

1.8. Macroscopic, Microscopic and wood fiber description:

In the following section, the general description, macroscopy, microscopy and fibers are presented, as well as photomacrography and photomicrography of the radial, tangential and transversal sections, alongside fiber measurements from the five tropical species commercialized by the state of Mato-Grosso-Brazil, in accordance to the standards recommended byCoradin and Muniz (1992)and other publications (Camargos and Gonçalez, 2001; Santini Junior, 2013).

Zerbini(2008)emphasizes the importance of anatomical characterization of wood, since this supports the study of the behavior of other characteristics (colorimetrics, physical, mechanical) of species, collaborating to improve use and selection in terms of quality and industrial productivity.

TAUARI (*Courataroblongifolia*)

Common name: Tauari, dedaleiro, embirema, embirema-branca, embirema-cheirosa, tauari-branco, tauari-amarelo, tauari-rosa.

Scientific Name: *Couratari oblongifolia* Ducke& R. Knuth

Family: Sapotaceae

General Description: Sapwood and heartwood are indistinct, with yellowish white or grayish white coloration. Indistinct limit of growth rings, with shine of the longitudinal surfaces, imperceptible smell and taste, wood soft to manual cut in the transversal plane, right grain, medium texture and absent figure.

Macroscopic, Microscopic and wood fiber description: In the transversal plane (Figures 2 and 3), pores are present and visible to the naked eye, tangential diameter (100-200 µm), with diffuse porosity, low frequency (<5/2 mm²), pore grouping in similar solitary/multiple radials portions, from circular to oval shapes and laid out in radial chains. Perforation plates observed with the use of a simple lens, pores unobstructed. The axial parenchyma observed under 20x magnification lens, in reticulated streams. Radial parenchyma was observed to be visible to the naked eye in the transversal section and under 20x magnification lens in the tangential section. Little contrast, thin (100µm), small (<1mm) and infrequent (5-10/mm). Secretion structures and cambial variants were not found. Stratified structures are not present. Fiber description considered in measuring length, width and diameter of the lumen and cellular wall thickness, quantitive fiber data (Table 3).

Fig. 2: Photomacrography of *Couratari oblongifolia* wood– transversal, radial and tangential planes, with 20x magnification and 1mm scale.

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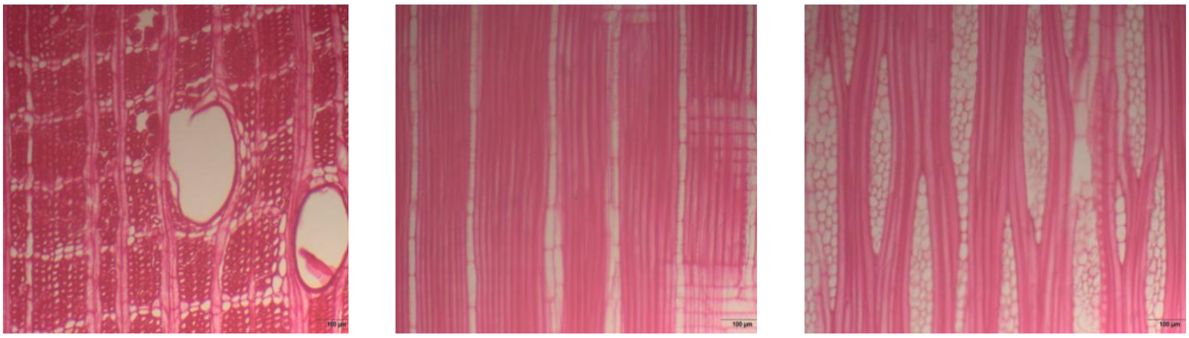

Fig. 3: Photomicrography of *Couratari oblongifolia* wood– transversal, radial and tangential sections, 100µm scale.

Table 3: Quantitive data of anatomical characteristics of *C. oblongifolia*, with mean, minimum, maximum, variation coefficient, and variance and standard deviation values.

Tauari *C. oblongifolia*	CF (mm)	LF (µm)	DL (µm)	EP (µm)
Average	1.72	25.39	15.41	5.00
Minimum	1.45	20.42	10.87	3.52
Maximum	1.92	32.42	18.71	7.44
V. C. (%)	8.37	12.58	15.82	20.80
Variance	0.02	10.20	5.94	1.08
S. Deviation	0.14	3.19	2.44	1.04

CF: Fiber Length; LF: Fiber Width; DL: Fiber diameter; EP: Fiber wall thickness.

JATOBÁ (*Hymenaeacourbaril*)

Common Name: Courbaril, jatobá, jatobá-da-mata, jatobá-mirim, jatobá-roxo, jatobá-verdadeiro, jataí, jataí-amarelo, jataí-vermelho, jutaí, jutaí-açu, jutaí-roxo.

Cientific Name: *Hymenaeacourbaril* L.

Family: Fabaceae

General Description: Wood presents distinct difference between sapwood and heartwood, with reddish brown sapwood. Distinct limits the growth rings, individualized by marginal parenchyma, with shiny longitudinal surfaces, imperceptible smell and taste, wood is hard to cut manually in the transversal plane, irregular and reverse grain, fine texture and figure is present.

Macroscopic, Microscopic and wood fiber description: In the transversal section (Figures 4 and 5), pores are present and visible to the naked eye, mean tangential diameter (100-200 µm), with diffuse porosity, average frequency (6-30/2mm²), pore grouping predominately multiple, of circular and oval format and disposed in an undefined pattern. Perforations plates were not observed even with the use of magnifying lens, unobstructed pores. Axial parenchyma observed by the naked eye, lozenge aliform paratraqueal, vasicentric or in marginal streaks. Radial parenchyma was observed to be visible the naked eye, being visible in the transversal and tangential surfaces. Low contrast, thin (100µm), small (<1mm) and infrequent (5-10/mm). Secretion structures and cambial variants s were not found. Stratified structures are not present. Fiber description considered in measuring length, width and diameter of the lumen and cellular wall thickness, quantitive fiber data (Table 4).

Fig. 4: Photomacrography of *Hymenaea courbaril* wood– transversal, radial and tangential planes, with 20x magnification and 1mm scale.

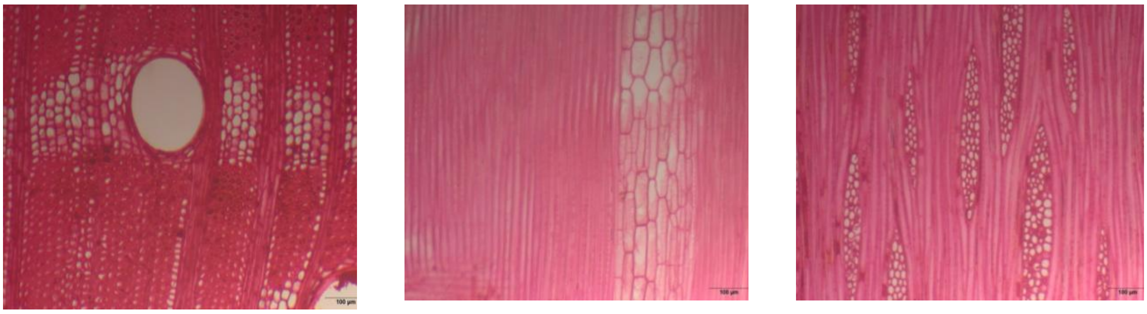

Fig. 5: Photomicrography of *H. courbaril* wood– transversal, radial and tangential sections, 100µm scale.

Table 4: Quantitive data of anatomical characteristics of *H. courbaril*, with mean, minimum, maximum, variation coefficient, and variance and standard deviation values.

Jatobá	CF	LF	DL	EP
H. courbaril	(mm)	(µm)	(µm)	(µm)
Average	1.29	20.80	6.87	6.97
Minimum	1.16	16.47	5.00	5.63
Maximum	1.48	25.90	8.99	8.99
V. C. (%)	6.36	13.12	17.98	14.35
Variance	0.01	7.45	1.52	1.00
S. Deviation	0.08	2.73	1.23	1.00

CF: Fiber Length; LF: Fiber Width; DL: Fiber diameter; EP: Fiber wall thickness.

ANGELIM VERMELHO (*Dinizia excelsa*)

Common Name: Angelim-vermelho, faveira-ferro, faveira-dura.

ScientificName: *Dinizia excelsa* Ducke.

Família: Fabaceae

General Description: Distinct difference between sapwood and heartwood, with reddish brown color. Distinct limits of growth rings, with shiny longitudinal surfaces, unpleasant smell and imperceptible taste, wood is hard to cut manually in the transversal plane, right grain, medium texture and figure present.

Macroscopic, Microscopic and wood fiber description: In the transversal section (Figures 6 and 7), pores are present and visible to the naked eye, mean tangential diameter (100-200 µm), with diffuse porosity, average frequency (6-30/2mm²), pore grouping in similar solitary portions and multiple radials, of circular and oval format and disposed in an undefined pattern. Perforations plates were observed with the use of magnifying lens, simple, partially obstructed pores with whitish substance. Axial parenchyma was observed by the naked eye, paratracheal aliform was short, linear and confluent, in short lengths and marginal streaks. Radial parenchyma was observed by use of 20x magnification lens, being visible in the transversal and tangential surfaces. Low contrast, thin (100µm), small (<1mm) and infrequent (5-10/mm). Secretion structures and cambial variants were not found. Stratified structures are not present. Fiber description considered in measuring length, width and diameter of the lumen and cellular wall thickness, quantitive fiber data (Table 5).

Fig. 6: Photomacrography of*Diniziaexcelsa* wood– transversal, radial and tangential planes, with 20x magnification and 1mm scale.

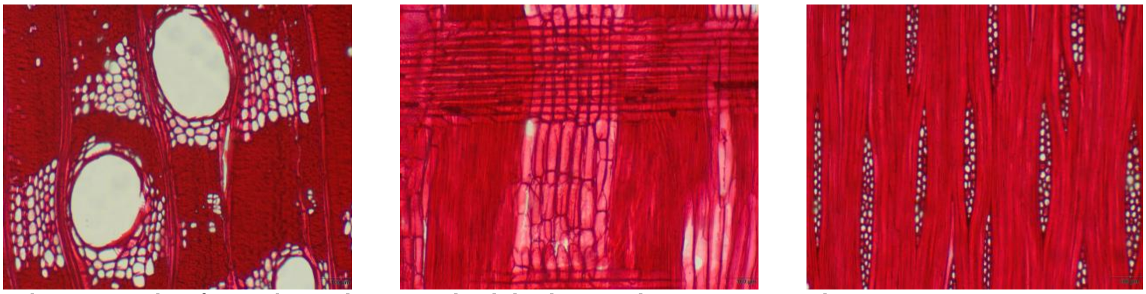

Fig. 7: Photomicrography of*D. Excelsa* wood– transversal, radial and tangential sections, 100µm scale.

Table 5: Quantitive data of anatomical characteristics of *D. excelsa*, with mean, minimum, maximum, variation coefficient, and variance and standard deviation values.

Angelim-vermelho	CF	LF	DL	EP
D. excelsa	(mm)	(µm)	(µm)	(µm)
Average	1.24	18.38	3.30	7.54
Minimum	1.02	12.85	2.16	5.21
Maximum	1.55	23.17	5.46	9.22
V. C. (%)	11.02	17.23	30.50	18.79
Variance	0.02	10.03	1.01	2.01
S. Deviation	0.14	3.17	1.01	1.42

CF: Fiber Length; LF: Fiber Width; DL: Fiber diameter; EP: Fiber wall thickness.

IPÊ (*Handroanthusserratifolius*)

Common Name: Ipê-verde, Ipê, Ipê-amarelo, Ipê do cerrado, Ipê-pardo, Ipê-ovo-de-macuco, Piúva-amarela.

Scientific Name: *Handroanthus serratifolius* (Vahl) S. O. Grose

Family: Bignoniaceae

General Description: Wood presents distinct difference between sapwood and heartwood, with olive-green coloration. Distinct limits of growth rings, individualized by dark fibrous tangential zones, with shiny surfaces, pleasant smell and imperceptible taste, wood is hard to cut manually in the transversal plane, crisscrossed or reverse grain, thin texture and figure present. Occurrence in figure by vascular lines.

Macroscopic, Microscopic and wood fiber description: In the transversal section (Figures 8 and 9), pores are present and visible with a 20x amplification lens, small tangential diameter (<100µm), with diffuse porosity, high frequency (>30/2mm²), predominately solitary, of circular and oval format and disposed in an undefined pattern. Perforations plates were observed with the use of magnifying lens, simples, and partially obstructed pores with yellowish substance (ipeína). Axial parenchyma was observed by use of a 20x magnifying lens, short extension vasicentric and linear paratracheal aliform Radial parenchyma was observed by use of 20x magnification lens. Low contrast, thin (100µm), small (<1mm) and infrequent (5-10/mm). In the tangential section, streaks are visible under 20x magnifying lens on the surface. Secretion structures were not found, and stratified structures are present and irregular, 4 streaks per axial mm. Fiber description considered in measuring length, width and diameter of the lumen and cellular wall thickness, quantitive fiber data (Table 6).

Fig. 8: Photomacrographyof *Handroanthusserratifolius* wood– transversal, radial and tangential planes, with 20x magnification and 1mm scale.

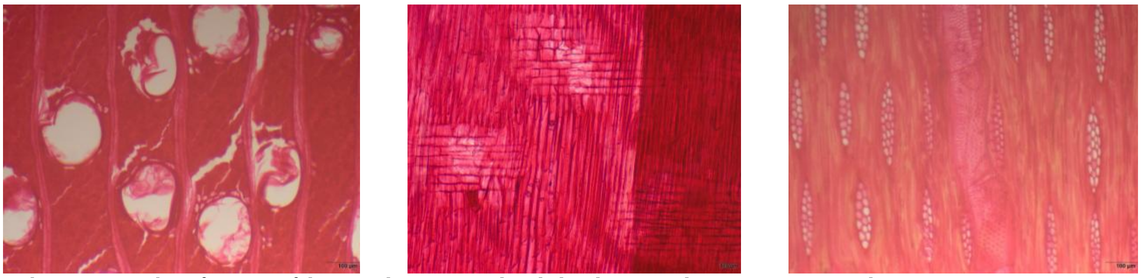

Fig. 9: Photomicrography of H. serratifolius wood – transversal, radial and tangential sections, 100µm scale.

Table 6: Quantitive data of anatomical characteristics of *H. serratifolius,* with mean, minimum, maximum, variation coefficient, and variance and standard deviation values.

Ipê *H. serratifolius*	CF (mm)	LF (µm)	DL (µm)	EP (µm)
Average	1.30	17.21	2.14	7.54
Minimum	1.14	12.28	1.41	5.43
Maximum	1.55	20.69	2.98	9.18
V. C. (%)	7.39	13.30	23.62	13.81
Variance	0.01	5.23	0.25	1.08
S. Deviation	0.10	2.29	0.50	1.04

CF: Fiber Length; LF: Fiber Width; DL: Fiber diameter; EP: Fiber wall thickness.

ABIURANA (*Pouteria egrégia*)

Common Name: Abiu, abiu-branca, abiu-casca-grossa, abiu-casca-seca, abiurana-amarela, abiurana-branca, abiurana, abiurana-vermelha, guapeva, guaxará, grumixá, pariri, guaxará, leiteiro, leiteiro-branco, leiteiro-vermelho, tatarubá, taturabá.

Scientific Name: *Pouteria egregia* Sandwith.

Family: Sapotaceae

General Description: Wood presents indistinct difference between sapwood and heartwood, with dark redish brown coloration. Indistinct limits of growth rings, with shine in longitudinal surfaces, pleasant smell and imperceptible taste, wood is hard to cut manually in the transversal plane, right to irregular grain, thin texture and absent figure.

Macroscopic, Microscopic and wood fiber description: In the transversal section (Figures 10 and 11), pores are present and visible to the naked eye, medium tangential diameter (100-200µm), with diffuse porosity, high frequency (>30/2mm²), pore grouping in predominately in multiple radials, of circular and oval format and arranged in radial chains. Perforations plates were observed with the use of magnifying lens, simples, and partially obstructed pores with tyloses. Axial parenchyma was observed by use of a 20x magnifying lens, in narrow streaks/lines. Radial parenchyma was observed by use of 20x magnification lens, being visible in the transversal surface. Low contrast, thin (100µm), small (<1mm) and very frequent (>10/mm). Secretion and cambial variants structures were not found. Stratified structures are not present. Fiber description considered in measuring length, width and diameter of the lumen and cellular wall thickness, quantitive fiber data (Table 7).

Fig. 10: Photomacrographyof *Pouteriaegregia*wood– transversal, radial and tangential planes, with 20x magnification and 1mm scale.

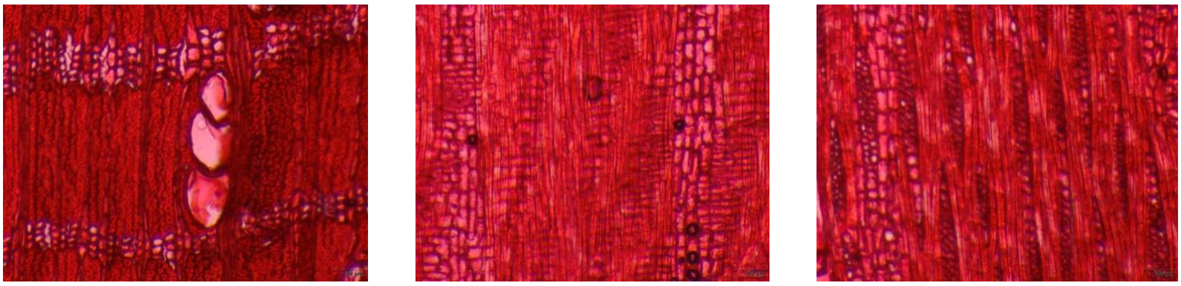

Fig. 11: Photomicrographyof *P. egregia*wood– transversal, radial and tangential sections, 100μm scale.

Table 7: Quantitive data of anatomical characteristics of *P. egregia,* with mean, minimum, maximum, variation coefficient, and variance and standard deviation values.

Abiurana	CF	LF	DL	EP
P. egregia	(mm)	(μm)	(μm)	(μm)
Average	1.32	20.73	4.56	8.08
Minimum	1.11	16.35	3.4	6.18
Maximum	1.59	26.51	6.93	10.85
V. C. (%)	10.87	13.26	22.31	15.63
Variance	0.02	7.56	1.04	1.60
S. Deviation	0.14	2.75	1.02	1.26

CF: Fiber Length; LF: Fiber Width; DL: Fiber diameter; EP: Fiber wall thickness.

Conclusion:

Quantitive colorimetry is an efficient tool in classifying wood coloration and differentiating between radial and tangential sections of a species of wood.The spectrocolorimetry made it possible to obtain an objective description of the coloration of wood samples from Amazonian species under study.

The *Couratari oblongifolia* and *Pouteria egregia* species have lighter coloring, respectively, grayish white and pink. The *Couratari*species presented a darker tangential section compared to its radial section. The other species, *Hymenaea courbaril*, *Diniziaexcelsa*, *Handroanthus serratifolius* and *Pouteria egrégia* possessed similar section coloration. Splitting these wood species in either the radial or the tangential section of will produce stacks of similarly colored wood, increasing their sales value in commercialization.

The *Couratari oblongifolia* species possesses a smooth wood, direct grain, average texture and mean fiber length of 1,72mm, above average amongst leafy species. The wood from *Hymenaea courbaril*is hard with irregular grain, fine texture and present figure. The *Diniziaexcelsa*, as well as the *Handroanthus serratifolius* species possess hard wood, of medium and fine texture and present figure. *Handroanthus figure* is in vascular lines. *Pouteriaegregia* wood possesses fine texture, right and irregular grains and absent figure.

The anatomical description and fiber measurement of these Amazonian species show intrinsic characteristics of their wood, differentiating their peculiarities and detail richness, attributes that identify the wood, giving a variety of choice of use and increase of sales value in commercializing these woods.

Forest species were identified on the basis of their macroscopic, microscopic and fiber anatomical characteristics in conjunction with the physical characteristics of color, this identification becomes essential in the determination of their use by the industry, in the regulation and inspection of the wood trade of the state of Mato Grosso, Brazil, as well as the conservation of Amazonian biodiversity.

The use of colorimetry as a technique for determining the color is simple and quick to obtain, and can be used in the selection and classification of the pieces of wood resulting from the unfolding and also in the homogenization of the batches of wood, increasing the quality of the product of the industry to consumer market.

In addition, obtaining the colorimetric parameters through the Cielab system(1976) allows a standardization of colors among different species of wood from all over the world. This adds value and can expand the market for tropical timber.

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