

Format project technical report

Project 433/06 R3 (I)

“Sustainable Model for the Brazilian Wood Flooring Production Chain”

Subproject:

Physical and Mechanical Properties of the Amazon Wood Species

Mário Rabelo de Souza, Divino Eterno Teixeira, Mário José Siqueira, João Evangelista Anacleto, Marina Ulian, Roberto Lecomte.

Brazilian Forest Service (SFB)/Forest Products Laboratory (LPF)

Summary

The present study aimed to characterize the physical and mechanical properties and the workability of 14 Amazonian wood species, in order to identify potential alternative raw materials that maybe used in the production of the domestic flooring industry. Three trees of each species were cut and from each, two beams of 250x17x17 cm were obtained in the field. One specimen per beam was obtained and submitted to testing, totaling six samples per species. Physical and mechanical testing comprised density, moisture content, shrinkage, compression parallel and perpendicular to the grain, nail extraction, Janka hardness, cleavage, static bending and tension perpendicular to the grain. Workability testing of sanding, boring, planing and abrasion were conducted as well. Based on the results obtained it can be concluded that all the species studied are alternative raw material for flooring production, however cupiúba displays an unpleasant odor and will probably need some type of treatment.

1 Introduction

With the expanding demand for wood flooring in Brazil in the recent years, more options have become available in the market. Flooring from wood base panels and vinyl flooring has been reaching the market, also due to the crescent regulations over the solid wood materials, mainly from the tropical forests.

The preference of the consumers for the solid wood flooring and the event of the public law of forest concessions in Brazil will put pressure over the well-known wood species traditionally used for flooring, assuming that the construction sector will increase the demand for flooring.

With the increase of the population income and federal credit available, the possibility of housing renovation is another material consuming opportunity.

The characterization of the wood species selected in this project will bring information available on lesser used wood species for flooring. The knowledge of the physical and mechan-

ical properties, mainly density, dimensional stability and hardness and the workability of the species by professionals and home builders may strengthen the choice of the species most suitable for flooring application.

The information available in this project concerning the resistance of the wood species to abrasion is another valuable characteristic for flooring utilization, mainly if remarked that this information is scarce in the literature.

2 Applied methodology

General characteristics

The general characteristics of the wood species were made as to describe the type of grain, the figures, color, luster and resistance to manual cutting.

2.1 Wood sampling

The 14 wood species selected to the Project were collected in September 2011 at the unity of annual production (UPA-06) from the forest exploitation area of the Grupo ORSA S.A., in the municipality of Almeirim/Monte Dourado – State of Pará, Brazil.

Three trees were cut per species and two beams/tree of 17x17x250 cm were sawn and send to the Forest Products Laboratory-LPF of the Brazilian Forest Service-SFB in Brasília.

Upon receiving the lumber, one set was put to natural drying for the dry testing and another set was immersed in a tank with water for the green (saturated) testing.

The samples for the dry testing were placed in a room with controlled conditions of temperature and humidity in attempt to reach equilibrium moisture content of 12% before testing.

The list of wood species studied in the project is presented in Table 1.

Table 1: List of wood species.

Código	Common Name	Scientific Name
A	Angelim Vermelho	<i>Dinizia excelsa</i> Ducke
B	Itaúba Amarela	<i>Mezilaurus itauba</i> (Meisn) exMez
C	Cedrinho	<i>Erisma uncinatum</i> Warm.
D	Cupiúba	<i>Goupia glabra</i> Aubl.
E	Pequiá	<i>Caryocar villosum</i> (Aubl.) Pers.
F	Angelim da Mata	<i>Hymenolobium excelsum</i> Ducke
G	Maparajuba	<i>Manilkara bidentata</i> (A. DC.) A. Chev
H	Timborana	<i>Piptadenia gonoacantha</i> (Mart.)
I	Sucupira Preta	<i>Bowdichia nitida</i> Spruce ex Benth.
J	Tachi Preto	<i>Tachigali myrmecophila</i> Ducke
K	Tanibuca	<i>Terminalia amazonica</i> (J.F. Gmel)
L	Mandioqueira-escamosa	<i>Qualea paraensis</i> Ducke
M	Sapucaia	<i>Lecythis pisonis</i> Cambess
N	Jarana Amarela	<i>Lecythis poiteaui</i> O. Berg

2.2 Wood testing

The 14 wood species selected to be characterized in the Project were submitted to physical and mechanical testing, which included: density (basic, dry, green and apparent at 12% moisture content), moisture content, shrinkage, compression parallel and perpendicular to the grain, nail extraction, Janka hardness, cleavage, static bending and tension perpendicular to the grain. The mechanical tests were conducted at dry (12% moisture content) and green conditions.

Additionally, the wood species were submitted to testing on sanding, boring, planing, and abrasion to determine the species workability.

The results were submitted to statistical analysis using the SPSS statistical software and means and standard deviation of each property was determined at 5% of confidence level.

2.3 Determination of the physical properties

2.3.1. Moisture content

The moisture content of the samples was determined at green and dry conditions according to the COPANT 460-72 standard (similar to ASTM D143-09) using equation 1:

$$MC = \frac{(M_i - M_d)}{M_d} \times 100 \quad \text{Eq. 1}$$

Where:

MC is the moisture content (%)

M_i is the mass before oven drying (g)

M_d is the mass after oven drying (g).

2.3.2. Density

The density was determined on specimens measuring 2x2x10 cm at the basic, dry, green and 12% moisture content conditions according to the COPANT 461-72 standard using equations 2 to 5:

$$PE = \frac{P}{V} \quad \text{Eq. 2}$$

$$PE_b = \frac{P_a}{V_s} \quad \text{Eq. 3}$$

$$PE_g = \frac{P_g}{V_s} \quad \text{Eq. 4}$$

$$PE_d = \frac{P_a}{V_a} \quad \text{Eq. 5}$$

Where:

PE is the density at 12% (g/cm^3)

PE_b is the basic density (g/cm^3)

PE_g is the green density (g/cm^3)

PE_d is the dry density (g/cm^3)

P is the mass at 12% (g)
 P_a is the oven dry mass (g)
 P_g is the green mass (g)
V is the volume at 12% (cm³).
 V_s is the green volume (cm³).
 V_a is the oven dry volume (cm³)

2.3.3. Shrinkage

The radial, tangential and volumetric shrinkage of the wood species were determined according to the COPANT 462-72 standard using the equations 6 to 9:

$$C_{tn} = \frac{d_{vt} - d_{st}}{d_{vt}} \times 100 \quad \text{Eq. 6}$$

$$C_{rn} = \frac{d_{vr} - d_{sr}}{d_{vr}} \times 100 \quad \text{Eq. 7}$$

$$C_{ln} = \frac{d_{vl} - d_{sl}}{d_{vl}} \times 100 \quad \text{Eq. 8}$$

$$C_{vn} = C_{tn} + C_{rn} + C_{ln} \quad \text{Eq. 9}$$

Where:

c_{tn} : is the tangential shrinkage in green samples (CH> 30%) to the dry state in an normalized environment (CH = 12%), expressed in percentage;
 d_{vt} : is the tangential dimension of green samples (CH> 30%);
 d_{st} : is the tangential dimension of dry samples in normalized environment (CH=12%)
 c_{rn} : is the radial shrinkage in green samples (CH>30%) to the dry state in normalized environment (CH= 12%), expressed in percentage;
 d_{vr} : is the radial dimension of green samples (CH>30%);
 d_{sr} : is the radial dimension of dry samples in normalized environment (CH=12%)
 c_{ln} : is the longitudinal shrinkage in green samples (CH>30%) to the dry state in normalized environment (CH= 12%), expressed in percentage;
 d_{vl} : is the longitudinal dimension of green samples (CH>30%);
 d_{sl} : is the longitudinal dimension of dry samples in normalized environment (CH= 12%)
 c_{vn} : is the volumetric shrinkage in green samples (CH>30%) to the dry state in normalized environment (CH= 12%), expressed in percentage;

2.4 Determination of the mechanical properties

2.4.1. Static bending

The static bending (MOR and MOE) of the wood species was determined at green and dry conditions according to the COPANT 555-72 standard using equations 10 to 12:

$$\text{MOR} = \frac{3 \times P_m \times L}{2 \times b \times h^2} \quad \text{Eq. 10}$$

$$MOE = \frac{P_2 \times L^3}{4 \times d_1 \times b \times h^3} \quad \text{Eq. 11}$$

$$TPL = \frac{3 \times P_2 \times L}{2 \times b \times h^2} \quad \text{Eq. 12}$$

Where:

MOR is the modulus of rupture in static bending (kgf/cm²)
 MOE is the modulus of elasticity in static bending (kgf/cm²)
 TPL is the tension at proportional limit in static bending (kgf/cm²)
 P_m is the maximum load at rupture (kgf)
 P₂ is the load at proportional limit (kgf)
 b is the specimen width (cm)
 h is the specimen depth (cm)
 L is the span of testing (cm)
 d₁ is the deflection at proportional limit (cm)

2.4.2. Compression parallel and perpendicular to grain

The compression parallel and perpendicular to grain were determined at green and dry conditions according to the COPANT 464-72 and COPANT 466-72 standards using the equations 13 and 14:

$$RUM = \frac{P}{S} \quad \text{Eq. 13}$$

$$RLP = \frac{P_1}{S} \quad \text{Eq. 14}$$

Where:

RUM is the compression parallel to grain (kgf/cm²),
 RLP is the compression perpendicular to grain (kgf/cm²)
 P is the maximum load at rupture (kgf)
 P₁ is the load at proportional limit (kgf)
 S is the area cross section (cm²)

2.4.3. Nail extraction

The nail extraction of the wood species was determined according to the COPANT 744-72 standard using the equation 15:

$$NE = P \quad \text{Eq. 15}$$

Where:

NE is the nail extraction (kgf)
 P is the maximum load at rupture (kgf)

2.4.4. Janka hardness

The Janka hardness of the wood species was determined according to the COPANT 465-72 standard using the equation 16:

$$JH = \frac{P}{S} \quad \text{Eq. 16}$$

Where:

JH is the Janka hardness (kgf/cm²)

P is the maximum load (kgf)

S is the sphere area cross section (cm²)

2.4.5. Shear strength parallel to the grain

The Shear strength parallel to the grain of the wood species was determined according to the COPANT 463-72 standard using the equation 17:

$$EUM = \frac{P}{S} \quad \text{Eq. 17}$$

Where:

EUM is the Shear strength parallel to the grain (kgf/cm²)

P is the maximum load (kgf)

A is the area subjected to shear (cm²).

2.4.6. Tension perpendicular to the grain

The tension strength perpendicular to the grain of the wood species was determined according to the COPANT 743-75 standard using the equation 18:

$$TP = \frac{P}{S} \quad \text{Eq. 18}$$

Where:

TP is the tension perpendicular to the grain (kgf/cm²)

P is the maximum load (kgf)

A is the area subjected to shear (cm²).

2.4.7. Resistance to cleavage

The resistance to cleavage of the wood species was determined according to the COPANT 741-75 standard using the equation 19:

$$RC = \frac{P}{w} \quad \text{Eq. 19}$$

Where:

RC is the resistance to cleavage (kgf/cm)

P is the maximum load (kgf)
w is the width of area of cleavage (cm).

2.5 Determination of the workability and abrasion

2.5.1 Workability

The facility or difficulty of working with wood using machine tools was determined in planing, boring and sanding.

Planing, boring and sanding were conducted in samples with dimensions of 500x120x24 mm according to the ASTM D1666-87 standard as follows.

2.5.1.1 Boring test

A borer RDMM704 5W equipped with drills of 25 mm diameter was used. Boring was made in each sample in two points at a minimum distance of 25 mm from the edges and also between holes.

2.5.1.2 Planing test

A five-axis model 120170 SOLIMAQ moulder was used in planing the wood samples in the tangential face. An average of 2 mm planing was made with two passages in opposite directions.

2.5.1.3 Sanding test

This test was performed after planing using an INVICTA sanding machine with 3525 rpm. At first an 80-grit paper-back belt was used in the longitudinal tangential face to sanding of the sample by manual pressure. Afterwards, the same procedure was employed, this time using a 120-grit paper-back belt in the opposite direction.

The three tests were evaluated visually, first in the surfaces of each sample to check for defects of machining such as raised grain, fuzzy grain, and interlocked grain. Finally, the superficial finishing of the samples was classified into five quality classes by assigning grades after manual and visual analysis, as described in Table 2.

Table 2: Classes of quality of superficial finishing in machine testing of wood.

Class	Grade	Defect free rate (%)
Excellent	1	80-100
Good	2	60-79
Fair	3	40-59
Poor	4	20-39
Verypoor	5	0-19

2.5.2 Resistance to abrasion

Six specimens per wood species were acclimatized before testing and used to evaluate the resistance to abrasion based on the loss of mass according to the ABNT NBR 14535:2000 standard, which is similar to the ASTM D 4060-95. Each specimen was subjected to the Taber abrasimeter with wheel H18, load of 1000 g and 500 cycles. The tested samples had the dimensions of 100x100x4 mm. Cleaning the abrasive wheels after each

250 cycles was necessary to remove excess of dust that could interfere in the results. The wear rate of the specimen was determined using equation 20:

$$TD = \frac{100(A-B)}{c} \quad \text{Eq. 20}$$

Where:

TD is the wear rate (g) per 100 cycles

A is the mass before testing (g)

B is the mass after testing (g)

3 Presentation of the data

The general characteristics of the wood species are presented in the Annex 1.

Physical Properties

The results of the physical properties are presented in Table 3.

Mechanical Properties

The results of the mechanical properties are presented in Tables 4, 5 and 6.

Table 3. Results of the physical properties.

Code of Species	Common name	Density Basic (g/cm ³)	Density Dry (g/cm ³)	Density at 12% (g/cm ³)	Density Green (g/cm ³)	Shrinkage Tangential (%)	Shrinkage Radial (%)	Shrinkage Volumetric (%)	Ratio CT/CR	Abrasion Mass Loss (g)
A	Angelim Vermelho	0.88 0.04 6	1.03 0.04 6	1.07 0.04 6	1.28 0.02 6	9.1 1.0 6	5.7 0.3 6	14.8 1.2 6	1.6 0.1 6	0.10 0.02 6
B	Itaúba Amarela	0.76 0.02 6	0.86 0.03 6	0.91 0.02 6	1.03 0.05 6	8.1 0.8 6	3.2 0.7 6	11.3 1.4 6	2.7 0.5 6	0.45 0.12 6
C	Cedrinho	0.53 0.05 6	0.62 0.04 6	0.66 0.04 6	0.97 0.11 6	9.1 0.4 6	4.5 0.6 6	13.6 0.9 6	2.0 0.2 6	0.14 0.01 6
D	Cupiúba	0.71 0.02 6	0.82 0.04 6	0.87 0.06 6	1.15 0.03 6	7.8 0.9 6	4.5 1.1 6	12.3 2.0 6	1.8 0.3 6	0.12 0.01 6
E	Pequiá	0.73 0.06 6	0.85 0.07 6	0.90 0.06 6	1.18 0.05 6	8.3 0.6 6	4.6 0.4 6	12.9 0.6 6	1.8 0.2 6	0.19 0.06 6
F	Angelim da Mata	0.63 0.04 6	0.71 0.05 6	0.76 0.05 6	1.08 0.1 6	7.4 1.1 6	4.8 1.0 6	12.2 1.9 6	1.6 0.2 6	0.21 0.03 6
G	Maparajuba	0.80 0.04 6	0.94 0.05 6	0.97 0.05 6	1.19 0.03 6	9.1 0.7 6	5.1 0.7 6	14.3 1.3 6	1.8 0.2 6	0.20 0.04 6
H	Timborana	0.74 0.04 6	0.84 0.04 6	0.86 0.04 6	1.07 0.06 6	7.3 0.4 6	5.1 0.5 6	12.4 0.8 6	1.4 0.1 6	0.44 0.10 6
I	Sucupira Preta	0.80 0.02 6	0.93 0.02 6	0.95 0.02 6	1.12 0.02 6	8.6 1.0 6	6.0 0.6 6	14.6 1.5 6	1.4 0.1 6	0.20 0.03 6
J	Tachi Preto	0.60 0.06 6	0.68 0.08 6	0.76 0.06 6	1.14 0.02 6	7.3 0.5 6	4.3 0.8 6	11.6 1.3 6	1.8 0.2 6	0.16 0.04 6
K	Tanibuca	0.78 0.04 6	0.92 0.05 6	0.97 0.09 6	1.21 0.05 6	8.3 0.9 6	6.1 0.5 6	14.4 1.3 6	1.4 0.1 6	0.19 0.02 6
L	Mandioqueira-escamosa	0.65 0.03 6	0.78 0.05 6	0.82 0.06 6	1.08 0.03 6	10.9 0.6 6	6.1 1.6 6	17.0 2.1 6	1.9 0.4 6	0.17 0.03 6
M	Castanha Sapucaia	0.86 0.04 6	1.00 0.03 6	1.03 0.03 6	1.26 0.02 6	7.7 1.5 6	5.4 0.8 6	13.1 2.1 6	1.4 0.2 6	0.16 0.04 6
N	Jarana Amarela	0.86 0.03 6	1.05 0.04 6	1.08 0.04 6	1.28 0.01 6	12.8 0.8 6	6.8 0.9 6	19.6 1.5 6	1.9 0.3 6	0.18 0.06 6

Note: Numbers in each cell are respectively: Mean, standard deviation and number of specimens tested. Dry is the specimen conditioned to 12% moisture content; green is the specimen saturated in water

Table 4. Results of the mechanical properties.

Code of Species	Common name	MOE Green (kgf/cm ²)	MOR Green (kgf/cm ²)	TPL Green (kgf/cm ²)	MOE Dry (kgf/cm ²)	MOR Dry (kgf/cm ²)	TPL Dry (kgf/cm ²)	Hardness Side Green (kgf/cm ²)	Hardness Side Dry (kgf/cm ²)	Hardness End Green (kgf/cm ²)	Hardness End Dry (kgf/cm ²)
A	Angelim Vermelho	126343 7687 4	1125 86 6	934 29 4	146230 11039 5	1464 85 5	1169 167 5	1030 90 6	1468 153 6	949 115 6	1593 89 6
B	Itaúba Amarela	112761 6619 6	931 109 6	697 96 6	137675 7064 5	1263 79 5	904 96 5	569 84 6	713 83 6	499 70 6	664 40 6
C	Cedrinho	82065 6699 6	646 52 6	481 31 6	104146 3803 6	864 130 6	595 76 6	368 76 6	525 49 6	421 77 6	642 38 6
D	Cupiúba	105762 13415 6	854 209 6	711 195 6	121613 13559 6	1217 182 3	879 117 3	682 144 6	824 193 6	706 174 6	908 207 6
E	Pequiá	92301 19220 6	758 147 6	613 157 6	111949 18663 5	1074 205 4	700 83 4	756 215 6	832 173 6	688 193 6	782 134 6
F	Angelim da Mata	100025 9275 4	903 69 5	653 87 5	128315 9326 6	1175 136 6	811 74 6	590 66 6	710 37 6	624 48 6	823 60 6
G	Maparajuba	109054 10808 6	1019 33 6	742 75 6	135854 6905 6	1357 171 6	799 113 6	752 67 6	986 140 6	639 53 6	982 109 6
H	Timborana	111969 5632 6	1002 157 6	763 79 6	133956 5674 6	1250 221 6	876 41 5	811 30 6	882 53 6	761 33 6	860 62 6
I	Sucupira Preta	141777 4316 6	1398 97 6	1104 73 6	163380 6914 6	1694 165 6	1161 90 6	1073 95 6	1312 130 6	1089 56 6	1383 149 6
J	Tachi Preto	94475 11609 6	810 145 6	646 79 6	122481 15240 6	1167 130 6	753 76 6	642 161 6	781 142 6	712 155 6	886 149 6
K	Tanibuca	116833 4651 6	1010 105 6	804 41 6	140028 9118 6	1407 63 6	984 82 6	929 76 6	1277 91 6	916 69 6	1384 101 6
L	Mandioqueira-escamosa	106042 11094 6	832 74 6	601 36 6	140100 17250 6	1201 237 4	738 64 4	536 58 6	758 96 6	609 48 6	869 77 6
M	Castanha Sapucaia	108835 9381 6	914 148 6	735 99 6	129973 11915 6	1310 111 6	711 78 6	942 81 6	1189 126 6	793 47 6	1233 107 6
N	Jarana Amarela	116889 13050 6	942 140 6	767 93 6	150595 7810 6	1360 316 6	784 178 6	974 48 5	1403 156 6	874 18 5	1429 162 6

Note: Numbers in each cell are respectively: Mean, standard deviation and number of specimens tested. Dry is the specimen conditioned to 12% moisture content; green is the specimen saturated in water; MOE is the modulus of elasticity in static bending; MOR is the modulus of rupture in static bending; TPL is the tension at the proportional limit in static bending.

Table 5. Results of the mechanical properties (continue...).

Code of Species	Common name	Compression perpendicular Green (kgf/cm ²)	Compression perpendicular Dry (kgf/cm ²)	Compression parallel Green (kgf/cm ²)	Compression parallel Dry (kgf/cm ²)	Nail extraction Side Green (kgf)	Nail extraction Side Dry (kgf)	Nail extraction End Green (kgf)	Nail extraction End Dry (kgf)
A	Angelim Vermelho	183 28 5	191 24 6	619 32 6	796 119 6	95 15 6	221 20 6	129 11 6	132 22 6
B	Itaúba Amarela	105 21 6	155 18 6	480 93 6	687 81 6	38 20 6	31 9 6	38 14 6	35 10 6
C	Cedrinho	57 6 6	72 9 6	336 22 6	504 19 6	44 9 6	126 10 6	72 14 6	88 5 6
D	Cupiúba	99 15 6	132 22 6	476 89 6	670 81 6	91 15 6	115 37 6	130 34 6	87 11 6
E	Pequiá	108 21 6	136 26 6	414 92 6	517 137 6	87 24 6	73 23 6	130 33 6	60 13 6
F	Angelim da Mata	84 10 6	119 18 6	450 68 6	624 52 6	79 8 6	158 17 6	131 13 6	104 12 6
G	Maparajuba	146 43 6	152 18 6	518 60 6	696 63 6	88 7 6	67 6 6	79 10 6	66 7 6
H	Timborana	120 8 6	150 12 6	544 75 6	757 65 6	112 21 6	86 15 6	182 13 6	71 5 6
I	Sucupira Preta	134 19 6	162 19 6	797 35 6	934 116 6	154 17 6	193 17 6	215 16 6	136 18 6
J	Tachi Preto	96 23 6	118 16 6	406 66 6	620 64 6	70 15 6	142 19 6	124 27 6	92 11 6
K	Tanibuca	132 9 6	176 30 6	546 42 6	763 31 6	133 11 6	194 8 6	189 11 6	174 17 6
L	Mandioqueira-escamosa	74 6 6	110 15 6	400 35 6	653 51 6	73 11 6	156 12 6	100 12 6	94 14 6
M	Castanha Sapucaia	171 23 5	176 10 6	460 157 6	643 52 6	77 9 6	199 9 6	124 11 6	166 17 6
N	Jarana Amarela	176 48 5	212 26 6	531 73 6	720 123 6	81 13 5	174 18 6	132 16 5	130 20 6

Note: Numbers in each cell are respectively: Mean, standard deviation and number of specimens tested. Dry is the specimen conditioned to 12% moisture content; green is the specimen saturated in water.

Table 6. Results of the mechanical properties (continue...)

Code of Species	Common name	Tension perpendicular Green (kgf/cm ²)	Tension perpendicular Dry (kgf/cm ²)	Cleavage Green (kgf/cm)	Cleavage Dry (kgf/cm)	Shear strength Green (kgf/cm ²)	Shear strength Dry (kgf/cm ²)
A	Angelim Vermelho	59 11 6	65 18 5	58 15 6	162 33 6	120 8 6	157 10 6
B	Itaúba Amarela	79 8 6	66 18 6	68 7 6	214 64 6	85 10 6	118 6 6
C	Cedrinho	32 7 5	38 13 5	37 6 6	117 28 6	68 8 6	86 12 6
D	Cupiúba	45 17 4	39 9 4	69 21 6	200 74 6	105 15 6	134 24 5
E	Pequiá	69 17 6	75 31 4	65 9 6	207 62 6	105 12 6	142 13 6
F	Angelim da Mata	52 7 4	51 5 4	51 5 6	140 19 6	97 11 6	127 8 5
G	Maparajuba	52 18 6	78 18 6	60 19 6	301 94 6	115 8 6	131 8 5
H	Timborana	80 15 6	110 43 6	81 12 6	240 61 6	121 9 6	153 9 6
I	Sucupira Preta	65 20 6	108 20 6	68 11 6	155 32 6	127 18 6	175 7 6
J	Tachi Preto	58 7 6	128 29 5	58 13 6	202 23 6	113 18 6	142 14 6
K	Tanibuca	65 9 6	116 31 6	69 10 6	189 26 6	119 12 6	163 19 6
L	Mandioqueira-escamosa	49 8 6	91 30 6	56 10 6	138 35 5	96 5 6	133 20 5
M	Castanha Sapucaia	55 18 6	143 55 5	55 7 6	253 67 6	114 15 6	151 9 6
N	Jarana Amarela	71 19 4	245 67 3	61 21 5	278 93 6	117 30 5	187 12 5

Note: Numbers in each cell are respectively: Mean, standard deviation and number of specimens tested. Dry is the specimen conditioned to 12% moisture content; green is the specimen saturated in water.

4 Analysis and interpretation of the data and results

The classification of the wood species in heavy, medium or light was based in the publication by Melo, Coradin and Mendes (1990), as:

Light wood: basic density up to 0.50 g/cm³.

Medium density: basic density between 0.50 and 0.72 g/cm³.

Heavy wood: basic density from 0.72 g/cm³.

Based on this classification the species cedrinho, cupiúba, angelim da mata, tachi preto and mandioqueira-escamosa were classified as medium density. The remaining were graded as high density.

The results of workability of the wood species characterized are presented in Table 7:

Table 7. Results of the workability.

Code of Species	Common name	Planing	Sanding 80-grit	Sanding 120-grit	Boring
A	Angelim Vermelho	Good	Excellent	Excellent	Fair
B	Itaúba Amarela	Good	Good	Excellent	Fair
C	Cedrinho	Good	Good	Excellent	Good
D	Cupiúba	Good	Good	Excellent	Good
E	Pequiá	Fair	Good	Excellent	Fair
F	Angelim da Mata	Good	Good	Excellent	Good
G	Maparajuba	Excellent	Good	Excellent	Excellent
H	Timborana	Good	Good	Excellent	Excellent
I	Sucupira Preta	Good	Excellent	Excellent	Good
J	Tachi Preto	Good	Excellent	Excellent	Good
K	Tanibuca	Good	Excellent	Excellent	Excellent
L	Mandioqueira-escamosa	Fair	Good	Excellent	Good
M	Castanha Sapucaia	Good	Good	Excellent	Good
N	Jarana Amarela	Good	Good	Excellent	Good

The species angelim vermelho, sucupira preta, tachi preto and tanibuca were classified as excellent when using the 80-grit paper-back belt in sanding. The others were graded as good. Under the 120-grit paper-back belt in sanding all species were graded as excellent.

When subjected to planing the species were classified as:

Excellent: Maparajuba.

Good: Angelim Vermelho, Itaúba Amarela, Cedrinho, Cupiúba, Angelim da Mata, Timborana, Sucupira Preta, Tachi Preto, Tanibuca, Castanha Sapucaia and Jarana Amarela

Fair: Pequiá and Mandioqueira-escamosa

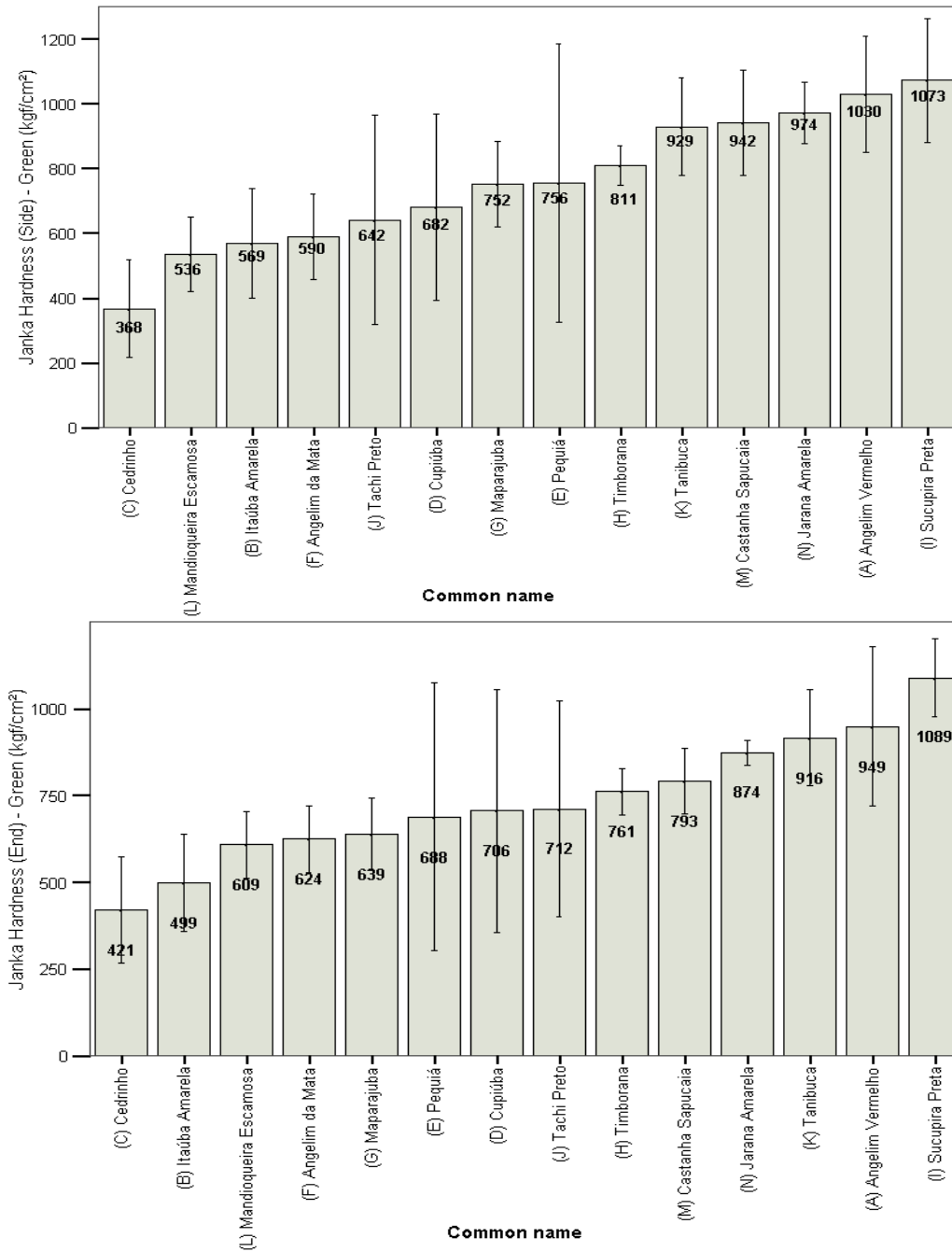
When subjected to boring the species were classified as:

Excellent: Maparajuba, Timborana and Tanibuca.

Good: Cedrinho, Cupiúba, Angelim da Mata, Sucupira Preta, Tachi Preto, Mandioqueira-escamosa, Castanha Sapucaia and Jarana Amarela.

Regular: Angelim Vermelho, Itaúba Amarela and Pequiá.

The species with higher Janka hardness side green and dry were sucupira preta, angelim vermelho, jarana amarela, castanha sapucaia, timborana, maparajuba and tanibuca. The lowest ones were cedrinho, mandioqueira-escamosa, itauba amarela and angelim da mata. Figure 1 shows the Janka Hardness side-end in green and dry conditions in crescent order.



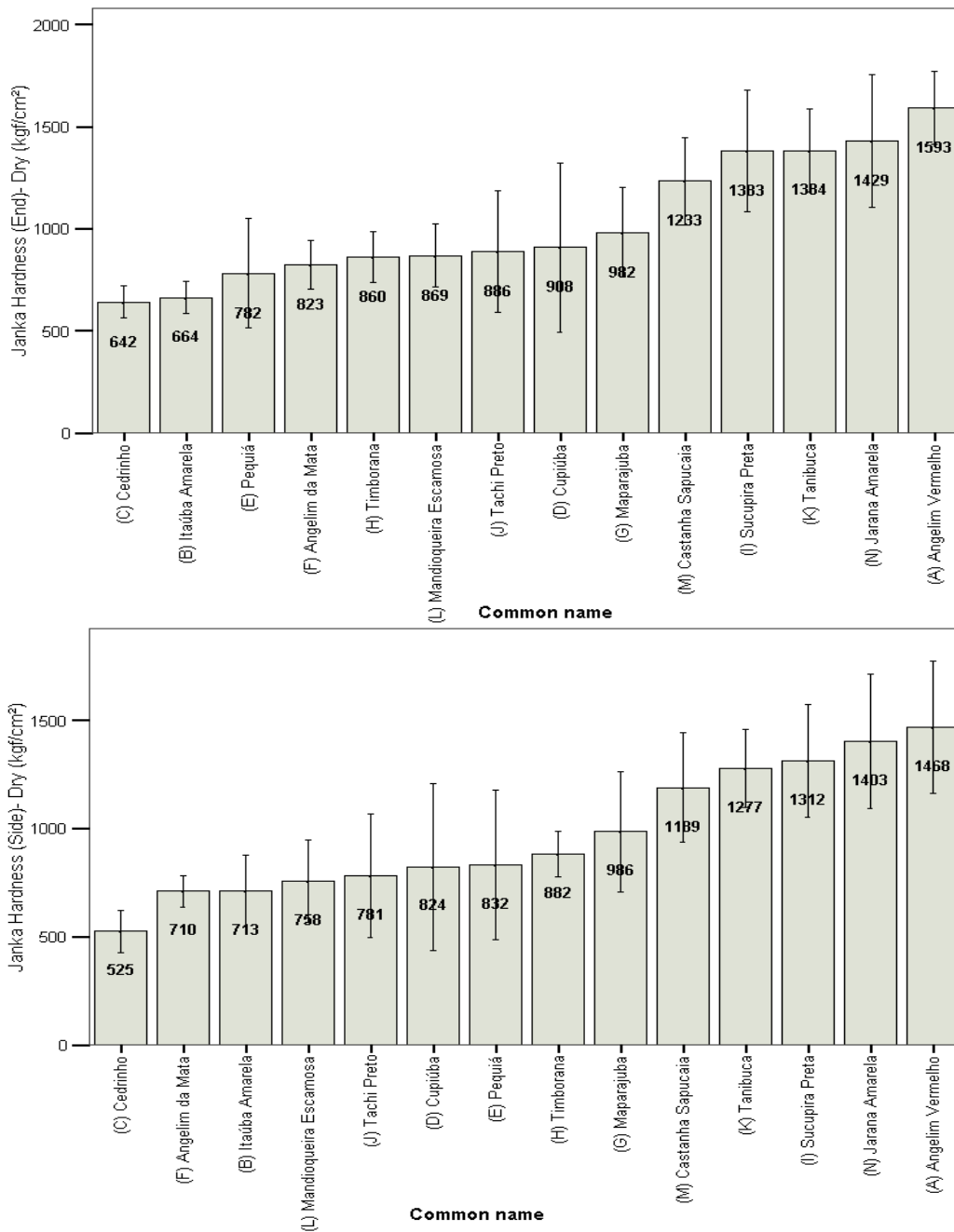


Figure 1. Results of Janka hardness side-end green and dry.

The correlation between Janka hardness and abrasion was not significant and explained only 12%, 18%, 21% and 34%, respectively for side-green, end-green, side-dry and end-dry, respectively.

5 Conclusions

Some of the species studied are difficult to dry naturally and presented defects such as cracks, making it hard to obtain defect free specimens for testing.

Almost all species were good or excellent to machine. Only mandioqueira and pequiá were fair in planing and pequiá, angelim vermelho and itaúba amarela were fair in boring.

The most promising species for use as flooring due mainly to properties such as density, abrasion, hardness, compression perpendicular and density are: Angelim vermelho, timborana, maparajuba, sucupira preta, tanibuca, castanha sapucaia and jarana amarela.

6 Implications for practice

This study is very important to consumers and producers of wood and wood flooring, since it makes available the information on the properties of the species to the decision makers in this commerce

Bibliography

AMERICAN SOCIETY FOR TESTING AND MATERIALS. **ASTM D143-09**: Standard Test Methods for Small Clear Specimens of Timber. Philadelphia, USA, 2009. p.31.

AMERICAN SOCIETY FOR TESTING AND MATERIALS. **ASTM D1666-87**: Standard methods for conducting machining tests of wood and wood-base materials. Philadelphia, USA, 2005. p.19.

AMERICAN SOCIETY FOR TESTING AND MATERIALS. **ASTM D4060-95**. Standard test method for abrasion resistance of organic coating by the taber abraser, 1995.

ASSOCIAÇÃO BARSILEIRA DE NORMAS TÉCNICAS. **ABNT NBR 14535:2000**: Móveis de madeira – Tratamento de superfícies – requisitos de proteção e acabamento. Brasil. 22p.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 460-72**. Timber. Determination of humidity.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 461-72**. Timber. Determination of apparent specific gravity.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 462-72**. Timber. Determination of contraction.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 463-72**. Timber. Determination of shearing strength. Parallel to grain.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 464-72**. Timber. Determination of axial compression or parallel to grain.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 465-72**. Timber. Determination of hardness.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 466-72**. Timber. Determination of compression perpendicular to grain.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 555-72**. Timber. Method for testing static flexure.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 741-75**. Timber. Determination of resistance to cleavage.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 743-75**. Timber. Determination of stress transverse to grain.

COMMISSION PANAMERICANA DE NORMAS TÉCNICAS - **COPANT 744-75**. Timber. Method for the extraction of nails.

MELO, J.E.; CORADIN, V.T.R.; MENDES, J.C. Classes de densidade para madeiras da Amazônia brasileira. In: CONGRESSO FLORESTAL BRASILEIRO, 6, Campos do Jordão, 1990. **Anais**. São Paulo: Sociedade brasileira de silvicultura, 1990. p 695 - 699.

ANNEX 1. General characteristics of the wood species

1. *Dinizia excelsa* Ducke

Botanical family: Mimosaceae

Popular names: Angelim, Angelim-falso, Angelim-ferro, Angelim-pedra, Angelim-pedra-verdadeiro, Angelim-vermelho, Dinízia-parda, Fava, Fava-carvão, Favadura, Fava-ferro, Fava-grande, Faveira, Faveira-carvão, Faveira-dura, Faveira-ferro, Faveiro-do-grande, Gurupá,

General characteristics:
Heartwood/sapwood little different;
Thickness of sapwood: 5,0 to 12.0 cm;
Heartwood color: reddish brown light;
sapwood color: reddish gray; Growth rings: distinct; Grain: interlocked, texture: medium; tangential figure: caused by vascular highlighted lines; radial figure: in broad longitudinal bands, caused by growth rings; Brightness: moderate; Smell: nasty and weak; Resistance to manual cross-cutting: hard.

Vessels/pores: visible to the naked eye, small to medium; few; diffuse porosity; solitary, multiple and sometimes in radial; clogged by oil-resin or whitish substance.

Axial Parenchyma: visible to the naked eye, paratracheal aliform extension of the diamond, occasionally confluent.

Rays: visible just under the lens at the top and tangential face; few.

Growth rings: distinct, slightly individualized by fibrous areas darker and tangential lines of marginal parenchyma.

Chemical and physical tests: The heartwood is not treatable with creosote (oily soluble) and CCA (water soluble).

Natural durability: the heartwood has a high resistance to attack by wood-destroying organisms (fungi and insects) (IPT, 1989a). In field tests with stakes, this wood was considered highly durable with longer life spans than eight years (Jesus et al., 1998).

Tractability: Waterproof to preservative solutions (IPT, 1989a). The heartwood is not treatable with creosote (oily soluble) nor with CCA (water soluble), even in proceedings

under pressure (IBDF, 1988; IBAMA, 1997a).

Geographical distribution: Northern Brazil

Phytogeographical area: Amazônia, Acre, Amapá, Amazonas, Pará and Rondônia.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Dinizia excelsa Ducke

Source: IPT, IBAMA e LPF

2. *Mezilaurus itauba* (Meisn) Taub ex Mez

Botanical family: Lauraceae

Popular names: Cedro-pardo, Itaúba, Itaúba-abacate, Itaúba-amarela, Itaúba-grande, Itaúba-penima, Itaúba-piúna, Itaúba-preta, Itaúba-verdadeira, Itaúba-vermelha, Lorê, Louro-itaúba, Nhambiquara

General characteristics: Heartwood: yellowish brown; Sapwood: grayish brown, distinct - 2.0 to 5.0 cm thick; Growth rings: little different; Grain: straight to wavy; Texture: medium to fine; Figure: absent; Brightness: weak, green weight (kg/m³): 1140, basic specific gravity (g/cm³): 0.70.

Vessels/pores: visible only under lens, small to medium; few; diffuse porosity; solitary and in radial multiples; blocked by tyloses.

Axial Parenchyma: Invisible even under lens, scanty paratracheal.

Rays: visible just under the top lens and the tangential face, fine, very few to few.

Growth rings: Indistinct or possibly bounded by tangential fibrous darker areas.

Chemical and physical tests: presents low permeability to preserving solutions. (IPT, 1989a) tests with water soluble solutions applied under pressure, showed that the sapwood is difficult to treat and the core is refractory. (INPA, 1991; Berni et al, 1979) The wood is difficult to preserve, with retention oleossolúveis condoms below 100 kg/m³. (IBDF, 1981)

Geographical distribution: Northern Brazil

Phytogeographical area: Amazônia, Acre, Amapá, Amazonas, Pará and Rondônia.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Mezilaurus itauba (Meisn) Taub ex Mez

Source: IPT ,IBAMA e LPF

3. *Erisma uncinatum* Warm.

Botanical family a: Vochysiaceae

Popular names: bruteiro, cachimbo-de-jabuti, cambará, cambará-rosa, cedrilho, jaboti, jaboti-da-terra-firme, quaruba-vermelha, quarubarana, quarubatinga, verga-de-jabuti.

General characteristics: Heartwood: reddish to purplish brown; Sapwood: distinct, grayish light brown, 4-14 cm thick; Growth rings: little different; Grain: straight; Texture: medium; Figure: absent; Brightness: weak; Green Weight (g/m³): 1100, basic specific gravity (g/cm³): 0.48.

Vessels/pores: visible to the naked eye, medium to large, very few to few, diffuse porosity; solitary and multiple two to three; blocked by tyloses.

Axial Parenchyma: visible to the naked eye, wide and long in tracks tangential to the vessel, and in short passages.

Rays: visible only by lens, from the top and the tangential thin face; few.

Growth rings: indistinct.

Included phloem: present in the parenchyma bands.

Chemical and physical tests: Impregnation Facility: Group I; Retention (kg/m³): min. 308 - med. 348 - max. 446; Penetration: Total uniform.

Geographical distribution: Northern and central-western Brazil

Phytogeographical area: Amazônia, Acre, Amapá, Amazonas, Mato Grosso, Pará and Rondônia.

Conservation status: Not included in the list of 100 most traded species native from Brazil in 2008.



Erisma uncinatum Warm.

Source: IPT, IBAMA e LPF

4. *Goupia glabra* Aubl.

Botanical family: Goupiaceae

Popular names: Bragantina, Cacha-ceiro, Copiúba, Copiúva, Cupiúba, Cupi-úba-rosa, Cupuba, Cutiúba, Peniqueiro, Peroba-bosta, Peroba-do-norte, Peroba-fedida, Peroba-fedorenta, Perobinha, Tento

General characteristics:
Heartwood/sapwood: slightly distinct
Thickness of sapwood: 4.0 cm to 7.0 cm;
Heartwood color: light red (2.5 YR 6/6);
sapwood color: reddish yellow (7.5 YR 7/6);
Layers growth: little different; grain: interlocked; Texture: medium; tangential figure: detached, caused by vascular lines; radial figure: longitudinal bands in little detached, caused by grain; Brightness: absent; Smell: characteristic unpleasant; Resistance manual cutting : hard.

Vessels/pores: visible to the naked eye, medium, short, diffuse porosity; Solo; clogged by oil-resin.

Axial Parenchyma: only visible under lens, diffuse apotracheal in aggregate

Rays: visible only by lens, from the top and the tangential thin face few or many.

Growth rings: indistinct.

Chemical and physical tests: heartwood and sapwood have moderate permeability to preservative solutions both oily soluble (creosote) as hydro soluble (CCA). The retention of oily soluble condom is 200 kg/m³ to 300 kg/m³. (IBDF, 1981) Have (Brito Neto et al., 1984) recognized the core of cupiúba as low permeability treatment with creosote oil.

Natural durability: in laboratory testing of cupiúba wood shown to have high resistance to attack by wood-destroying organisms (fungi and termites) (IPT, 1989a). Provides resistance to decay fungi (white and brown rot) and termites wood-dried, however, is not resistant to marine wood borer (Chudnoff, 1979, IBAMA, 1997a). Study by (SUDAM / IPT, 1981) found that the durability of this wood is more than 12 years of service in contact with the ground.

Tractability: heartwood and sapwood have moderate permeability to preservative solutions both oily soluble (creosote) and soluble (CCA). Retention of soluble oils → condom is 200 kg / m³ 300 kg / m³ (IBDF, 1981).

Geographical distribution: Northern and central-western Brazil

Phytogeographical area: Amazônia, Acre, Amapá, Amazonas, Mato Grosso, Pará and Rondônia

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Goupia glabra Aubl.

Source: IPT, IBAMA e LPF

5. *Caryocar villosum* (Aubl.) Pers.

Botanical family: Caryocaraceae.

Popular names: pequi, pequi-roxo, pequiá, piqui, piqui-rosa, piquiá-bravo, piquiá-verdadeiro.

General characteristics: Heartwood /sapwood: distinct; thickness of sapwood: 2.5 cm to 7.0 cm; Heartwood color: pale brown to very pale brown (10YR 6/3 to 10YR 7/4); Sapwood Color: white to pale yellow (2.5 y 8/2 to 2.5Y 8/4); Note: the color is changed to light brownish-gray (10YR 6/2) due to fungi; growth layers: little different; United : interlocked; Texture: medium; tangential figure: fibrous aspect, caused by vascular lines just mention; radial figure: slightly detached due to vascular lines; Brightness: absent; Smell: imperceptible; Resistance to manual cut: moderately hard.

Vessels/pores: visible to the naked eye, diffuse porosity, medium to large, solitary and multiple; blocked by tyloses. **Axial Parenchyma:** visible only under lens; apotracheal diffuse and diffuse in aggregates forming a frame with rays, sometimes thinly marginal bands.

Rays: visible only under lens on top, fine and very numerous, in the tangential face barely visible even under the lens.

Growth rings: characterized by quite regular fibrous zones and eventually the marginal parenchyma.

Natural durability: The wood on laboratory tests showed high resistance to attack by wood-destroying organisms. (IPT, 1989a)

Tractability: has low permeability to preservative solutions when subjected to pressure impregnation. (IPT, 1989a)

Geographical distribution: Northern Brazil

Phytogeographical area: Amazon.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Caryocar villosum (Aubl.) Pers.

Source: IPT, IBAMA e LPF

6. *Hymenolobium excelsum* Ducke

Botanical family: Fabaceae

Popular names: Angelim (AM), angelim-comum (AC, PA), angelim-da-mata (PA), angelim-rajado (AC, RO, RR), angelim-rajado-da-mata (AC, RR), fava-folha-fina (AM, AP).

General characteristics: Dense wood (0.80-0.90 g/cm³), difficult workability, but gets good finish, red-brown heartwood of yellow-brownish, grayish sapwood; interlocked grain for regular, coarse texture, smooth to the touch, absence of brightness; faint smell (Melo & Gomes, 1979; SUDAM, 1979).

Vessels/pores: clearly visible to the naked eye, very few (up 4/mm²), medium to large, solitary, twin radial and small, some with white and dark substances.

Axial Parenchyma: very abundant, very distinct to the naked eye, forming very wide continuous strips, apart, sometimes interrupted at oblique arrangements, wavy, possibly marginal.

Rays: visible to the naked eye on the transverse face, tangential to the face and laminated, number of lines laminating an average of 3 lines per mm.

Growth rings: well marked by dark fibrous areas.

Geographical distribution: Northern Brazil

Phytogeographical area: Amazon.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Hymenolobium excelsum Ducke

Source: IPT , IBAMA eLPF

7. *Manilkara huberi* (Ducke) Chevalier

Botanical family: Sapotaceae

Popular names: Aparaiú, Apraiú, Aprauá, Balata, Chauá, Gararoba, Maçaranduba, Maçaranduba-amarela, Maçaranduba-balata, Maçaranduba-branca, Maçaranduba-damarinha, Maçaranduba-da-terra-firme, Maçaranduba-de-leite, Maçaranduba-do-ceará, Maçaranduba-mansa, Maçaranduba-preta, Maçaranduba-roxa, Maçaranduba-verdadeira, Maçaranduba-vermelha, Maparajuba, Paraju, Parajuba, Ucuúba, Ucuúba-da-folha-grande, Ucuubarana, Ucuúba-vermelha.

General characteristics: Heartwood/sapwood: distinct; Heartwood color: reddish brown (5YR 5/4); sapwood color: pale yellow (2.5Y 8/4); Growth layers: the fuzzy little different; Grain: straight; Texture: fine; Figure tangential: detached, caused by vascular lines; radial Figure: detached, caused by vascular lines; Brightness: absent; Smell: imperceptible; Resistance to manual cutting: hard.

Vessels/pores: visible only under lens, small to medium; few; diffuse porosity, radial arrangement; solitary, multiple, blocked by tyloses.

Axial Parenchyma: only visible under lens in numerous lines, sometimes interrupted.

Rays: visible just under the lens at the top, in the tangential face is invisible even under lens; few to numerous.

Growth rings: distinct, individualized by fibrous tangential darker areas.

Chemical and physical tests: the heartwood is impermeable to water-soluble preservative solutions (CCC-A), even in pressure treatment. (IBAMA, 1997a).

Geographical distribution: Northern, midwestern, southeastern, northeastern Brazil

Phytogeographical area: Acre, Amapá, Amazonas, Bahia, Espírito Santo, Maranhão, Mato Grosso, Pará, Paraná, Rio de Janeiro and Rondônia.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Manilkara huberi (Ducke) Chevalier

Source: IPT, IBAMA e LPF

8. *Piptadenia gonoacantha* (Mart.)

Botanical family: Mimosaceae.

Popular names: Angico, Angico-branco, Angico-jacaré, Angico-vermelho, Angiquinho, Camboeteiro, Camoeteiro, Caniveteiro, Casco-de-jacaré, Fava, Faveira, Folha-fina, Icarapé, Jacaré, Jacarezeiro, Monjoleiro, Monjolo, Paricá-branco, Paricá-grande-da-terra-firme, Pau-jacaré, Serreiro, Timborana.

General characteristics: Heartwood /sapwood: little different; Color: Light brown to reddish brown; Growth rings: distinct, irregular; Grain: irregular cross; Texture: medium; Figure: Lines (radial); Brightness: Medium; Green Weight (kg/m³): 1120 Weight basic specific (g/cm³): 0.68.

Geographical distribution: Region Midwest, Southeast, northern Brazil.

Phytogeographical area: Rio de Janeiro, Minas Gerais, Mato Grosso do Sul until Santa Catarina, mainly in the rain forest of the Atlantic slope.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.

Impregnation: Facility: Group IV; retention (kg / m³): med-Min.89 196 - max 267

Tractability: Sawing: difficult, planing: medium.



Piptadenia gonoacantha (Mart.)

Source: IBAMA e LPF

9. *Bowdichia nitida* Spruce

Botanical family: Fabaceae

Popular names: Cutiúba, Macanaíba, Matanaíba, Sapupira, Sapupira-da-mata, Sebepira, Sepipira, Sicupira, Sucupira, Sucupira-amarela, Sucupira-da-mata, Sucupira-da-terra-firme, Sucupira-marreta, Sucupira-pele-de-sapo, Sucupira-preta, Sucupira-vermelha.

General characteristics: The coloration of heartwood sucupira freshly cut is chocolate brown with tint, becoming dark brown after drying and also presenting narrow bands of a lighter brown. The sapwood is narrow, clearly differentiated from the heartwood and grayish or pinkish-gray. The wood has coarse texture, although homogeneous, some design features, high brightness, and grain varies from straight to slightly interlocked. The smell and taste are indistinguishable

Vessels/pores: visible to the naked eye, large, few, scattered porosity; prevalent and multiple solitary of up to four vessels; clogged with resin or oil-white substance.

Axial Parenchyma: visible to the naked eye, paratracheal aliform, vasicentric and confluent at oblique short stretches.

Rays: visible only from the top and the lens tangential face, thin, short, stratified (by 2 mm).

Geographical distribution: Northern and central-western Brazil.

Phytogeographical area: Amazonas, Pará and Mato Grosso.

Conservation status: Included in the official list of species of flora endangered, not included in the CITES Appendices.



Bowdichia nitida Spruce

Source: IPT, IBAMA e LPF

10. *Tachigali myrmecophila* Ducke

Botanical family: Leguminosae-
Caesalpinioideae.

Popular names: Taxi, taxi-pitomba, taxi-preto, taxi-preto-da-folha-grande, taxi-preto-da-mata, taxi-preto-folha-grande, taxi-preto-folha-graúda, taxizeiro.

General characteristics:
Heartwood/sapwood: indistinguishable by color, brownish to yellowish heartwood. Limits of distinct growth rings. Wood with gloss on longitudinal surfaces with moderately hard to manual cross-cutting or interlocked grain interlocked, médium texture, figure banded distinctive odor, caused by the prominence of the growth rings.

Vessels/pores: Present, visible to the naked eye, diameter (100 to 200µm), diffuse distribution medium frequency (from 6 to 30 vessels per 2mm²) predominantly radial multiple (more than 2/3) less than 4 vessels, arranged in radial, circular-shaped oval, perforation plates observed with a 10x lens, simple, clear vases.

Axial Parenchyma: Observed only with the aid of a 10x lens, scanty paratracheal and vasicentric.

Rays: Observed only in the two lens surfaces 10x little contrast in the radial surface, fine (less than 100µm wide), low (less than 1 mm in height) uncommon (5 to 10 rays per mm).

Stratified structures: Absent.

Secretory structures: not observed.

Chemical and physical tests: Negative cromazurol test, positive fluorescence, yellowish, average specific gravity (0.50 to 0.72 g / cm³).

Natural durability: The wooden cab is considered moderately resistant to fungi (IPT, 1989b).

Tractability: has low permeability to preservative solutions when subjected to pressure impregnation (IPT 1989b).

Geographical distribution: Northern Brazil

Phytogeographical area: Amazon.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Tachigali myrmecophila Ducke

Source: IBAMA , LPF e IPT

11. *Terminalia amazonica* (J.F.Gmel) Exell.

Botanical family: Combretaceae

Popular names: Capitão-amarelo, Cinzeiro, Cuia, Cuiarana, Mirindiba, Tanibuca, Tanimbuca

General characteristics: Heartwood: Light brown to brown; Sapwood: slightly distinct, yellowish light brown, 3-10 cm thick; Growth rings: little different; Grain: wavy; Texture: medium; Figure: absent; Brightness: medium, green weight (kg/m³): 1240; basic specific gravity (g/cm³): 0.80.

Vessels/pores: noticeable to the naked eye at the top, diffuse porosity, prevalent and multiple solitary, occasionally obstructed by oil-resin or white matter.

Axial Parenchyma: visible only under lens; little contrast, paratracheal aliform tending to form short confluences and sometimes marginal in thin strips.

Rays: visible only from the top and the lens tangential face.

Growth rings: demarcated by marginal parenchyma.

Chemical and physical tests: based on their anatomical structure, must be permeable to preservative solutions when subjected to pressure impregnation. (IPT, 1989a)

Geographical distribution: Northern and central-western Brazil

Phytogeographical area: Amazônia, Amazonas, Mato Grosso and Pará.

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Terminalia amazonica (J.F.Gmel) Exell.

Source: IPT e IBAMA

12. *Qualea paraensis* Ducke

Botanical family: Vochysiaceae

Popular names: Mandioqueira

General characteristics: Dense wood (0.70 to 0.80 g/cm³); heartwood yellowish beige different from yellowish-brown sapwood with fibrous aspect, sloping grain, coarse texture, smell and taste indistinct. Moderately resistant to attack by fungi and termites. According to the literature the wood is moderately easy to saw and plane, easy nail and screw.

Vessels/pores: Visible pores by naked eye, few, medium and large, solitary or grouped in 2:03 pores, empty blocked by tyloses.

Axial Parenchyma: visible to the naked eye, aliform, short or long fins, tending to compose oblique arrangements.

Rays: Thin, numerous rays, seen only with lens, the tangential plane are low and irregularly arranged.

Secretory structures: axial secretory canals in series, possibly marking the growth layer together with the parenchyma.

Geographical distribution: Northern and central-western Brazil.

Phytogeographical area: Amazonas, Pará, Acre and Mato Grosso

Conservation status: Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Qualea paraensis Ducke

Source: SINDIMASP e LPF

13. *Lecythis pisonis* Cambess.

Botanical family: Lecythidaceae

Popular names: Árvore-de-cambuca, Árvore-de-macaco, Caçamba-do-mato, Cambuca-de-macaco, Castanharana, Castanha-sapucaia, Chapéu-de-sol, Cuia-de-macaco, Cumbuca-de-macaco, Embira-de-jacuíba, Embiratã, Fruta-de-macaco, Jaçapucã, Jaçapucaia, Jaçapucari, Jecuibá, Jequitibá, Juquetibá, Marmita-de-macaco, Pau-carga, Pau-d'arco-branco, Pau-de-caixão, Quetelê, Ruchuchu, Sapucaí, Sapucaia, Sapucaia-branca, Sapucaiaçu, Sapucaia-de-castanha, Sapucaia-de-pilão, Sapucaia-do-amazonas, Sapucaia-grande, Sapucaia-verdadeira, Sapucaia-vermelha, Sapucarana.

General characteristics: Heartwood /sapwood: distinct Thickness of sapwood: 2.0cm to 2.0cm 1; Heartwood color: yellowish red (5YR 5/6); sapwood color: yellow (2.5Y 8/6) with the presence of dark spots, Rings growth: little different; Grain: slightly interlocked; Texture: medium; tangential figure: caused by vascular highlighted lines; radial figure: caused by some prominent vascular lines and having axial channels, giving the appearance damaged wood, and sometimes with patches, Brightness: absent; Smell: indistinct; Resistance to manual cross-cutting: hard.

Axial Parenchyma: visible only under lens; into very thin beam forming with the radius a perfect lattice (lattice parenchyma).

Vessels/pores: visible only under lens at the top and tangential face, diffuse porosity, small to medium, solitary and multiple; blocked by tyloses.

Rays: visible only by lens from the top and tangential face

Stratified structures: Absent.

Growth rings: bit demarcated by fibrous and/or proximity of the lines parenchymal areas (IPT, 1983).

Chemical and physical tests: has low permeability to preservative solutions when subjected to pressure impregnation. (IPT,

1989a)

Geographical distribution: Northern, southeastern, northeastern Brazil

Phytogeographical area: Amazonas, Bahia, Espírito Santo, Minas Gerais and Pará.

Conservation status:

Not included in the official list of species of flora endangered, not included in the CITES Appendices.



Lecythis pisonis Cambess.

Source: IPT, IBAMA e LPF

14. *Lecythis poiteaui*

Botanical family: Lecythidaceae

Popular names: Jarana amarela

General characteristics: Heartwood /sapwood: insufficient sampling for determination; Heartwood color: brownish-red; Growth rings: little different; Limits to Growth (individualization) rings: the decrease in the frequency of parenchyma bands, resulting in a distinct fibrous zone. Brightness: Brightness without the longitudinal surfaces; Smell: imperceptible; Resistance to manual cross cutting knife: Hard to manual cross-cutting; Grain: interlocked or interlocked; Texture: medium; Figure: present in bands caused by the cutting angle or by the grain, Spokes contrasted the radial surface.



Lecythis poiteaui



Lecythis poiteaui

Source: LPF



Lecythis poiteaui