Determination of the basic density of cedro wood (*cedrela fissilis* Vell.) along the stem

Álvaro Felipe Valério, Luciano Farinha Watzlawick, Raul Silvestre, Henrique Soares Koehler

Abstract

The objective of this work was to determine and compare the variation of basic density of the wood throughout the stem of *Cedrela fissilis* Vell., specie belonging to the Meliaceae family and known popularly as Cedro. The sample was performed in three selected trees at random in dense ombrophila forest, in the Municipal District of Apiuna and Presidente Nereu Ramos-SC. The trees were knocked and they had its dendometric variables measured. The basic density was determined in samples 1,5 x 1,5 x 5 cm, taken from inside of the disc (cerne) and from the outside (alburno), being these collected next to chest (DAP), 0%, 10%, 50%, 75% and 95% from the point of morphologic inversion, above this, two samples with branches named G_1 and G_2 were collected. The basic density was obtained through the relation between dry weight and fresh volume of samples and showing itself decreasing from the base to the top of the tree. In the analysis of variance (ANOVA) it was verified statistically significant differences between the averages in densities along the trunk and the branches, the average basic density was 431.06 kg m^{-3}. The found uniformity of the basic density along the stem is a characteristic that gives the specie stability and security for its use in structural projects... However, it is needed deeper studies to improve its scientific fundaments on its physical and technological properties.

Key words: specific mass; physical property; wood use.

Introduction

The specific mass reflects the amount of woody area per volume unit, or the amount of empty spaces existing in a wood. Thus, it should be noted that the evaluation of the quality of wood-based density is very useful from the technological point of view, being an excellent indicator of the properties of wood (VALE et al., 1999).

Besides being an indication of the quality of wood, it is an excellent index to an analysis of the feasibility of their use in various purposes, the density of the wood is important because it is a liable characteristic to genetic improvement and considered highly inherited (LOPES and GARCIA, 2002).

For Chimelo (1980) the basic density is considered the most important physical property of wood, since it is a significant parameter for both geneticists and technologists of wood, because it keeps a relationship between other properties and the use of wood. But Busnardo et al. (1987) affirm to be a feature rather complex, resulting from the combination of anatomical characters, physicists and chemists. Regarding to the variability of specific mass base, one should consider the variations between genders, between species belonging to the same genus as well as between trees. It may be noted that the density of the wood is influenced by many factors and varies significantly depending on the age, origin, place of origin, spacing, depending on the rate of growth, gender and species, and even between trees in the same species (FERREIRA and KAGEYAMA, 1978; TOMAZELLO FILHO,1985; SOUZA et al.,1986).

The relevant literature has shown over decades many studies that show the relationship between the dimensions of fibers, the cell wall thickness, volume of vessels and parenchyma, wood proportion between spring and autumn, and arrangement of the anatomical elements. The density is an important factor in determining the physical and mechanical properties which characterize different woody species, different trees of a given species and even different regions of the same tree, according to its variability (FOELKEL et al., 1971).

According to Klock (2000), the intensive use of wood as raw material for industrial purposes or construction can occur only with the appropriate knowledge of their properties. As a heterogeneous organic element, composed primarily of cellulose, polioses (hemicelluloses), lignin and extractives, wood presents an enormous versatility of uses for a variety of products. The improvement in the employment of new technologies for processing and rational use of wood in the generation of new products requires appropriate knowledge for their characteristics and behavior as a raw material.

The *Cedrela fissilis* Vell. species belongs to Meliaceae family, is a tree-size tree, with broad adaptation throughout Latin America (MATTOS, 1980; PENNINGTON and STYLES, 1981). However, it is a rare species evenly (BAWA and ASHTON, 1991), regarded as alogama (STYLES, 1972; CARVALHO, 1994). According to Lorenzi (1992) *Cedrela fissilis* presents light to moderately heavy wood, soft to cut and remarkably durable in dry, and the sapwood separate from the heart. Its wood with noble characteristics caused an intense and irrational exploitation in the past (PINAZZO, 1992), putting the species under severe genetic erosion due to loss of many populations and individuals (FAO, 1996).

As discussed, it can be noticed the importance of the density of wood to forest-based industry as well as conducting studies with native species, so the present study aims at determining the variation and comparison of the density of the wood core of the core (inner part of), Sapwood (outside) and branches of *Cedrela fissilis* Vell.

Materials and methods

The forest area where the study was conducted is located between the parallels 27 º 08 '34 "and 27 15' 37"south latitude, and between the meridians 49 of 11 '57"and 49 17' 28" west longitude of Greenwhich, in the Municipal Districts of Apiúna and President Nereu Ramos, state of Santa Catarina, composed by the low, middle and upper valley of the Itajaí River and comprising a total area of 3799.2 hectares.

As classification of Brazilian vegetation realized by the IBGE (1992) and Klein (1978), the original vegetation of the Itajaí basin is, for the most part, a dense pluvial tropical forest, called Dense Atlantic Forest (VELLOSO et al., 1990).

Although it is located in subtropical climate zone, this forest shows all the characteristics of a pluvial tropical forest: high species richness, which was found 359 tree and shrub species, belonging to 72 families (SEVEGNANI, 2003).

The samples were selected in the field and three trees were identified at random, then their dendrométricas variables were measured. After this, the trunk was cut to different heights, being withdrawn a slice 0.0%, 10%, 50%, 75% and 95% based on the height of the point of morphological reversal, plus a slice of 1.30 m above the ground (DAP) and a branch, the thickness of the disks were approximately 5 cm.

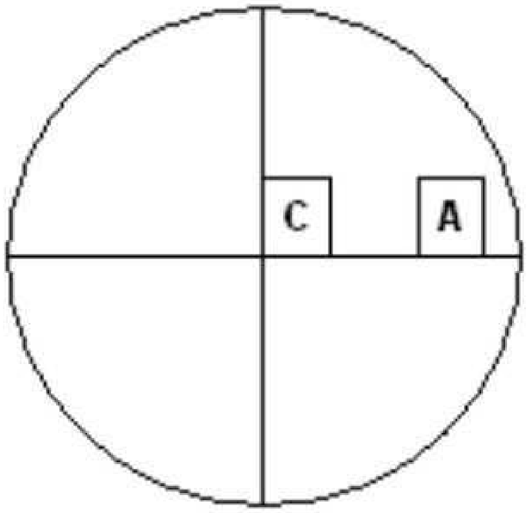
The determination of basic density (relationship between drought mass in greenhouse and the volume in the completely saturated state), was held with bodies of evidence of wood with 1.5 x 1.5 x 5.0 cm, taken in internal and external portions of shelled slices (Figure 1) collected on 6 positions along the stem and 1 of every tree branch.

The samples were first placed in water to saturation, after determining the volume, the evidence bodies were placed in the oven with a temperature of 103 ± 2 ° C for drying until constant weight, to obtain the completely dry weight.

Results and discussions

The average density results obtained of the internal and external part of the tree for different heights are shown in table 1. The basic inside density presented lower density compared to the outside. These results are opposed to the results of several studies commonly found in the literature and described in studies with other forest species by Oliveira and Silva (2003), and Rezende Ferraz (1985) and Tomazello Filho (1987). Despite densities show variations along the position in the tree; they follow a similar trend of increase towards the bottom to the top of the tree, which indicates that when parts are subjected to the process of drying, they will have uniformity in the loss of water, thus reducing significantly the deformation of the material.

Figure 1. System of sampling conducted in discs of *Cedrela fissilis* Vell.



Where: C = Heartwood (the inside)

The Alburno = (outside)

The basic density was calculated using the relationship:

Db = (Ms / Vs) * 100

Where:

Db = basic density (kg m-^{3})

Ms = mass of the body of dry evidence (g)

Vs = volume of the evidence body in a saturated stage (cm^3)

The basic density has increased towards the marrow (the inside) to the cambial region (outside). This growth was also observed by Amaral et al. (1971), with studies in density with *Araucaria angustifolia* (Bert) O. Ktze.

There is a trend of density increasing towards the top to the bottom of the tree both inside and outside of the bole, a common feature in hardwood species, and similar to those seen by Sturion et al. (1987) for various species of Eucalyptus and Scolforo (2004) in *Eremanthus erythropappus* (DC) MacLeish.

The average performance for certain basic density of the wood *Cedrela fissilis* along the trunk of the trees sampled, along with their standard deviations, disregarding the position in bole (internal and external) are presented in table 2.

The trees analyzed had large individual variability of density, which suggests that there are great possibilities for a genetic improvement program aimed at selection of matrices.

The analysis of variance (Table 3) showed difference in density between the inside and outside of the tree and on to the heights studied. It also showed that tree height factors and position of the trunk are not independent.

The figures 2, 3 and 4 illustrate the trends observed for the basic average density, internal and external along the stem.

The greatest value for density was observed at the base of the tree (0%) in the sapwood with 585.63 kg m^{-3} and the lowest at the top (95%) in the heart with 285 kg m^{-3}. The highest average density was observed for the branches, with 509.66 kg m^{-3}, and the density of the bole of 431.06 kg m^{-3}, lower than the values given for the same species by Lorenzi (1992) of 550 kg m^{-3}.

Days and Lahr (2004) in studies involving the apparent density of species *Cedrela odorata* and *Cedrela sp.* found a density of 514 and 512 kg m^{-3}, respectively. These values are close to those observed in this study.

The basic density observed was within the limits recommended for sawn timber to be used in the furniture industry, which also ensures good workability.

Table 1. Average density in kg m^{-3} for different heights tested to the inside and outside of the tree of *Cedrela fissilis* Vell.

Position in tree	Relative height						
	0.00%	**10%**	**DAP**	**50%**	**75%**	**95%**	**G_1/G_2**
Outside (kg m^{-3})	480.59	461.28	433.84	440.41	428.20	412.65	527.78
Inside (kg m^{-3})	481.66	403.65	393.17	372.49	361.45	346.07	491.54

Table 2. Basic density average per position (height) along the trunk of the trees sampled from *Cedrela fissilis* Vell.

Position	Average density (kg m^{-3})	Standard deviation	Nº samples
0% of height	481.12	82.71	6
10% of height	432.47	73.86	6
1.30 m of height	413.50	90.87	6
50% of height	406.45	96.74	6
75% of height	394.82	83.17	6
95% of height	379.36	96.10	6
Branches	509.66	62.36	6

Table 3. Results of the analysis of variance and the test of Bartlett for position and height.

Source of variation	DF	Sum of square	Mean square	Observed F
Block	2	0,0785	0,0392	7,3193*
Treatment	11	0,0521	0,0047	0,8842*
Position1	1	0,0078	0,0078	1,4508*
Height1	5	0,0314	0,0063	1,1701*
Position x heitht1	5	0,0130	0,0026	0,4849*
Experimental Erro	22	0,1180	0,0054	
TOTAL	35	0,2486		

1 = test of Bartlett and homogeneity of variance
** = Significant at 95% probability*

Furthermore, the found density indicates that the species possibly presents a high shrinkage, and it represents stability for products made with this wood.

Comparing the species studied with wood traditionally used by furniture industries in the region, the average density found in this study is near the one used by them. The species Araucaria (*Araucaria angustifolia)* one of the most requested for the production of mobile sets a basic average density of 555 kg m^{-3} (LORENZI, 1992). The species Bracatinga (*Mimosa scabrella* Benth.) and Eucalyptus (*Eucalyptus viminalis*) commonly used for energy purposes shows densities of 521 and 0489 kg m^{-3}, respectively (PEREIRA and LAVORANTI, 1986; STURION et al., 1988) and species Pinus (*Pinus taeda*) used in the furniture industry shows average density between 390 to 430 kg m^{-3} (GONZALEZ et al., 1993; SUIREZS, 2000).

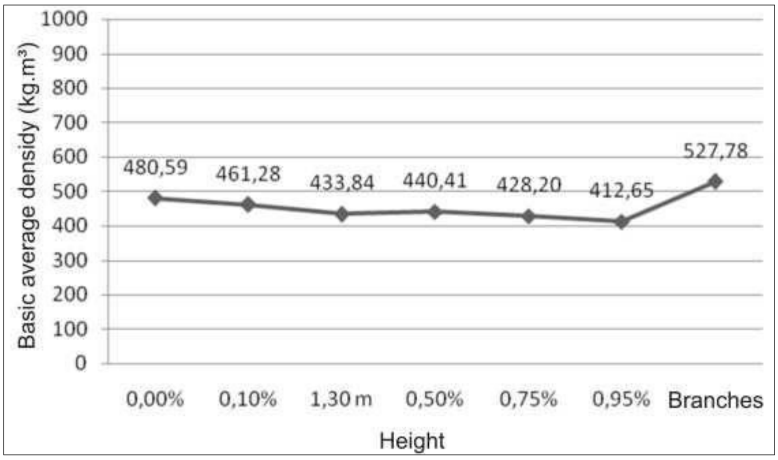
Conclusions

Through analysis of the results we can conclude that the basic average density of the wood of Cedro (*Cedrela fissilis*) is 431.06 kg m^{-3}, along the trunk, showing statistically significant differences between them and regarding the position the internal and external, not showing independence regarding to height.

The basic density found along the stem is a characteristic that gives the species stability and safety for use in structural projects, but it is necessary, further investigation to improve the scientific basis of their physical properties and technology.

The individual variability of the density of trees examined indicates that there are great possibilities for an improvement program aimed at genetic selection of matrices.

Figure 2. Basic density external wood of *Cedrela fissilis* along the trees trunk height.



Y = basic average density X = Height

Figure 3. Basic density inside the wood of *Cedrela fissilis* along the trees trunk height.

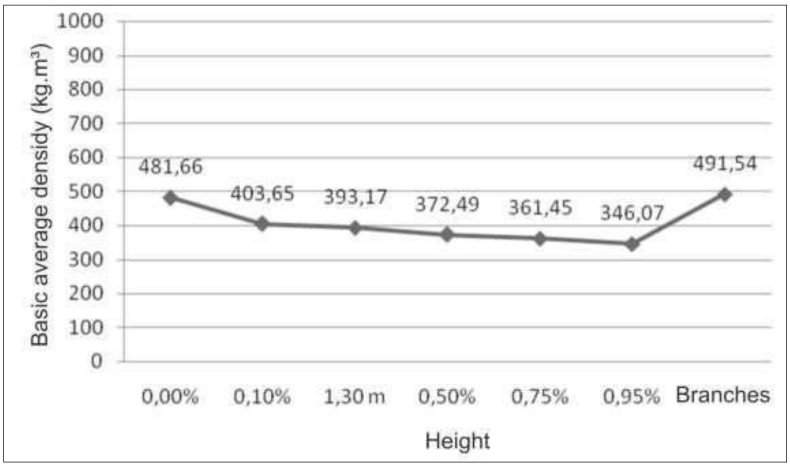
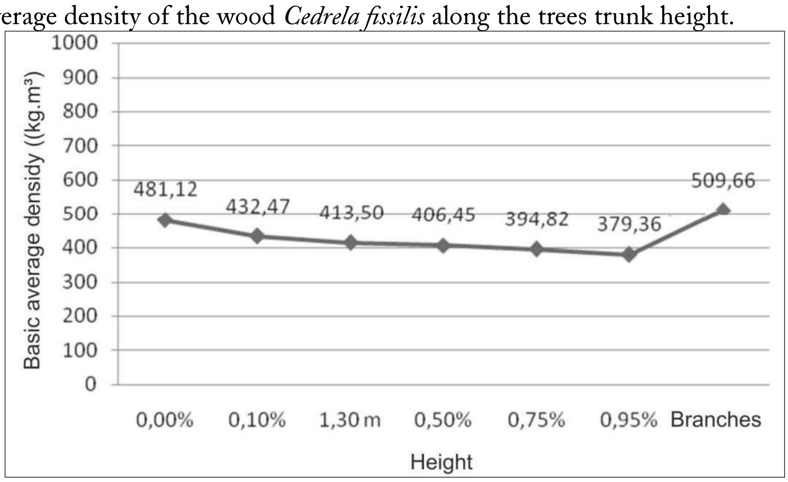


Figure 4. Basic average density of the wood *Cedrela fissilis* along the trees trunk height.



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