

INFLUENCE OF SOME ANATOMICAL FEATURES ON THE DENSITY OF WOOD

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ABSTRACT

The wood of coniferous trees is characterized by simple and orderly structure. Within the annual ring the tracheids are sealed and thickened. The work examines the relationships between anatomical characteristics of wood and its density.

The tracheids have been examined in the wood of the spruce. Traces in the dimensional change in the annual ring have been measured successively from the earliest to the latest. The studied wood is divided into groups with narrow and wide rings. A comparison is made between the values for individual groups to seek relationships between anatomical structure and the density of wood.

Key words: conifers, annual rings, tracheids, spruce

INTRODUCTION

The softwood is characterized by a simple construction. It is constructed mainly of one type of cells called tracheids and usually arranged in regular radial groups. These cells have both conductive and mechanical function in the beginning of the ring (ie early tracheids) they perform mainly conductive and at the end (ie late tracheids) - mostly mechanical. In some species such as white pine and European larch transition between early and late wood is abrupt, while the other is gradual. So is the wood of spruce. The determination of the transition to it, and the size of the zone later became timber after measuring the size of the cells [3].

The density of wood is considered as a complex quality parameter. On the one hand it strongly depends on the anatomical structure, and on the other directly affects almost all physical and mechanical properties. It is known that there is a correlation between the width of the annual rings and wood density. In softwood with the increasing width of the Rings density decreases [6].

Spruce wood in the country is a relatively detailed study. Todorov, M., 1970,

examined in his thesis work climate parameters of the anatomical structures and properties depending on the altitude [6]. Entchev, E., 1976, has examined the structure and properties of spruce wood in the country [4]. Nikolov, S. et al 1989 discussed the structure and properties of wood in various forms of spruce [5]. Blaskova, G., 1989, has explores the characteristics of juvenile wood [1]. Some authors consider the size of cells in the radial and tangential direction together to clarify the differences between early and late wood [7]. The data in the literature, however, as well as the influence of different areas in the annual ring on its density are scarce.

The aim of the work is to seek correlations between the size of anatomical elements of spruce wood and its density.

METHODS AND MATERIALS

It has studied spruce wood from different habitats with different width of annual rings. Test pieces have been prepared to determine the density of the wood according to ISO 3131. From each sample were prepared temporary microscopic preparations of the cross section (Figure 1). Measure-

ments using a light microscope with light passing through a „Laboval“.

For every agent is selected a radial line with healthy and even-cells have been done. Measurements have been performed in the

radial direction between the two limits of the annual rings, and measured consistently as a whole cell after a cell belonging to one radial line.

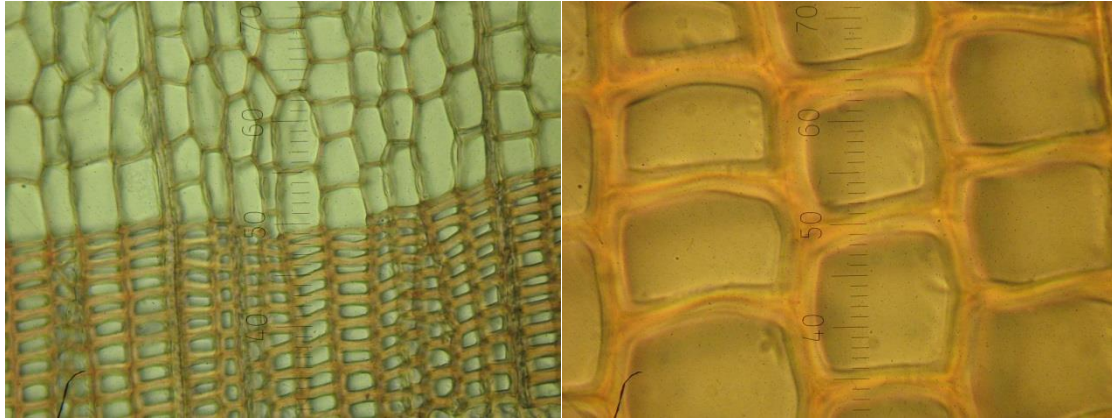


Figure 1: Determination of the area of research and metrics

From anatomy has been measured the width of annual rings, the number of cells that build them, the cell size and cell wall gap in the radial and tangential direction. Since they are calculated stenosity – the area of the cell walls and cell cavities. According to the Mork rule set width of late wood and the transition zone between the early and late wood is taken into consideration.

In analyzing the results, the wood is divided into two groups – with wide and narrow annual rings. Correlations are sought between anatomical structure and density of the wood. The results of a single factor re-

gression analysis and regression equations have been derived showing the influence of anatomical elements on the density of the wood.

RESULTS AND DISCUSSION

The average width of the rings from the first group is about 3,75 mm, while the second – about 1,20 mm (Figure 2). The difference in width is about 3 times while the density of the wood with wide rings is 395 kg.m^{-3} , and wood with narrow rings – 440 kg.m^{-3} .

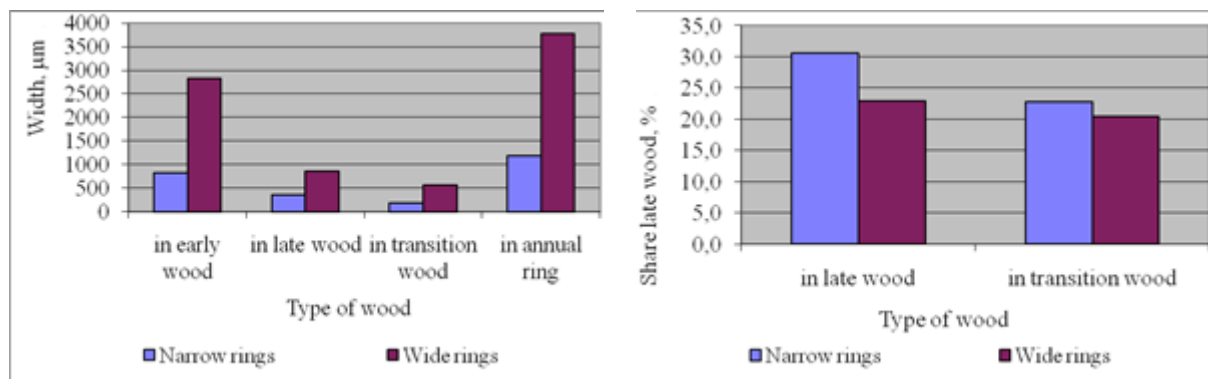


Figure 2: Distribution of the width of the individual zones in absolute (left) and relative values (right).

The analysis of the width of the rings is visible bandwidth with early wood rings is as narrow width of the transition zone of narrow rings. Moreover, the proportion of transitional zones and late wood is also different. The wide and narrow rings in the late wood zone is less than the transition zone, while the narrow gap is greater.

By examining correlations find a negative relationship between the bandwidth of early wood and density ($R = -0,63$) is found, and also between annual ring width and density ($R = -0,61$). Since the proportion of affected areas is only with late wood, the dependence is positive ($R = 0,54$). Dependencies between other zones and density are negligible.

The distribution of the number cells in completely different areas overlap as shown in Figure 2 for the width of the individual zones. Correlations are also shown. There is a negative correlation between the number of tracheids for early wood and wood density ($R = -0,65$). A similar relationship between the number of cells in the annual ring density ($R = -0,55$) is also given.

The distribution of the average width of the cell gap is also similar (Figure 3). It is noteworthy that the size of the cell cavities of the cells from the two groups are similar widths, and the change in the radial direction and the average cell is identical.

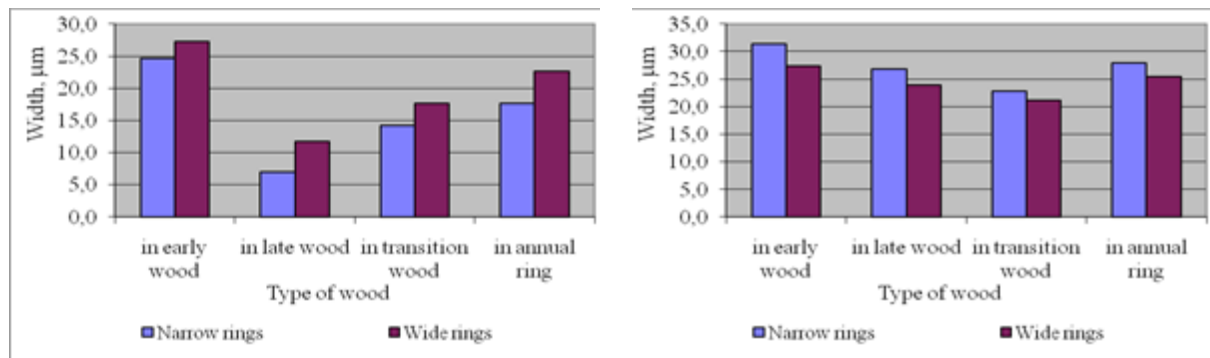


Figure 3: Size of the cell gap in individual zones in the radial direction (left) and secondary (right)

Dimensions obtained are similar to those in the literature values 27,3–29,7 µm for early and 8,5–9,3 µm for later tracheids [1]. An average negative correlation between the size of the cell gap of round tracheids ring density ($R = -0,51$) is found.

A similar statement can be made on the cell walls (Figure 4). In the narrow rings

tracheids cell walls are thicker, the exceptions being only those in the early wood. The resulting dimensions are similar and higher than those of the literature values of 3,9–4,8 µm for early and 8,2–9,7 µm for later tracheidi [6].

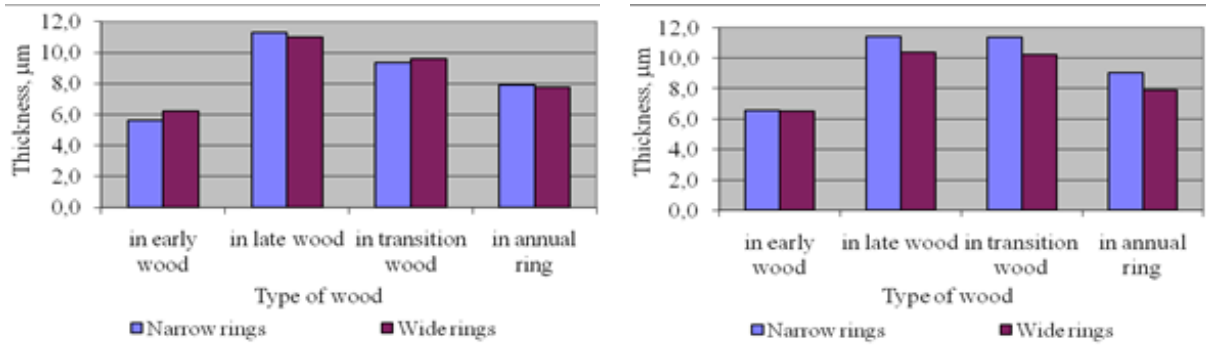


Figure 4: Average size of the cell wall in different zones in the radial direction (left) and secondary (right)

As a consequence the results shown above may indicate that the values obtained for the amount of cells in different areas completely overlaps with wide and narrow rings. There is no established correlation between the amount of cell wall and the density of the wood [2].

While the number of cells is identical, another consequence of differences in the

size of cell walls and cell cavities is stenosity (Figure 5). While early stenosity timber values are close, then with the late, especially in the transition zone traheids of narrow rings are significantly higher. These results are similar to those in the literature and in previous studies [3].

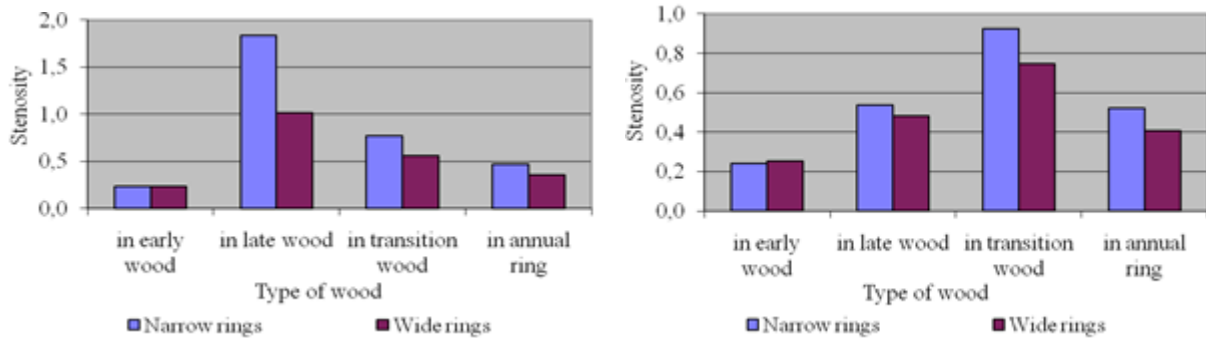


Figure 5: Values of total stenosity in different zones in the radial direction (left) and secondary (right)

A similar pattern is observed in stenosity in the radial direction. The difference in values of late traheids as those in the transition zone can be explained by the fact that conifers traheids greatly reduce the size in the radial direction, while in tangential remains relatively constant. There was a positive correlation between high stenosity in the radial direction and density ($R = 0,74$). A similar, but average is the relationship with the late wood ($R = 0,56$). The relation-

ship between total stenosity and density is positive ($R = 0,54$).

The distribution of values of the area of the cell walls, the cell cavities and cells is similar to the width of the cell gap thickness of the cell walls and the size of the cells (Figure 6). There is only one correlation between the area of cell lumens annual ring general and wood density ($R = -0,45$). Dependencies between other elements and density are negligible.

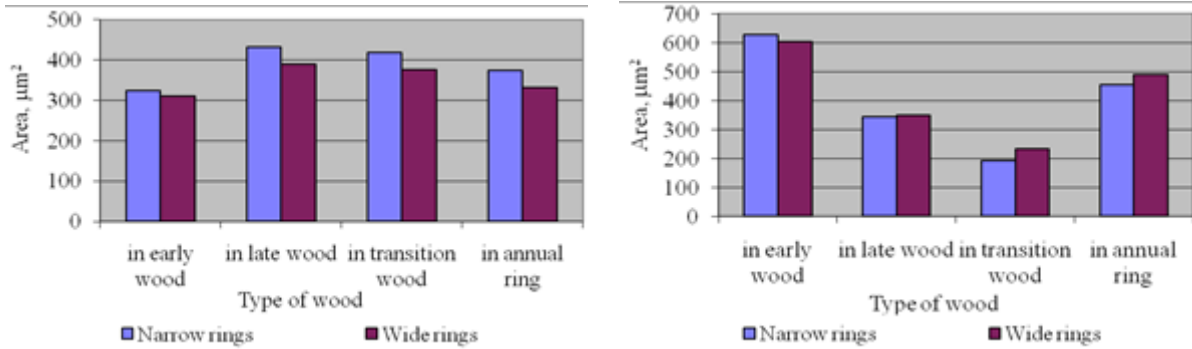


Figure 6: Values of the area of the cell walls (left) and cell lumen (right) in different areas

For each anatomical parameters was derived a regression equation. Closest to the calculated values determined experimentally are obtained in the average size of the cell gap, the area of the cell gap and width of

annual rings. All three regression equations refer to the narrow annual rings. The analysis of regression equations show that with the increasing values of the three parameters density decreases.

Table 1: Constants of some regression equations

Factor	Rings	b	a	R
Number of cells, number	narrow	-1,18	496,4	-0,51
	wide	-0,20	417,3	-0,20
	total	-0,58	465,3	-0,57
Amount of cell gap – average, µm	narrow	-7,50	621,40	-0,66
	wide	-7,40	571,75	-0,40
	total	-10,00	655,19	-0,53
Common stenosity	narrow	35,30	431,67	0,20
	wide	244,11	298,42	0,55
	total	154,43	350,04	0,51
Width of the rings, mm	narrow	-0,05	500,3	-0,71
	wide	-0,01	421,59	-0,23
	total	-0,02	465,81	-0,62
Size of the late wood, %	narrow	0,66	429,4	0,24
	wide	2,22	343,61	0,57
	total	2,13	363,93	0,54

CONCLUSIONS

After analyzing the change of the size of traheids within the annual ring and dependencies between anatomical structure and density of wood, the following important conclusions can be made:

- Confirmed are dependencies between the bandwidth of early wood and wood density between annual

ring width and density between the proportion of late wood density and increase in the size of the cell gap of round traheids ring reduces the density.

- There is no established correlation between the amount of cell wall and the density of the wood.

- The increased stenosity as in the radial direction and the overall stenosity leads to increased density.
- The increase of the size of the cell gap of the annual ring reduces the density of the wood.
- More can be adequately described depending of the narrow annual rings.

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