Wood and charcoal anatomy in species of the Brazilian cerrado: effect of carbonization on wood structure

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Summary: *Anthracology is a science already quite well established in Brazil, but there is little information about anatomical modifications due to carbonization in tropical species. In this paper, fresh and charred wood samples from ten Brazilian species were analyzed. Anatomical characters were described and measurements of the main anatomical features of wood and charcoal were statistically compared. The charcoal anatomical structure is closely related to wood anatomy, although some modifications were observed, according to the anisotropic behaviour of wood elements. Reduction of the vessels' tangential diameter was the most evident change. Shrinkage in ray width occurred only in some individuals. The present work supports the identification of charred wood species, contributing to palaeoenvironmental and archaeobotanical studies, as well as to control of charcoal production.*

Key words: *wood anatomy, charcoal, anthracology, cerrado, Brazil.*

INTRODUCTION

Previous works analyzed the structural changes in charcoal prepared at different temperatures, either focusing on mass loss and volumetric shrinkage (e.g. McGinnes *et al*., 1971; Beall *et al*., 1974; Slocum *et al*., 1978), or regarding more detailed anatomical analysis (Prior and Alvin, 1983, 1986; Prior and Gasson, 1993; Kim and Hanna, 2006; Kwon *et al*., 2009; Dias Leme *et al*., 2010). In spite of that, modifications in wood anatomy after charring are still poorly known, especially considering the rich Brazilian tropical flora.

The present study aims to contribute to the comprehension of the anatomical changes in charcoals produced at 400ºC, by the analysis before and after carbonization, as well as to the understanding of the behaviour of different wood types regarding the carbonization process. We also aim to provide information on the wood anatomy of Brazilian native species.

MATERIALS AND METHODS

Three different individuals for each of ten species representative of the cerrado environment were analyzed: *Copaifera langsdorffii* (Leg. Caes.); *Dalbergia violacea* (Leg.Fab.); *Dimorphandra mollis* (Leg. Mim.); *Stryphnodendron polyphyllum* (Leg. Mim.); *Caryocar brasiliense* (Caryocaraceae); *Couepia grandiflora* (Chrysobalanaceae); *Tapirira guianensis* (Anacardiaceae); *Qualea grandiflora* (Vochysiaceae); *Vochysia tucanorum* (Vochysiaceae); *Pouteria torta* (Sapotaceae). The species selection comprises a diversity of wood anatomical types that might be differently affected by the carbonization process.

Samples were collected from an 180ha private reserve of *cerrado* in São Paulo state, Brazil (23º02'55.5" S, 48º31'26.1" W). Three cm-thick discs were obtained from the basal portion of the most developed branches. From these discs, 15-20 µm fresh wood sections were mounted on slides double-stained with safranin and astra blue, and charcoal samples were produced in a muffle furnace at 400 ºC during 40 minutes.

Descriptions and measurements of wood and charcoal anatomy followed the IAWA Committee (1989) recommendations.

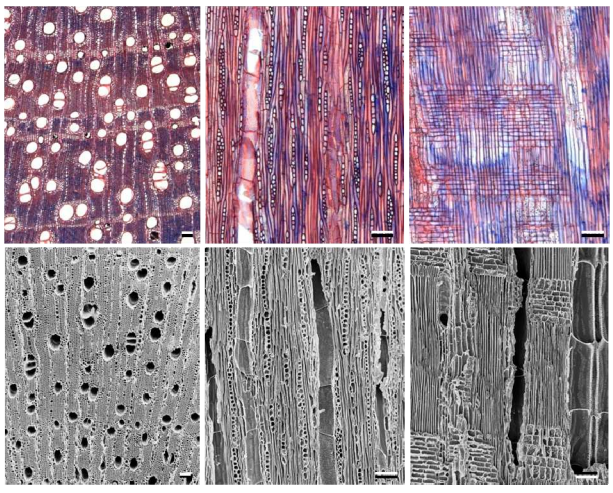

FIGURE 1: Copaifera langsdorffii. *Wood (above) and charcoal (below) micrographs. Bars: 100 µm.*

RESULTS

Detailed anatomical descriptions were elaborated for each one of the studied species. Either in wood or in charcoal samples, the following measurements were

taken: tangential diameter of vessels (μm); frequency of vessels (vessels/mm²), tangential diameter of intervessel pit apertures (μm), ray frequency (rays/mm), ray width (μm), and ray height (μm). Statistical tests were applied to wood and charcoal quantitative features aiming to identify possible significant changes due to charring.

DISCUSSION

Vessels were the wood features most affected by charring. A significant reduction in the tangential diameter of vessels was verified in eight out of ten of the analyzed species. The average reduction was of 17%, varying from 2% in *T. guianensis* to 32% in *V. tucanorum*. These results were related to the anisotropic behavior of wood on drying and its conversion into charcoal, with larger contraction in the tangential direction (e.g. McGinnes *et al*., 1971; Prior and Gasson, 1993; Kwon *et al*., 2009).

Some individuals of *D. mollis*, *S. polyphyllum*, *V. tucanorum* and *P. torta* presented a change in vessels' outline from circular to angular after carbonization.

In spite of the significant reduction in the tangential diameter of vessels, there was no significant change in the frequency of vessels. Similarly, no significant difference in the tangential diameter of intervessel pit apertures between wood and charcoal was verified. Ray frequency increased in most of the individuals analyzed, but did not present significant statistical variation.

Significant changes in ray width occurred only in some individuals of *S. polyphyllum, C. grandiflora,* and *V. tucanorum* (narrower rays in charcoal than in wood). In *V. tucanorum* this shrinkage was greater in larger rays, but more studies are still necessary to verify if there is a tendency of greater shrinkage in larger rays.

Ray height did not present significant changes between wood and charcoal either. Our results suggest ray height is a parameter with low significance to evaluate anatomical changes in charcoal, especially because of the great inter- and intraspecific variability of this feature.

Gelatinous fibers were found in 80% of the material. Their analysis did not evidence any considerable change.

CONCLUSIONS

The results here presented confirm that charcoal anatomical structure is closely related to wood anatomy. Wood and charcoal anatomy analyses attest the preservation of qualitative structural features after carbonization at 400 ºC, in spite of the occurence of anisotropic contraction and of small morphometric variations, especially concerning the tangential diameter of vessels. These modifications did not affect charcoal quality, nor do they prevent the correct identification of charcoal taxa.

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