

Anatomical features and its radial variations among different *Catalpa bungei* clones

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I Introduction

Catalpa bungei is a woody plant belonging to the genus *Catalpa*, family Bignoniaceae, it is common processed into furniture, coffins, musical instruments, and boats because it has good dimensional stability, resistance to deterioration, and mechanical performances in ancient China. Since the resource of nature planation of *C. bungei* was diminishing sharply, lots of breeding works have done for selecting genotype materials. However, the variation of wood anatomical properties caused by genetic origin and cambial age in *C. bungei* is limited reported.

In the present paper, microfibrillar angle, dimensions of fibers and vessels, and tissue proportions were examined in detail. Furthermore, the radial variation patterns of those parameters were induced and the differences of those parameters among clones were summarized. It is the objective of the present study to deliver specific information for screening more suitable genotype of *C. bungei* when the quality of wood is highly ranked in breeding programs.

II Materials and methods

a Study Site and Sample Preparation

C. bungei trees with about 13 years of age were felled randomly selected from plantation in Maiji area, Tianshui City, Gansu province, China (105°25'~106°43' E, 34°06'~34°48' N).

In this work, we used six *C. bungei* clones: 1-1(N=3 trees), 1-3 (N=3 trees), 2-7(N=3 trees), 2-8(N=3 trees), 8-1(N=4 trees), 9-1 (N=3 trees). At the time of harvesting, their height and stem diameters were measured, the directions of north were also marked. A 3-cm-thick cross-sectional disc from each tree was sampled at breast height for further analyses of growth traits and wood anatomy.

b Microscopic Images and Morphology Measurements

For anatomical characterization, wood macerations were carried out using glacial acetic acid and 30% hydrogen peroxide. Wood cubes (2×2×2 cm³) were prepared along radial positions from the pith to the bark and the wood blocks were softened by boiling in water with microwave. The fiber and vessel dimensions were observed using a light microscope (Nikon ECLIPSE Ni, Nikon Corporation, Tokyo, Japan) with a DS-Ri2 camera and Image NIS 5.10 software, and images were taken at 2× and 4×magnifications for analysis. Also the ultra features were observed under an SEM (TESCAN VEGA 3 SBH, TESCAN, Ltd., Kohoutovice, Czech Republic). Descriptive anatomical terminology followed the IAWA List of Microscopic Features for Hardwood Identification (IAWA Committee 1989).

III Results

a Xylem anatomical features

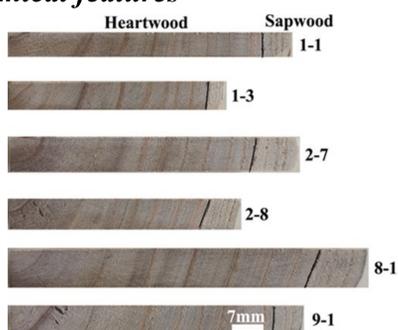


Figure 1. Xylem observations of six *C. bungei* clones, Cross-sectional surface was photographed at air-dried condition.

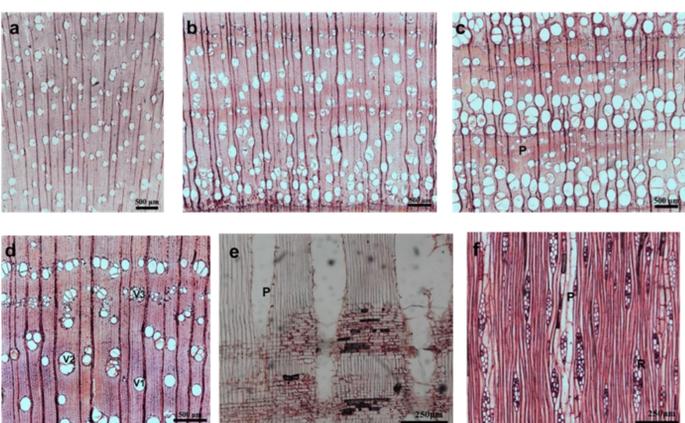


Figure 2. Sections of xylem in *C. bungei* in 1-1: (a) between the age of 1 and 2 years, wood was diffuse porous; (b) between the age of 3 and 9 years, wood was semi-ring-porous, ring width was about 5 mm, the latewood percentage was 80%; (c) between the age of 10 and 13 years, wood was ring-porous, ring width was about 2 mm, the latewood percentage was 30%; axial parenchyma (P) with 5–15 cells per parenchyma strand; (d) vessels solitary (V1), radial multiples of 2–3 cells (V2) and clusters common (V3) of wood diffuse porous; (e) radial section of the second year, vasicentric axial parenchyma (P); (f) tangential section of latewood areas from the eighth year, fusiform ray (R) width was 2-3 cells, axial parenchyma (P) in paratracheal-zonate.

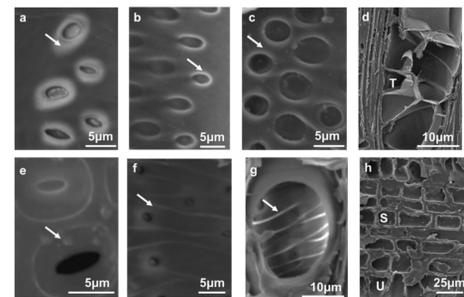


Figure 3. SEM photos of the radial and tangential sections of *C. bungei* in 1-1. (a) intervessel pits with numerous deposition (arrow) in EW of the second year; (b) intervessel pits with lesser deposition (arrow) in EW of the seventh year; (c) intervessel pits with rare deposition (arrow) in EW of the twelfth year; (d) thin-walled tyloses in vessel elements; (e) warty layers in the pits (arrow) in EW of the ninth year; (f) the small pits in LW of the ninth year (arrow); (g) simple perforation plates and helical thickenings (arrow) in vessel elements; (h) ray cells heterocellular with one row of upright (U) and square marginal (S) cells.

b Radial variation of anatomical characteristics

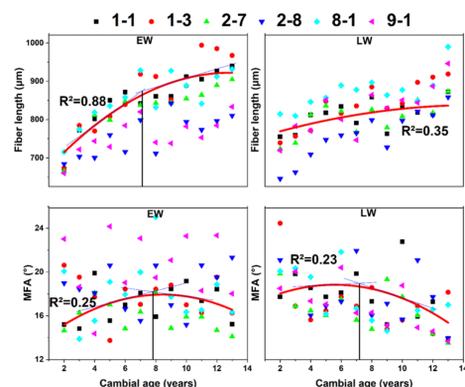


Figure 4. Variation in both earlywood (EW) and latewood (LW) of fiber length and MFA, also demarcation of juvenile and mature wood zones from six *C. bungei* clones. The demarcation was calculated through tangent intersection according to the multiple linear regression curves.

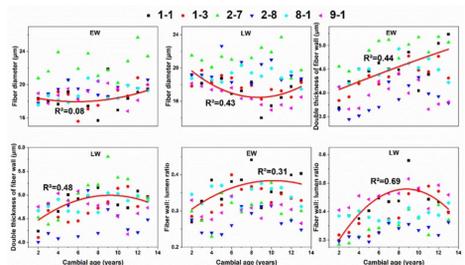


Figure 5. The fiber characters in both earlywood (EW) and latewood (LW): (a) Fiber diameter, (b) Double thickness of fiber wall, (c) Fiber wall: lumen ratio for the six *C. bungei* clones by cambial age.

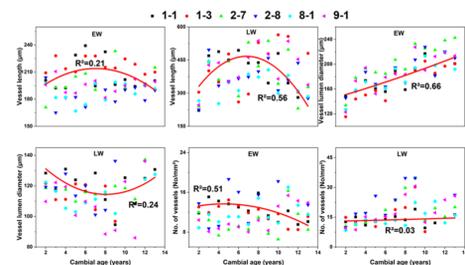


Figure 6. The vessels characters of both earlywood (EW) and latewood (LW): (a) Vessel length, (b) Vessel diameter, (c) No. of vessels for the six *C. bungei* clones by cambial age.

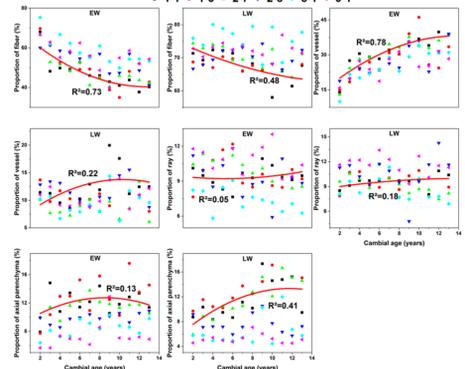


Figure 7. The tissue proportion in both earlywood (EW) and latewood (LW): (a) Proportion of fiber, (b) Proportion of vessel, (c) Proportion of ray, (d) Proportion of axial parenchyma for the six *C. bungei* clones by cambial age.

IV Conclusion

Between the age of 1 and 2 years, wood was diffuse-porous; between the age of 3 and 9 years, wood was semi-ring-porous; between the age of 10 and 13 years, wood was ring-porous. The amount of deposits increased from sapwood to heartwood. The demarcation between juvenile and mature wood was between the age of 7 and 8 years based on the radial variation pattern of fiber length (earlywood) and microfibrillar angle. The effect of clones on anatomical characteristics were significant except for microfibrillar angle in latewood, some clones showed the best performance when compared with others. From pith to bark, fiber length, double wall thickness, fiber wall: lumen ratio, vessel diameter in earlywood, proportion of vessel in earlywood and axial parenchyma in latewood increased significantly, whereas No. of vessels in earlywood and proportion of fiber decreased significantly. In addition, other features such as vessel length, microfibrillar angle and proportion of ray did not differ significantly from pith to bark.