



A Guide to Determining Wood Properties of *Acacia koa*

Nicklos S. Dudley and Jodi Yamasaki

Summary

The primary attribute of *Acacia koa* is the quality of its wood as determined by color, figure, density, strength, shrinkage, durability, and workability. This report summarizes the wood properties of koa and presents a sampling strategy for collecting wood samples in populations of koa. Based on whole tree sampling state-wide, there was a wide range of variability in wood color and figure. Branch sampling, a less destructive technique, can also be employed as a determinant of wood quality. Formation of heartwood was found to occur in koa at Keauhou between 10-15 years. This suggests that commercial thinning regimes may begin after age 15 and pre-commercial thinning may begin before age 10 depending on seed source, site conditions, and management objectives. Selecting outstanding trees within a population for color and figure in addition to form and growth performance has the potential to significantly add value to stands of koa.

Introduction

Acacia koa is Hawaii's most important tree species from an economic, ecological, and cultural standpoint. However, the properties of koa wood have not been well-documented (Table 1). Koa is highly valued as a furniture, cabinet wood, and craft wood, owing to its highly variable color and figure, nearly equal radial and tangential shrinkage in drying, and ability to take a high polish. The weight or density of koa is quite variable, ranging from 30 to 80 pounds per cubic foot (Holmes, 1981). The Hawaiian koa classification system is based on color and density (Table 1).

Development of Sampling Strategies for Determining Koa Wood Properties

To develop appropriate sampling strategies, the relevant wood properties need to be identified. These properties were described in Table 1 and provide a basis for sampling. Among the range

of wood properties previously discussed, the two most important are the color of the wood and the figure of the grain, which are thought to be under genetic control (Sorensson 1997, Zobel 1984). Our objective is to test sampling methods that predict wood properties in koa populations. A summary of sampling methods for wood quality is provided (Table 2).

The goals of this study follow: a. Develop a database of koa wood samples from state-wide populations to better understand geographic variation of koa wood properties. (Figure 1.) b. Determine the relationship between color and figure in branchwood and stemwood of the same tree. (Figure 2.) c. Evaluate color and figure in dominate, co-dominant, and suppressed trees from the same population. (Figure 3.) d. Determine the age, color and figure expressed in wood of sampled trees. e. Compare the wood quality of open grown koa to that of koa grown in a closed forest. (Figure 4.)

Table 1. Properties of Koa Wood (Skolmen 1968, Harrar 1942, Holmes 1981)

Properties	Assessment
Color:	Varies in color from blonde to dark chocolate, with reddish brown being the most common color.
Figure:	The most common grain figures in koa are straight-grained wood, (grain pattern elements are aligned parallel to the long axis of the log) and wavy or curly grain pattern (the result of undulations in grain pattern).
Density:	30-40 pounds per cubic foot (low density) e.g., koa la'aumai'a (banana-colored koa)
	40-60 pounds per cubic foot (medium density) e.g., koa 'awapuhi (ginger koa)
	60-80 pounds per cubic foot (heavy) e.g., koa 'i'o 'ohia (hard ohia-like grain)
Strength:	Koa compares closely to black walnut in all its mechanical properties
Shrinkage: (Green to Oven Dry)	Tangential: 6.2% Radial: 5.5%
Durability:	Both heartwood and sapwood are highly susceptible to attack by both the Formosan subterranean and dry wood termite. The wood is not as resistant to decay.
Workability:	Koa will finish to a high polish. It is considered easy to work and carve. However, highly figured wood is very difficult to machine due to varying orientation of the grain.

Summary of Wood Sampling from 1999 Collections

Work continued on building a koa wood sample database. Twenty koa trees were sampled and collected from Kauai and Hawaii. On Kauai, wood samples were collected concurrently with seed collection during 1999. The focus of this sampling was to match wood quality from populations producing the most promising trees at both the Hamakua and Maunawili provenance test sites (Fig. 5). In addition, a destructive time series harvest was conducted at Kamehameha School's reforestation project at Keauhou Ranch on Hawaii where koa trees of known ages were sampled. Finally, several koa samples were submitted for evaluation by wood workers and other forestry professionals.

Sample trees were selected from Puu Ka Pele Forest Reserve located on northwestern Kauai, and from Kamehameha School's reforestation project at Keauhou Ranch, near Volcano on Hawaii. Trees selected for destructive sampling were either mechanically damaged by

road clearing equipment, suffered incidental blow-down from a wind storm, or were from over-stocked locations and requiring thinning.

Two methods of selecting sample trees were employed. In the Puu Ka Pele Forest on Kauai, trees were randomly selected in areas where seed had been collected from outstanding individual trees. The samples trees were located between 2,500 ft and 3,500 ft. At Keauhou on Hawaii, sample trees were selected from three canopy classes per age class. The age classes were 10, 15, and 20 years. The canopy classes were as follows: dominant tree (largest tree within a sampling area with canopy fully exposed to sun), co-dominant trees (the largest trees in sampling area with canopies co-



Figure 1. A. Blonde, curly (Oahu) B. Red (Hawaii) C. Light brown (Oahu) D. Brown (Maui) E. Brown, banded (Oahu) F. Brown, curly (Oahu)

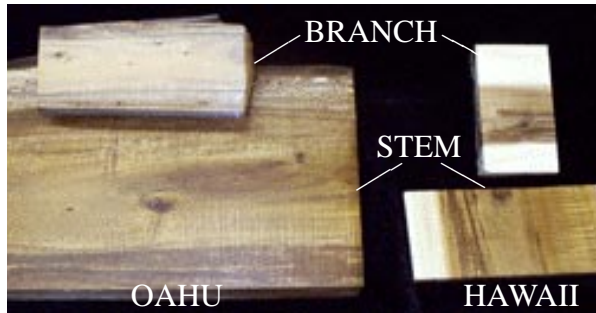


Figure 2. Stem and branch samples both exhibiting matching color and figure from two different locations.

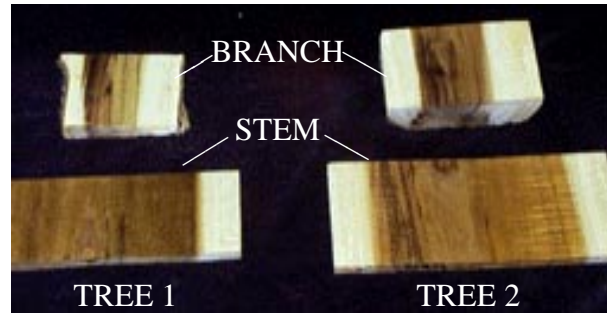


Figure 3. Matching stem and branch samples from two trees at Keauhou Ranch.

mingled), suppressed trees (the smallest trees in sampling area with canopies shaded by larger trees in sample area). The elevation of the trees sampled at Keauhou were between 4,500 ft and 5,500 ft.

For each sample tree, diameter at DBH and stem height to first live branch was recorded. The tree was felled and a radial wood disc was taken from both stem and branch. In addition, a second flat sawn sample was taken to compare heartwood, color and figure of both stem and branch of sample tree.

Heartwood was found in 15 of 20 trees sampled, 11 trees from the Puu Ka Pele forest on Kauai and 4 trees from Keauhou on Hawaii (Table 3). In each of the trees containing heartwood, the color and figure of wood in the stem matched that of the branch. (Fig. 2,3) This indicates that if heartwood is present, the branch

sample will accurately predict the color and figure of wood in the stem. The development of heartwood was not observed in 10-yr old trees or suppressed trees.

It has been suggested that timber characteristics of plantation-grown koa will be significantly inferior to that produced in the natural forest. A comparison of two wood samples from Kauai indicate these differences may not be that significant. Samples from old growth koa grown in natural forest (Fig. 4, tree 1) and a wood sample from 17-yr old tree (Fig. 4, tree 2) regenerated from scarification following road clearing after Hurricane Iwa (Kyono Pers. Comm.). This may be explained by the fact that koa is a ring diffuse hardwood with uniform vessel size throughout the ring. However, significant site and climate effects on timber characteristics have been noted. The wood of the

Table 2. Sampling Methods (Downes et al. 1997)

Sampling Methods	Assessment
Non-Destructive:	Visual assessment of a sample population for grain pattern is fast and suitable for a large number of trees. However, it requires experience and skill to determine grain pattern with this method. This method does not allow for determination of wood color.
Micro:	Incremental cores allow for sampling of color at several sampling points within the tree. It is relatively fast when compared to other destructive sampling methods. However, over compression of inner rings can make determination of grain pattern (figure) difficult.
Destructive:	Whole tree sampling is the most reliable method for determination of color and figure. It is expensive and time consuming, but may be justified if sampling potential parent trees in an improvement program or attempting to determine wood characteristics of a large population from a small number of individuals. This method can be utilized in conjunction with a harvesting operation or after incidental blow-downs.



Figure 4. Tree 1 is from a closed canopy forest and Tree 2 is from open road side area both in Kokee, Kauai.

open-grown short stem trees has better color and usually is more highly figured (Rock 1913).

Summary and Management Implications

In 1999, koa wood samples were collected from Hawaii, Kauai, Maui and Oahu. This sampling procedure demonstrates the range of variability in wood color and figure in koa and will aid in development of a wood sample database that makes connections between variations in wood color and figure with a geographic location.

Whole tree sampling is an effective method to determine color and figure in a sample tree or population of trees. However, color and figure of wood in branch sample matched stemwood of sample trees with heartwood. Branch sampling alone can be employed as less invasive and accurate method to determine color and figure of koa wood.

At Keauhou, heartwood begins to form in koa between 10 and 15 years. However, it is likely heartwood formation in koa will vary by genotype, environmental conditions, and management regimes.

In several sample trees, figured wood was found both in branch and stem of tree. This indicates that color and figure are under genetic control; however, more extensive sampling and

testing are needed to fully support this finding.

Thinning of koa stands up to 15 years will result in low value wood only. Commercial thinning of wood with color and figure may occur after 15 years. However, as silvicultural systems are developed for koa, it is likely that pre-commercial thinning will occur before age 10 and commercial thinning after age 15 depending on seed source, site conditions, and management objectives.

Selecting outstanding trees within a population for color and figure in addition to form and growth performance has the potential to significantly add value to Hawaiian forests and products.



Figure 5. Selected five year old koa tree from Maunawili, Oahu.

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Personal Communications

Kyono, Alvin M. Forestry Manager, Kauai. State of Hawaii. DLNR, DOFAW

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Table 3. Heartwood formation in *Acacia koa* from different ages and canopy classes at Keauhou, Hawaii.

Canopy class	10-yr old	15-yr old	20-yr old
Dominant	None	Present	Present
Co-dominant	None	Present	Present
Suppressed	None	None	None

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