Differentiation of the Sapwood and Heartwood of treated Apitong (*Dipterocarpus SSP.*) by Color Indicators

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There is no marked difference in the natural durability of the sapwood regardless of the species. In less-durable species there is very little difference, if any, between the natural durability of the sapwood and heartwood. The heartwood of a durable species is resistant to the attack of wood-destroying organisms due to the presence of toxic extractives.

The advancement in technology has made possible the use of sapwood, even in modern construction where durability is of prime importance. Sapwood that is adequately treated with the proper preservative for the particular end-use requirement will last as long as the untreated heartwood of the same species and cross-sectional area.

The treatability of different species is not the same. A uniform penetration and retention of the preservative is not usually obtained in the material treated in one charge, or even in the same piece, due to the heterogeneous nature of wood. In general, sapwood treats easier than heartwood, although in some species the sapwood is nearly as difficult to treat as the heartwood.

It is often necessary to distinguish the sapwood from the heartwood of both treated and untreated material. This is done to exclude untreated sapwood in construction work. The sapwood of some species is clearly delineated by its color from the heartwood. Where the difference is not very distinct, color indicators are often used.

In treated material, it is necessary to differentiate between the sapwood and heartwood in order to determine if the sapwood has been penetrated to the minimum depth of penetration as specified for a particular end-use requirement. Sample borings are taken and tested. Penetration is determined by measurement, if the color of the preservative is distinguishable from the color of the wood. For preservatives which impart no discernible color to the wood, differentiation is accomplished by color indicators.

Different species react differently to various indicators, but a particular reagent may give the same color reaction to the sapwood and the heartwood of a particular species. Because of this, no one particular reagent can be used to distinguish the sapwood from the heartwood of all species.

Studies have been made to determine the particular indicator that would distinguish the sapwood from the heartwood of treated and untreated wood. Results of these studies on local and foreign species are shown in Table 1.

Studies on the differentiation of sapwood and heartwood made on Philippine species have been limited to untreated wood. This study was conducted to determined the chemical indicator that could be used to differentiate the sapwood from the heartwood of untreated and Wolman salts treated apitong.

TABLE 1. RESULTS OF STUDIES ON THE DIFFERENTIATION OF SAPWOOD AND HEARTWOOD OF TREATED AND UNTREATED WOOD OF VARIOUS SPECIES

Reagent	Concentration or Composition	Species	Color Reaction	
			Sapwood	Heartwood
Ammonium bichromate	5 percent	Balobo (4)*	Reddish-yellow 8/4**	Yellow-red-yellow 6/4
Benedict's solution	See Appendix A	Binuang (4)	Yellow-red-yellow 5/8	Greenish-yellow 8/10
Benzidine-sodium nitrite solution	See Appendix A	Pines (1, 2, 3)***	Yellow	Dark red
Benzo-yellow pH sol.	— — — — — — — —	Oakes (1)	Yellow	Red
Fehling's solution	See Appendix A	Balobo (4)	Reddish-yellow 7/6)	Yellow-red-yellow 5/6
		Banai-banai (3)	Yellow-green yellow 5/6	Reddish-yellow-red 5/3
		Binuang (3)	Greenish-yellow	Yellow-red
Ferric chloride	10 percent	Balobo (4)	Yellow-green-yellow 6/2	Yellow 5/2
		Malapapaya (3)	Greenish-yellow 3/2	Yellow-red 5/10
Iodine	2 percent	Balobo (4)	Yellow 8/6	Yellowish-yellow-red 6/6
Methyl orange	1 percent	Balobo (4)	Yellowish-yellow-red 6/6	Yellow-red-yellow 7/10
Phenol-hydrochloric acid-ethanol sol.	See Appendix A	Douglas-fir (12)***	Light green	— — — — — — — — — —
Potassium iodide in iodine	2 percent KI added to 2 percent I	Kupang (4)	Yellow 6/10	Yellow-red-yellow 7/10
		Balobo (4)	Reddish-yellow 8/4	Yellowish-red-yellow 5/6
		Malapapaya (3)	Yellow-red 2/2	Red 7/10
Potassium permanganate solution	1 percent	Balobo (4)	Yellowish-yellow-red 7/6	Reddish-yellow-red 3/6
Sodium alizarin sulfate	0.75 percent	Douglas-fir (1)	Pink	Yellow

* Numbers inside the parentheses refer to the literatures cited.
** Fractions refer to the Munsel's Color Chart number denoting chroma and value of color.
*** The wood tested with the indicator was treated with a preservative, or that the indicator works equally well on woods treated with water-borne preservatives.

MATERIALS AND METHODS

Wood Specimens:

Ten 5 x 4 x 1/4-inch specimens were cut from the center of a 5 foot piece of airdried apitong. Five of the ten specimens were used in the color differentiation of the untreated sapwood and heartwood, while the other five were used for treated specimens. The five specimens alloted for treatment were ovendried before soaking for 42 hours in a 5 percent solution of Wolman salts (Tanalith U).

Each of the ten specimens were ripped into 10 strips of 1/2-inch, making a total of 100 strips.

Reagents:

The reagents and concentrations used in this study of treated and untreated apitong were those which have been tried on untreated Philippine species (3, 4) except Benedict's solution which was not available; and those which have also been tried on untreated and treated foreign species (1, 2, 3) except phenolhydrochloric acid-ethanol solution and benzo-yellow pH color which were also not available.

TABLE 2. REAGENTS AND CONCENTRATION USED IN THE DIFFERENTIATION OF SAPWOOD AND HEARTWOOD OF UNTREATED AND WOLMAN SALTS TREATED APITONG.

REAGENTS	CONCENTRATION AND COMPOSITION (Solutions in water)
Iodine	2-1/2 percent
Potassium iodide in iodine	2 percent potassium iodide added to 2 percent iodine
Methyl orange	1 percent
Ammonium bichromate	5 percent
Sodium alizarin sulfate	0.75 percent
Ferric chloride	10 percent
Potassium permanganate	
Fehling's solution	(See Appendix A)
Benzidine-sodium nitrite solution	(See Appendix A)

Application:

Ten strips of wood, five of which were treated and five untreated, were alloted to one indicator. Except for the benzidine-sodium nitrite solution, the rest of the reagents were applied to the cross-section and radial section of the strips with the aid of a medicine dropper. Care was taken not to use a dropper without washing it with water to avoid contamination of one reagent by another. The benzidine-sodium nitrite solution was placed in a 70 ml. test tube and the strips were immersed in the benzidine-sodium nitrite solution and ovendried for about 10 minutes at 100° plus or minus 3° Centigrade. This was done to induce reaction between the stain and the wood since reaction was not instantaneous.

DISCUSSION OF RESULTS

Untreated specimens:

Potassium iodide in iodine and benzidine-sodium nitrite solutions showed positive results on the untreated apitong specimens. The other reagents either did not react with the

wood or produced an indistinguishable color between the sapwood and the heartwood.

Potassium iodide in iodine produced a yellowish-brown color in the sapwood. Dark-blue spots were observed in the radial section, but were absent on the cross-section. A dark-brown color was observed in the heartwood. The benzidine-sodium nitrite solution turned the sapwood to a yellowish-brown and the heartwood to a reddish-brown.

Potassium iodide in iodine reacted on the cross-sectional surface in about 5 minutes while reaction was instantaneous on the radial section. Benzidine-sodium nitrite solution took about 20 minutes to react. The colors remained distinct indefinitely.

Specimens treated with Wolman salts (Tanalith U):

In all cases, the yellowish color that the Wolman salts imparted to the wood disappeared upon application of the different reagents. For benzidine-sodium nitrite solution, the wood turned to a uniform reddish-brown color before the color difference in the heartwood and sapwood appeared. For the other reagents, color reaction followed immediately.

Potassium iodide in iodine and benzidine-sodium nitrite solutions gave distinct color differences between the heartwood and the sapwood, while methyl orange, ammonium bichromate, and sodium alizarin sulfate gave color differences which were not very distinct. The other reagents either did not react or gave indistinct color reactions.

The sapwood turned to a bluish-black color as soon as the yellow color of the Tanalith U was removed when potassium iodide in iodine was applied. The heartwood gave no color reaction. Bluish spots were observed in both the sapwood and heartwood when methyl orange was applied but the spots in the sapwood were larger and less scattered. Ammonium bichromate and sodium alizarin sulfate gave bands of dark-brown to chocolate brown along the radial direction. Wider bands were observed in the sapwood while narrower and fewer bands were seen on the heartwood.

Benzidine-sodium nitrite solution turned the sapwood to a yellowish-brown color and the heartwood a reddish-brown. The color difference showed in about 20 minutes for those that were not ovendried after immersion in the stain. A deeper yellow was observed in the sapwood of the strips that were ovendried than those that were left to dry in the atmosphere.

CONCLUSIONS

1. Potassium iodide in iodine turned the untreated sapwood of apitong to a yellowish-brown with bluish spots on the radial section which were absent in the heartwood. The heartwood turned dark-brown.

The sapwood of the specimens treated with Wolman salts turned to a bluish-black color upon the application of potassium iodide in iodine. No color change was observed in the heartwood.

2. Benzidine-sodium nitrite solution produced in both the untreated and treated apitong sapwood a yellowish-brown color, and in the heartwood a reddish-brown color.

3. Most of the indicators used did not react with the treated and untreated wood. Those that did react gave indistinguishable or slightly distinguishable color. Less scattered and larger bluish spots were observed in the sapwood of treated specimens when methyl orange was applied, while dark-brown bands along the radial direction wider than those observed in the heartwood of treated specimens were seen in the sapwood when ammonium bichromate or sodium alizarin sulfate was applied.

The sapwood of untreated or Wolman salts treated apitong can be differentiated from the heartwood through color differences by the use of potassium iodide in iodine or benzidine-sodium nitrite solution.

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LITERATURE CITED

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APPENDIX A
COMPOSITION OF SOME OF THE REAGENTS USED AS INDICATORS

Benedict's solution	100 grams sodium carbonate, 175.8 grams sodium citrate, 17.3 grams copper sulfate, distilled water enough to make one liter solution.
Benzidine-sodium nitrite solution: (Reagent is solution of equal volumes of Parts A and B)	Part A: 1 gram benzidine dissolved in 5 grams of 25 percent hydrochloric acid (HCL) and 194 grams of water. Part B: 20 grams sodium nitrite dissolved in 180 grams of water.
Fehling's solution (Reagent is solution of equal volumes of Parts A and B)	Part A: 34.64 grams copper sulfate dissolved in 1/2 liter of water. Part B: 60 grams sodium hydroxide (NaOH), 173 grams Rochelle salt, 1/2 liter of water.
Phenol-hydrochloric acid-ethanol	10 ml. of phenol melted by heating in water-bath. The phenol is added to 5 ml. of hydrochloric acid to which sufficient ethanol (ethyl alcohol) is added to make a volume of 60 milliliters.