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Preliminary Studies on the Chemical Composition of Sound and Decayed Wood of *Acacia mangium*

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ABSTRAK

Suatu perbandingan telah dijalankan ke atas gula ringkas serta komponen-komponen kimia proksimat bagi kayu A. mangium *yang sihat dan yang mengalami pereputan lanjut. Perbezaan-perbezaan penting di antara kayu yang sihat dan yang berpenyakit didapati di dalam jumlah manitol dan bahan-bahan yang larut di dalam alkali. Perbezaan yang kecil diperhatikan di dalam jumlah bahan-bahan yang larut di dalam alkohol-benzena dan air panas.*

ABSTRACT

A comparison of the simple wood sugars and proximate chemical components in sound wood and wood with advanced decay of A. mangium *was made. There were significant differences in the amounts of mannitol and alkali solubles between the sound and decayed wood. A slight difference was observed in the amount of alcohol-benzene and hot water solubles.*

INTRODUCTION

A. mangium was originally introduced into Sabah in 1966 from Australia. It was first planted by the Sabah Forestry Department Authority (SAFODA) in 1978. The trees were initially established as fire-breakers, and were later found to be suitable for furniture making, as general purpose industrial timber, and for charcoal and wood pellets. It has the ability to grow very fast and almost anywhere. Hence it is a natural choice for reforestation and soil rehabilitation.

Unfortunately, *A. mangium* is susceptible to heart rot, a stem decay. Heart rot in *A. mangium* has been reported earlier (Anon, 1981). The main uses of this tree, especially with products needing solid wood, require the production of high quality timber. Hence, it is important to determine the causes of heart rot in *A. mangium* and possible methods of control. A chemical investigation on the wood of *A. mangium* could perhaps assist in assessing the problem of heart rot or at least provide a basic understanding of the chemical implications brought about by this damaging decay fungus. A preliminary investigation was thus made which involved a comparative study on the extractive contents of sound wood and wood with heart rot. Only changes in chemical composition were examined in this preliminary study.

MATERIALS AND METHODS

Selection and Preparation of Samples

Two 8-year old trees were chosen for study from a plantation in Batu Arang, Selangor. One tree was extensively decayed and the other was sound.

Each tree was divided into three portions, i.e. top, middle and butt. Each portion, in turn, was further divided into the sapwood and heartwood. Samples of the sapwood and heartwood were converted to fine shavings and then reduced to wood meals in a Wiley Mill.

Chemical Examination

Samples of heartwood and sapwood (2 g) were extracted with a mixture of methanol and water (75:25) (25 ml) for 12 hours. Aqueous solutions of these extracts were then analysed for simple sugars by high performance liquid chromatography (HPLC).

In the chemical analysis of the samples, the following standard methods were employed:-

a) One percent alkali solubles	:	1% caustic soda solubility of wood. TAPPI T212 in TAPPI Testing Procedures (Anon, 1978).
b) Alcohol – benzene solubles	:	Alcohol – benzene solubility of wood. TAPPI T204 in TAPPI Testing Procedures (Anon, 1978).
c) Cold water solubles	:	Water solubility of wood TAPPI T207 in TAPPI Testing Procedures (Anon, 1978).
d) Hot water solubles	:	Water solubility of wood. TAPPI T207 in TAPPI Testing Procedure (Anon, 1978).
e) Lignin	:	Acid-insoluble lignin in wood and pulp. TAPPI T222 in TAPPI Testing Procedures (Anon, 1978).

Each analysis was carried out in duplicate.

RESULTS AND DISCUSSION

Simple Sugars

The results of the HPLC analysis on the methanol-water (75:25) extracts of the sapwood and heartwood are shown in Table 1. In Tree 1 the highest level of sucrose was found in the butt sapwood, and the highest amount of xylose in the middle heartwood. Both these sugars were present in appreciable quantities throughout the tree whereas glucose and fructose were found only in very small amounts or as traces. In Tree II, the decayed tree, sucrose was found in increasing quantities from the top sapwood to the butt sapwood. Large quantities of xylose were present in the middle and butt heartwoods. Fructose and glucose were detected in the top sapwood and butt heartwood. Glucose was found in the middle sapwood as well. The results also showed that the tree with extensive decay contained a larger amount of total simple sugars. Among the simple sugars, fructose and mannitol were found in proportionally larger amounts. Certain qualitative patterns peculiar to the

TABLE 1
Free simple sugars in sound and decayed *A. mangium* wood (per cent dry basis).

Tree	Position in tree	Glucose	Fructose	Sucrose	Xylose	Mannitol
	Top SW	t	t	0.7	0.2	10.3
I	Top HW	t	t	t	4.5	t
(Sound)	Middle SW	t	t	0.9	0.9	10.6
	Middle HW	t	0.1	t	7.6	t
	Butt SW	0.4	t	8.1	1.1	2.1
	Butt HW	t	t	0.2	0.9	t
	Top SW	0.1	0.1	0.9	0.7	9.1
II	Top HW	t	t	t	1.9	t
(Decayed)	Middle SW	0.2	t	6.8	0.3	22.9
	Middle HW	t	t	1.6	5.0	t
	Butt SW	t	t	9.7	1.1	11.4
	Butt HW	0.2	0.3	0.2	4.5	t

Note : SW = sapwood HW = heartwood
t = < 0.1%

different tissues were also evident. The functional tissue, sapwood, generally contained more sucrose, whereas the nonfunctional heartwood had more xylose. Such findings seem to substantiate a similar pattern found in previous works (Smith and Zavarin 1960 and references herein).

The presence of mannitol requires comment. It was present mainly in the sapwood part of both trees with Tree II containing the highest amount in its middle sapwood (*Fig.1*). In general, the amount of mannitol in Tree II was nearly twice that in Tree I. Mannitol, a sugar alcohol, is very common in algae, fungi, lichens and higher plants (Leslie and Smith 1967). The main function of this sugar alcohol is to store energy, but mannitol may also be involved in the mechanism of translocation in phloem in higher plants (Harborne 1973). The higher amount of mannitol present in the decayed tree could be due to microbial formation of this substance by fungi, either from glucose, fructose, sucrose or mannose.

Alkali, Water, Alcohol-benzene Solubles and Acid-insoluble Lignin

Table 2 shows the amount of the various components in sapwood and heartwood of the two trees. The decayed tree contained a higher quantity of alkali-soluble constituents, especially in the sapwood. This is consistent with the increase of alkali solubles during the process of decay in wood.

Other differences in extractives and lignin contents between the two specimens may not be significant considering the known variability of such values between individuals of the same population.

The considerable destruction of the polysaccharides as reflected in the increased alkali solubility coupled with no significant loss of lignin in decayed trees are features that distinguish a brown rot type of degradation (Farmer 1967; Fengel and Wegener 1984).

CONCLUSIONS

The distribution of the three main sugars found in A. mangium, namely sucrose, xylose and mannitol, is different in its heartwood from that in its sapwood. Sucrose is found largely and mannitol solely in the sapwood whereas xylose appears to be the characteristic sugar in the heartwood. The level of sucrose and mannitol seems to be higher in the decayed tree than in the sound tree by a factor of approximately two.

It is apparent that the decay analysed was highly advanced brown rot since there was a

TABLE 2
Chemical analyses of sound and decayed A. mangium wood (figures in percent)

Tree	Position in tree	Moisture content	Alkali soluble	Cold water soluble	Hot water soluble	Alcohol-benzene soluble	Acid insoluble lignin
I	Top SW	10.7	20.2	3.3	3.5	2.0	27.8
	Top HW	15.5	16.1	2.2	3.5	3.2	25.9
	Middle SW	11.8	18.5	1.9	2.7	1.9	26.3
	Middle HW	13.4	13.2	0.8	2.6	4.6	29.9
	Butt SW	13.1	20.1	1.1	1.5	2.8	25.6
	Butt HW	13.1	15.8	1.1	3.1	3.1	27.1
II	Top SW	9.6	33.7	3.6	4.2	2.3	26.9
	Top HW	13.6	13.4	1.5	3.4	4.1	25.4
	Middle SW	13.1	30.2	0.5	1.5	2.0	26.4
	Middle HW	13.2	14.5	2.4	4.3	4.9	25.2
	Butt SW	12.6	32.4	0.6	1.2	2.6	16.2
	Butt HW	11.9	16.3	1.7	3.6	3.8	24.7

Note : Per cent acid – insoluble lignin was calculated on extractive free basis. Other values were based on oven-dry weight.
HW = Heartwood SW = sapwood

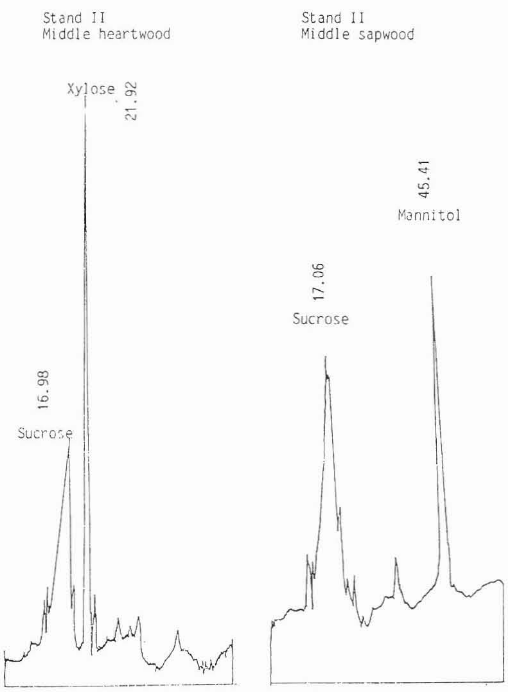

Fig. 1 HPLC chromatograms of simple sugars from middle sapwood and heartwood of decayed Tree II. Hewlett Packard Model HP 1037A; 300 mm × 7.8 mm Aminex HPX-87P column; 0.4 ml water min^{-1}, RI.

decided increase in alkali solubles in the decayed material.

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