Sugars and phenolics as heartwood formation attributes

in plantation teak (Tectona grandis) from Malaysia

Heartwood

Sapwood

EAK (Tectona grandis) is one of the most valuable tropical species (Bhat and Ma 2004). Biochemical and physiological process which occurred during heartwood formation have consequences on wood properties such as colour, natural durability and some mechanical properties. Understanding heartwood formation and determining some attributes may be useful to predict wood quality and its optimum valorisation.

Previous studies with temperate species show that sugars and phenolics are involved in heartwood formation process (Magel *et al.* 1997). Objective. Study radial distributions of sugars and phenolics through the stem in relation to heartwood formation mechanism in plantation-growth teak.

aterials and methods

thods

- Wood samples were taken successively into sapwood (SW), outer heartwood (OHW), middle heartwood (MHW) and inner heartwood (IHW) from 7 trees of *Tectona grandis* Linn. (5.5 to 10 years) from YSG trial in Malaysia (Fig 1).
- Sugars were analyzed by thin-layer chromatography coupled to an enzymatic method (Magel and Höll 1993).
- Phenolics were analyzed and quantified by HPLC coupled to a DAD detector.

Kesults and discussion

Radial distribution of sugars in teak



Fig. 2. Thin layer chromatography of teak wood extracts (standard: 5 mg/mL).

Seven sugars were detected in sapwood: glucose, fructose, sucrose, raffinose, stachyose and two unknown sugars.

Sugars content decreased from outer sapwood to inner sapwood. Heartwood seems free of sugars Fig 2.

> Fig. 3. Quantitative variations of starch and soluble sugars contents from sapwood to inner heartwood in teak, dwi dry weight.

Starch >> glucose, fructose > sucrose (fig 3). Sugars were accumulated in the sapwood and decreased abruptly in heartwood. These results confirm thin layer chromatography observations.

		Starch (gmoi bond glocoso/g dw)		Soluble sugars (prior)	/g dw)
	60		12 -		
	30 . 40 .		9 -		Glacose
	30 . 20 .		6 -		Succese
0	10		3 -		E TA
ot nts	0 1	CHW AND ISW	0		0.02
l in ht.	Transition zone	9	Trar	nsition zone	

These results show that the transition zone is the site of sugars depletion

and confirm the histochemical observations made by Nobuchi et al. (2005) and Datta and Kumar (1987). Sugars play a key role in heartwood formation as source of energy and carbon skeletons furnishers (Hauch and Magel 1998).



Fig. 4. Quantitative variations

Radial distribution of phenolics in teak

- In sapwood, presence of a hydroxycinnamic derivative (H1) and Tectoquinone (Q1).
- In heartwood, presence of Q1, 2-hydroxymethylanthraquinone (Q2), and an unidentified compound P1.
- Sapwood contains less phenolics than heartwood.
 - Tectoquinone is the main phenolic compound of teak wood: the content increase from sapwood to outer heartwood and decrease from outer heartwood to inner heartwood as observed by Lukmandaru and Takahashi (2009) with teak from Indonesia. Whereas Q2 and P1 decrease from outer heartwood to middle heartwood and increase from middle heartwood to inner heartwood.

These results show that the transition zone is the site of phenolic synthesis during heartwood formation. H1 and Q1 could be the phenolic precursors of heartwood phenolics synthesis. Phenolics may undergo to further alterations after their synthesis in the inner heartwood.



- Inverse radial distributions of sugars and phenolics suggests that sugars are metabolized for the synthesis of phenolics accumulated in teak wood as H1, tectoquinone (Q1), 2-hydroxymethylanthraquinone (Q2) and P1.
- H1 and Q1 may be the phenolic precursors for the synthesis of heartwood extractives in the transition zone. After their formation, phenolics are subject to further transformations during heartwood formation.
- Hence, the radial distribution of non-structural carbohydrates and that of phenolic compounds can be used as chemical attributes of the heartwood formation in teak wood.

Líterature

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> Fig. 1. Scheme of wood sampling: SW: sapwood, OHW outer heitwood, WHW: middle heartwood, IHW: inner heartwood. Scale: V(0