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Establishment of alpha-cellulose extraction method and its application using tropical tree sungkai (Peronema canescens Jack) for reliable paleoclimate reconstruction in tropical areas

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Tree rings are widely used to reconstruct paleoclimate in terrestrial areas in terms of high spatial / temporal resolution and great sensitivity for climatic factors (e.g., precipitation, relative humidity, air temperature, etc.). However, this is not necessarily the case for Asian tropical trees because growth rings of many tropical trees are ambiguous and also because trees that grow in dense rainforest are affected by other environmental factors, such as the existence of neighboring trees. Oxygen isotopic ratio of tree-ring alpha-cellulose can be a proxy of paleoclimate reconstruction in areas where little correlation is found between tree-ring widths and climatic factors [Waterhouse et al., 2002; Rinne et al., 2005]. Thus, continuous, alternative meteorological data in Asian tropical areas that drive the global climate system can also be provided by measuring the oxygen isotopic ratio of alpha-cellulose of tropical trees.

Previous works showed that tree-ring components (mainly cellulose, hemicelluloses and lignin) have different isotopic ratios [Wilson and Grinsted, 1977; Loader et al., 2003]. In addition, the isotopic ratios of untreated samples show weaker correlations with climate signals than that of chemically treated samples [Rinne et al., 2005]. For these reasons, it is necessary to effectively extract only alpha-cellulose for reliable paleoclimatic reconstruction. Furtermore, an optimum processing time can be different between species and hence it needs to be determined for each. However, there is no report that aims at estimation of an optimum processing time using tropical hardwoods. Sungkai (Peronema canescens Jack) is one of tropical hardwood species that formed distinct growth rings and has high sensitivity species for environment [Ohashi et al., 1992].

In this study, the optimum alpha-cellulose extraction time was estimated for sungkai (SungkaiNAN7, collected at Serang, West Java, Indonesia) by measuring oxygen and carbon isotopic ratios, ATR-IR and dry weight change. The procedure of chemical treatment has three steps (1. organic solvent extraction using acetone, 2. bleaching reaction using acidified sodium chlorite solution and 3. alkali reaction using 17% sodium hydroxide solution), which is based on Nakatsuka et al. (2004) who modified the procedure of Loader et al. (1997). The first criteria to determine reaction time at individual stages are that oxygen and carbon isotopic ratios become constant within analytical errors. The additional criteria are: (a) relative amount of lignin ≤ 0, (b) percentage of dry weight after the third stage $\leq 48.6\%$ [Martawijaya et al., 2005] and (c) disappearance of lignin and hemicellulose peaks in the ATR-IR absorption bands. As a result, reaction time at individual stages for sungkai was estimated as 30 min for organic solvent extraction (stage 1), 6 hrs (1 hr $\times$ 6) for bleaching reaction (stage 2) and 2.25 hrs (45 min $\times$ 3) for alkali reaction (stage 3).

The established procedure was applied to time series analysis of carbon and oxygen isotopes of two sungkai disks (SungkaiNAN7 and SungkaiNAN8) in order to evaluate their validity as paleoclimatic proxies.