Distribution of wood extractives in Gmelina arborea and their reactivity during alkali cooking

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Abstract

In this thesis, the spatial distribution of some wood extractives from *Gmelina arborea* (*G. arborea*) and their reactivity during alkaline cooking were investigated. This study aims to reveal the location of extractives in *G. arborea* wood with and without chemical pre-treatment using TOF-SIMS analysis, and to observe the behavior of these extractives in the alkaline-cooking reaction.

In chapter 2, the aim of the experiment was to investigate the distribution of wood extractives of *G. arborea* from the sapwood to heartwood by using Gas Chromatography-Mass Spectrometry (GC-MS) and Time-of-flight Secondary Ion Mass Spectrometry (TOF-SIMS). Several wood extractives, namely gmelinol, paulownin, 7'-*O*-ethyl arboreol, and β-sitosterol, were successfully isolated and purified from *G. arborea* heartwood. The quantitative information of these extractives was obtained using GC-MS and their spatial distribution in the wood tissues was analysed by TOF-SIMS. Some unusual behaviours of the wood extractives were observed in this experiment. For example, the distribution of paulownin was found majorly in sapwood region. It is most likely that paulownin located in this region to serve as a protection against pathogen attack. It is known that some of these extractives possess antifungal activity. An anomaly was also observed in the distribution of gmelinol. Generally, lignans may undergo polymerization towards the heartwood region. However, it was observed that gmelinol was highly accumulated in heartwood region without being secondarily altered. In summary, each extractive in *G. arborea* wood has its own characteristic distribution that associated to their properties in each wood region.

In chapter 3, the characterization and distribution of triglycerides on *G. arborea* wood were investigated using matrix-assisted TOF-SIMS. In this experiment, silver was used to assist the ionization process of triglycerides on the sample surface. From this experiment, it was observed that the triglycerides were able to form an adduct ion with silver and a proton, $[M+Ag+H]^+$. The triglyceride detected *in G. arborea* wood was stearic-olein-stearic glycerol, which was found in highest abundance in the sapwood region. However, the intensity of these peaks was still low; therefore, the distribution of triglycerides was not clearly revealed.

In chapter 4, the lignans from *G. arborea*, gmelinol and paulownin were subjected to the alkaline cooking. Also, in order to understand better about their behaviour and reaction mechanism, other analogue lignans such as pinoresinol, sesamin, and eudesmin were selected in this study. The result of this experiment suggest that non-phenolic lignans are not completely stable during alkaline cooking and the major products of this reaction are some kind of oligomers. It was also observed that small amounts of vanillin and acetovanillone were generated from pinoresinol, eudesmin, and gmelinol (yield 1-2%). Meanwhile, paulownin and sesamin were probably only decomposed or polymerized during alkaline cooking but their products were not identified yet. In addition, the hydroxyl group at C-β' position did not affect the stability of furofuran lignans during alkaline cooking.

In conclusions, the distribution of lignans and sterols in *G. arborea* wood has been successfully quantified and visualized by GC-MS and TOF-SIMS. Unfortunately, the distribution of triglyceride in *G. arborea* has not been clearly revealed because the concentration of this substance was too low. However, the triglycerides composition by TOF-SIMS can be detected after enhanced with silver coating. Finally, the reactivity and behavior of lignans from *G.arborea* has been studied. It appears that these compounds generate oligomers, vanillin, and acetovanillone during alkaline cooking.