ABSTRACTS (PH D THESIS)

Role of lignin in nutritional physiology of a lower termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae)

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The mechanisms of the decomposition of polysaccharides by termites have been well-documented. However, there is almost no information regarding the role of lignin in the nutritional physiology of wood-feeding insects. Studies on the role of lignin in the nutritional physiology of wood-feeding insects would improve our understanding of natural lignocellulose-decomposition mechanisms, and contribute to the development of sustainable technology to convert lignocellulosic biomass to valuable fuels and materials.

The present study therefore aimed to investigate the role of lignin in nutritional physiology of a lower termite, *Coptotermes formosanus* Shiraki.

The study observed the ability of *C. formosanus* to decompose natural lignin polymers from Japanese cedar (*Cryptomeria japonica*) (softwood), Japanese beech (*Fagus crenata*) (hardwood), and rice straw (*Oryza sativa* L. ssp. *japonica* cv. Nipponbare) (grass) by using high-resolution multidimensional nuclear magnetic resonance (NMR) techniques. The study also investigated the dietary effects of lignins on the physiological responses of *C. formosanus* workers as well as on their gut microbial community profiles by using automated ribosomal intergenic spacer analysis (ARISA).

High-resolution NMR structural data suggested preferential removal of syringyl aromatic units in hardwood lignins, but non-acylated guaiacyl units as well as tricin end-units in grass lignins. In addition, the data suggest that termites and/or their gut symbionts may favor degradation of C–C-bonded β–β and β–5 lignin inter-monomeric units over degradation of ether-bonded β–*O*–4 units, which is in contrast to what has been observed in typical lignin biodegradation undertaken by wood-decaying fungi.

The three purified lignins (milled wood lignins, MWLs), regardless of their structural differences, have no negative effect on termites' survival or body mass or the survival of all the three protists (*Pseudotrichonympha grassii*, *Holomastigotoides hartmanni*, and *Spirotrichonympha leidyi*) in their hindguts. In addition, the three MWL diets resulted in much lower termite survival compared to starvation conditions. Those results suggested that lignins are hardly utilized as a nutrient source by *C. formosanus* workers and are even rather detrimental to termites when used as a sole food source.

The study showed that lignins, regardless of their source (softwood, hardwood, and grass), have markedly positive effects on the survival of *C. formosanus* workers as well as the maintenance of the major protists *P. grassii* and *H. hartmanni* in their hindguts when fed with polysaccharide diets. The results strongly suggested that the presence of lignins in lignocelluloses is crucial to maintaining the physiological activities of *C. formosanus* workers.

Fractional analysis on ARISA profiling data obtained for workers fed on polysaccharide diets with and without lignins suggested that lignin when served with polysaccharides give marked effect on the bacterial pools in the hindgut of *C. formosanus* workers. Taken together with the author's previous findings, the results obtained from ARISA support the view that lignin takes an important role to maintain the gut microbial communities during the lignocellulose digestions in lower termites' digestive system.

Overall, the results support the view that lignin polymers are at least partially decomposed during their passage through the termite gut digestive system, although polysaccharide decomposition clearly dominates

the overall lignocellulose deconstruction process and the majority of lignin polymers remain intact in the digestive residues. It was also found that lignins give marked positive effects on the survival of *C. formosanus* workers as well as on their maintenance of hindgut protists when served with polysaccharide diets. Furthermore, it was suggested that the gut bacterial community profiles are also affected by dietary lignins. This study has provided evidence that the presence of lignin is crucial to maintaining the physiological activities and a wholesome hindgut digestive system of *C. formosanus* workers for their efficient lignocellulose decomposition.

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