Preliminary

Components and Anti-fungal Efficiency of Wood-vinegar-liquor Prepared under Different Carbonization Conditions*[1]

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Introduction

The wood-vinegar-liquor (WVL) obtained by the wood carbonization process is used for many applications today such as smoke solutions for food processing, soil-improvement materials, plant activators and herbicides. However, not very many systematic studies have been carried out on WVL because so many components are included and the composition changes easily with different types of raw materials, carbonization, or storage conditions.

A great concern about environmental and safety issues and disposal methods has been seriously paid to the field of wood preservation. There have been trials making use of the features of WVL as a natural product, and recent research has been focusing on the antifungal efficiency of WVL obtained from the wood carbonization process. As WVL contains a considerable amount of phenols, it is expected to have fungicidal and insecticidal effects.

In this study, the effects of carbonizing temperatures and heating rates on the chemical composition of WVL were evaluated. In addition, the effectiveness of WVL in controlling wood-destroying fungi and termites was examined.

Materials and Methods

Chips of sugi wood *(Cryptomeria japonica)*, hinoki wood *(Chamaecyparis obtusa)*, hiba wood *(Thujopsos dolabrata)* and bamboo *(Phyllostachys heterocycla)* were carbonized with a laboratory-scale furnace (Fig. 1) under the heating conditions of target temperature of 300–1,000°C and heating rate of 2–8°C/min to produce WVL. The specimens were carbonized with the furnace under control with thermocouples. A constant rate of N_2 flow of 100 ml/min was maintained throughout the pyrolysis reaction. Iced water was used for the collection of wood vinegar. Semi-pilot-plant furnaces were used for comparison. The system was air-closed and the WVL was collected using running water when carbonized with the semi-pilot-plant furnace.

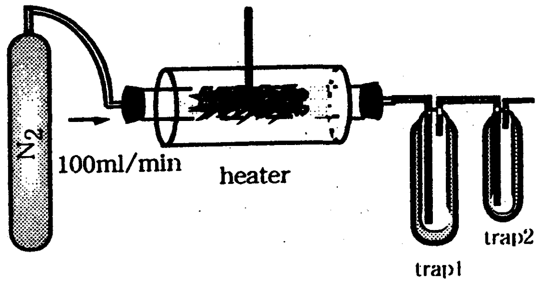

Fig. 1. Laboratory-scale Carbonization furnace.

Gas chromatography - mass spectrometry (GCMS-QP5050A, Shimadzu) was employed for chemical analysis of the components. The retention time for GCMS reported earlier[1)] was used for identification of the components. 0.15% pyrene was added as an internal standard to determine relative concentrations of each component. The WVL was tested for its fungicidal effectiveness using a monoculture of *Fomitopsis palustris* and *Trametes versicolor* on the agar medium and termiticidal effectiveness using Formosan subterranean termite, *Coptotermes formosanus*.

Results and Discussion

Fig. 2 shows the gas chromatogram of sugi WVL prepared at different carbonization temperatures. About 25 kinds of components from the WVL were identified from the gas chromatogram of wood vinegar in GCMS analysis when the sugi sapwood was carbonized under the conditions of target temperature of 500°C and heating rate of 4/min. The maximum yield of WVL was obtained at carbonization temperatures between 300°C and 400°C. Phenolic components such as phenol, guaiacol, and cresol, which are considered to act as biocidal agents, increased at the retention time between 30 and 60 minutes at around the same temperatures.

Although little difference in the production of each component was obatined by changing a target temperature, different heating rates led to differences in the amount of phenols. The yield of guaiacol and 4-methyl guaiacol increased with heating rates. Great differences

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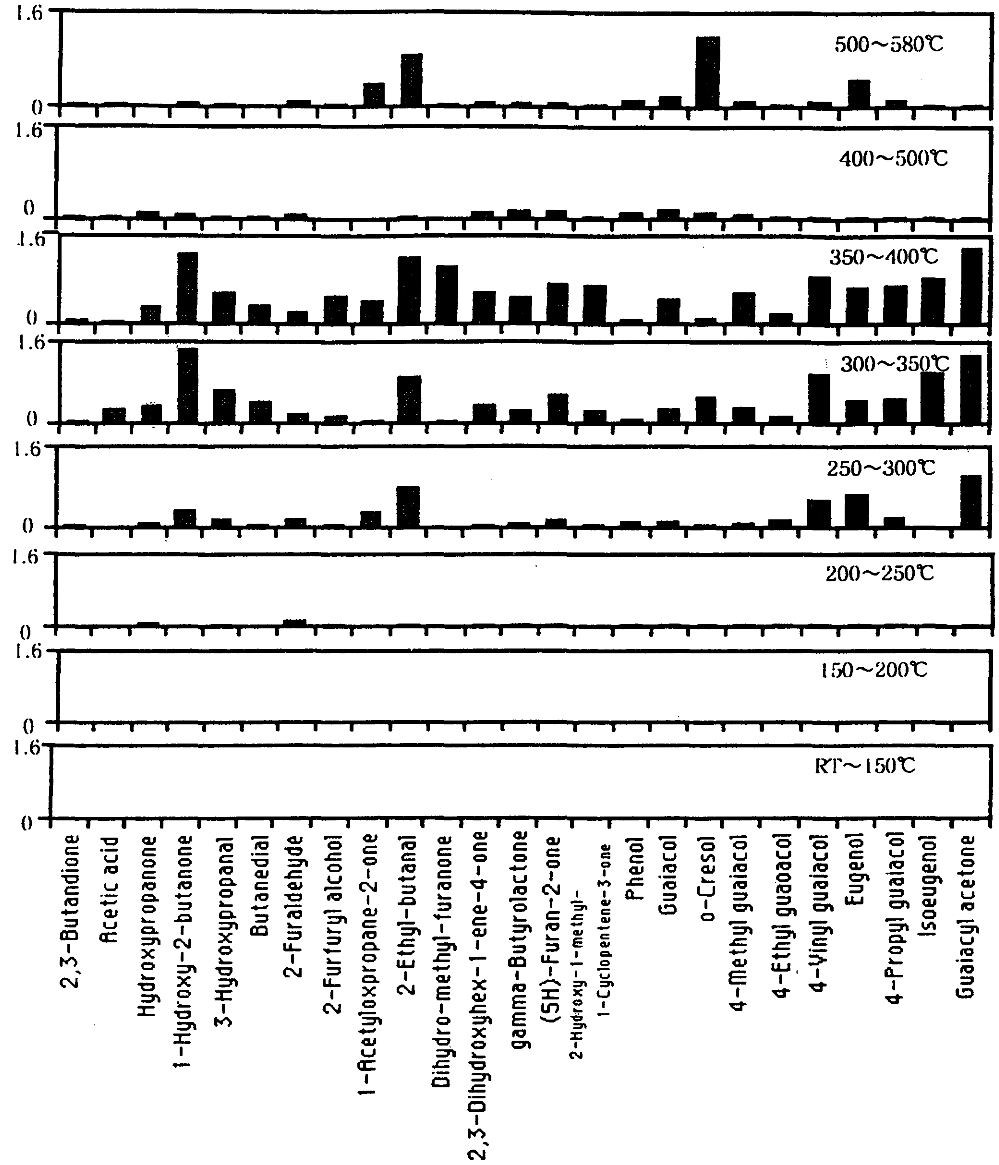

Fig. 2. Gas chromatogram of sugi WVL prepared under different carbonization temperatures.

between laboratory-scale and semi-pilot-plant furnaces were remarkably observed in the chemical components of WVL.

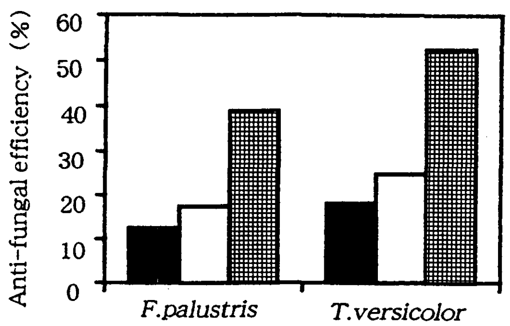

Fig. 3. Anti-fungal efficiency of sugi WVL prepared under different heating rates of 2, 4 and 8°C/min. ■ 2°C/min, □ 4°C/min, ▦ 8°C/min.

The fungicidal test showed little difference in the efficiency between the two test fungi at various target temperatures, while the change of heating rates resulted in remarkable differences in fungicidal efficiency. The proportion of cresol increased at the carbonization temperatures above 500°C. Biological test supported that the yield of fungitoxic components increased and the relevant efficiency improved with the increase of the heating rates (Fig. 3).

It was also proven that clear differences were observed in the results of testing between laboratory-scale and semi-pilot-plant furnaces. It has long been believed until now that the higher concentrations of WVL are better as wood preservatives. However, the equal effect are expected from the current results even at low concentrations when a collection method of WVL is carefully chosen.

As wood impregnated with WVL was resistant against both termites and wood-destroying fungi, fixation of WVL within wood should be studied. More bamboo-vinegar-liquor was collected with a higher content of phenols at lower temperatures compared to that of vinegar liquor from wood, and this appears to suggest the applicability of bamboo-vinegar-liquor to the control of fungi and insects.

References

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