Microwave Technology as a Non-Destructive Termite Control Method

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Microwave treatment is superior to conventional heating in a few aspects. Conventional heat treatment generally takes relatively longer because the heating periods depend on the thermal conduction of materials, whereas microwave can quickly raise the temperature interior of materials by different heating mechanism. Therefore, feasibility of microwave technique was discussed with three economically important Japanese termite species, *Coptotermes formosanus* Shiraki, *Reticulitermes speratus* (Kolbe), and *Incisitermes minor* (Hagen) in the laboratory, since the technique is expected to be an environmentally friendly alternative to the chemical treatment

The main object of this research was to develop a non-destructive termite control method by using microwave energy. Maximum power density was 100 mW/cm^2 and two levels of frequencies, 2.45 GHz and 5.8 GHz, were selectively studied based on practical applicability in the field.

In direct irradiation test, microwave was irradiated onto 100 workers of termites of *C. formosanus* in a plastic petri dish. Surface temperatures of termites before and after irradiation were measured by a radiation thermometer to determine thermal difference. Mortality development after exposure was recorded for 3 weeks in a termite culturing room. In addition, to determine the effect of microwave energy repellent to termites, the shielded area was created in the same irradiation space. The activity of termites was recorded by a digital video camera.

In indirect irradiation test, a 52 mm-diameter plastic petri dish with *I. minor* in was sandwitched by two wood specimens. Microwave energy was emitted onto the surface of upper wood specimen. The thermal differences in temperatures interior and exterior of wood specimens were measured by using K-type thermocouples and the radiation thermometer. Number of dead termites during exposure was counted regularly.

Thermal difference before and after direct irradiation was recognized as variations in temperature based on surface temperature of termite body The results suggested that microwave energy used in this study could not raise the temperature high enough to kill termites. Table 1 shows the mortality of each termite species 3 weeks after the direct microwave irradiation at 5.8GHz, 100mW/cm^2 . There was no significant difference in the mortality between exposed and non-exposed (control) termites, regardless of test termite species. This finding clearly supported that microwave energy did not affect termite physiologically. The repellent behavior of termites may be attributed to the inhomogeneous response related to frequency or termite species as indicated by statistical analysis of shot images. Thus, the effect of microwave was reflected only as heating of termites, and related to termite repellency, although the termites were less sensitive in the electromagnetic field.

On the other hand, in the indirect irradiation test, the temperature inside the wood specimens increased with exposure time. Both levels of microwave irradiation caused in higher mortality than the direct irradiation. At 2.45 GHz, the thin wood specimens were not heated high enough to induce 100% mortality, whereas all termites were killed in thicker specimens. The frequency level 5.8 GHz irradiation could raise the temperature within specimens, although 5.8 GHz irradiation was not attributed to uniformity of heating in whole irradiation area. These results demonstrated that the effect of microwave irradiation varied with thickness of wood, and that selection of microwave frequency suitable for wood dimension was extremely important to terminate the infestation of termites. Eradication of termites inside the wood by using microwave seems applicable at an adequate frequency, considering penetration depth in accordance with wood dimension.

Table 1. Mortality of termite (%) (mean $\pm$ SD) at 3 weeks after irradiation at 5.8GHz, 100mW/cm^2

Termite species	Exposure time (min)			
	Control	15	30	60
C. formosanus	15.5 ± 10.2	17.8 ± 20.1	17.8 ± 5.1	22.7 ± 6.0
R. speratus	23.5 ± 13.3	15.3 ± 8.1	15.4 ± 4.2	20 ± 8.1
I. minor	8.6 ± 9.2	6.7 ± 11.5	17.8 ± 20.4	13.3 ± 11.5