Laboratory Evaluation of Five Commercial Sports Drinks as Attractants and Arrestants for Subterranean Termites

by
Naotaka Maru, Kunio Tsunoda and Tsuyoshi Yoshimura
Kyoto University, Uji, Kyoto 611-0011, Japan

Abstract

In this study, 5 commercial sports drinks and a few their derivatives modified by adding ammonium dihydrogenphosphate or sucrose were tested by two laboratory methods for their effects as attractants and arrestants for subterranean termites. Preliminary choice-test in which 30 workers and three soldiers of *Coptotermes formosanus* Shiraki were exposed to filter papers in a petri dish, showed that consumption of treated filter papers was significantly greater than that of untreated ones ($P<0.05$). The subsequent choice-test with *C. formosanus* using soil also demonstrated that consumption of wood blocks treated with 5 treatment liquid samples was significantly higher than that of untreated one ($P<0.05$). The number of termites was similarly greater in containers with soil treated with 5 liquid samples than in untreated container ($P<0.05$). The addition of phosphate generally increased feeding and recruiting response, while sucrose did not always contribute to our expectation. The present laboratory tests suggested that the increased attracting and arresting effect was attributable to sports drinks, when these additives were applied at appropriate dilutions.

Key words : attractant, arrestant, baiting program, subterranean termite, sports drink

Introduction

Bait-application for subterranean termites is well known as environmentally sound method of termite management alternative to the use of conventional termiticides. However, both difficulty in discovering baits by termites and low termite-arrest on baits have been critical for successful termite management. In some cases, it may take several months for termites to find baits, resulting in delays in eliminating termite infestations. The use of attractants and arrestants is thought to improve the baiting program.

Many materials were reported so far to stimulate termites feeding and/or tunneling behavior. Cornelius *et al*. (2005, 2008, 2009) investigated the effects of the commercial sports drink (Gatorade) or Summon Preferred Food Source (FMC, Philadelphia, PA). Laboratory and field tests demonstrated that carbon dioxide (CO_2) attracted *Reticulitermes* spp. and that termites discovered more bait stations in the field near a source of CO_2 (Bernklau *et al*. 2005). *Reticulitermes hesperus* (Banks) preferred various mono-, di-, and trisaccharides by paper disks test (Saran *et al.* 2005). In the laboratory, *Reticulitermes* spp. foragers recruited in greater numbers to substrates drenched in solutions of sucrose and yeast or urea than to substrates drenched in water (Waller *et al.* 1999). Formosan subterranean termites oriented their tunneling towards wood disks decayed by brown-rot fungi and polymer disks impregnated with extracts of decayed wood (Su 2005).

The main object of this study was to evaluate sports drinks and their derivatives as attractants and/or arrestants for improving the effectiveness of bait technique against subterranean termites.

Materials and methods

Termites: **Test termites** *C. formosanus* were obtained from laboratory colonies maintained at the Research Institute for Sustainable Humanosphere (RISH) of Kyoto University. Sound, mature larvae (workers) and soldiers were used in the termite bioassay.

***Sports drinks and preparation of their derivatives*:** Five commercial sports drinks (A, B, C, D, E) were chosen by their ingredients.

Four sports drinks (A, B, C, E) without phosphate were mixed with ammonium dihydrogenphosphate (P) (0.02%, wt/vol), and three sports drink derivatives and one sports drink (AP, BP, D, EP) without sugars were prepared by mixing with sucrose (S) (4%, wt/vol) for filter paper choice-test. The total number of treatments tested were 13 (5 sports drinks and 8 derivatives).

Three treatment concentrations (1/1, 1/5, 1/10) were prepared by diluting sports drinks with distilled waters for soil choice-test. Six treatment liquid samples (A:1/1, A:1/5, A:1/10, C:1/5, E:1/5, E:1/10) were additionally prepared by mixing with ammonium dihydrogenphosphate (0.02%, wt/vol). The total number of treatment patterns tested were 21 (5 sports drinks×3 concentrations and 6 modified liquid samples).

***Choice-test using filter paper*:** As shown in Fig. 1, a filter paper (70 mm in diameter) was divided into quarters and two each of them were treated with sports drinks and modified liquid samples and distilled water, respectively. Treatment amount per one quater filter paper was 0.15 ml. Each of these papers was placed on a plastic petri dish (90 mm in diameter, 20 mm in depth). Thirty workers and three soldiers of *C. formosanus* were introduced in the central petri dish. This test was conducted in the dark room at 28°C ± 2°C. Five replications were used. The number of termites present in treated and untreated areas was counted at regular intervals after the initiation of bioassay (0, 2, 4, 24, 48, 72, 96, 120 h). After 5 days, consumption of filter papers was calculated.

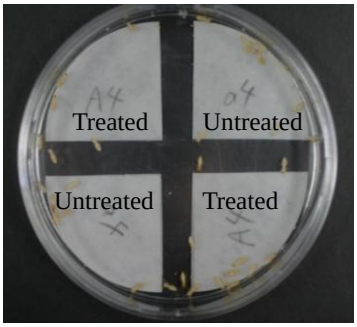

Fig.1. Device for choice-test using filter paper

***Choice-test using soil*:** Three acrylic cylindrical containers were connected by acrylic tubes. A bottom of center container was formed by plaster, and two side containers were placed inside petri dishes which served as bottoms. Soils (sandy roam 50 g) was mixed with an individual treatment liquid sample (12 ml) and distilled water (12 ml) and put into side containers, respectively (Fig. 2). Wood blocks [*Cryptomeria japonica* D. Don; 20 (T)×20 (R)×10 (L) mm] were placed put on the soil surface. One hundred workers and ten soldiers of *C. formosanus* were introduced into the center container. Assembled test unit was maintained under the same conditions mentioned above for three weeks. Consumption of wood blocks was determined and the number of termites present in each container was counted at the end of test.

***Data analysis*:** Statistical analysis was conducted by a paired *t*-test ($P<0.05$) [Excel statistics (Microsoft, Tokyo, Japan), 2003].

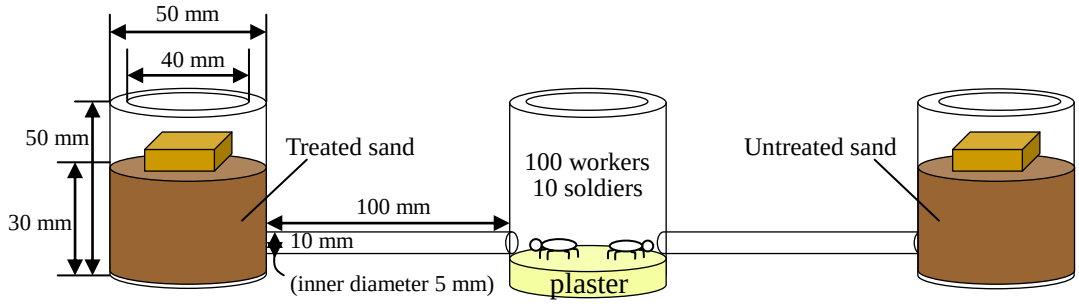

Fig.2. Experimental device of soil choice-test for *C. formosanus*

Results and discussion

***Choice-test using filter paper*:** Results are shown in Fig. 3. It should be noted that treated filter papers were consumed equally to or more than untreated ones except for DS. Significantly higher consumption was seen in the following cases: A, C, AP, CP, EP, P, and EPS.

The number of termites on treated filter papers was greater than on untreated ones in some cases. Those were A at 48, 72, 96 and120h; B at 4h; E at 96 and 120h; AP at 48, 72, 96 and 120h; BP at 24, 72 and120h; CP at 48h; EP at 48, 72, 96 and 120h; APS at 120h; DS at 24h; EPS at 24h ($P<0.05$).

The addition of phosphate seemed to enhance the consumption of filter papers and termites arresting. In contrast, the addition of sucrose was not always favorable for attraction and arrest/aggregation of termites on the treated filter paper.

***Choice-test using soil*:** Results are shown in Fig. 4. It was clearly shown that consumption of the wood blocks was significantly greater in the container treated with C (1/5), D (1/10), AP(1/1), AP(1/5) and CP(1/5) than in untreated container ($P<0.05$). The number of termites was significantly greater in the container treated with B (1/1), C (1/1), D (1/1), AP(1/1) and CP(1/5) than in untreated container ($P<0.05$).

Although discoloration of wood block surface was seen in the container with treated soil at a dilution rate 1/1, when wood blocks were recovered, their weight increased (B, C, D). However, they were apparently damaged by termites in visual observation. Since significant differences of wood blocks consumption didn't reflect significant differences of the number of termites in each container, the results must be interpreted with caution.

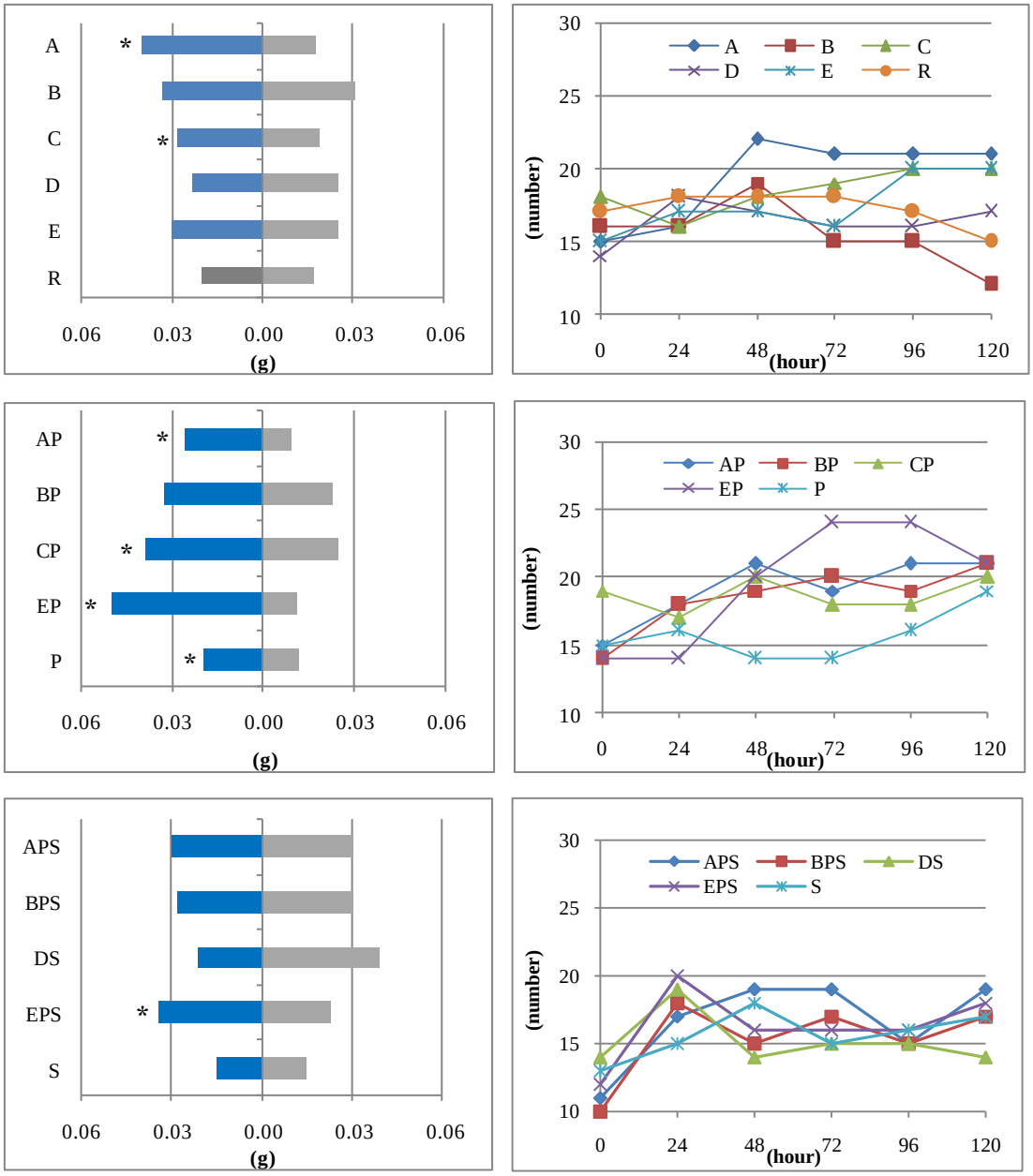

Fig. 3 Consumption of filter papers (figures on left) and the number of termites on treated filter papers (figures on right) in filter paper choice-test with *Coptotermes formosanus*. Horizontal bars represent consumption of treated and untreated filter papers, respectively. Asterisks indicate significant difference in the consumption of treated filter papers in *t*-test ($P<0.05$). (R=reference control, P= phosphate, S=sucrose)

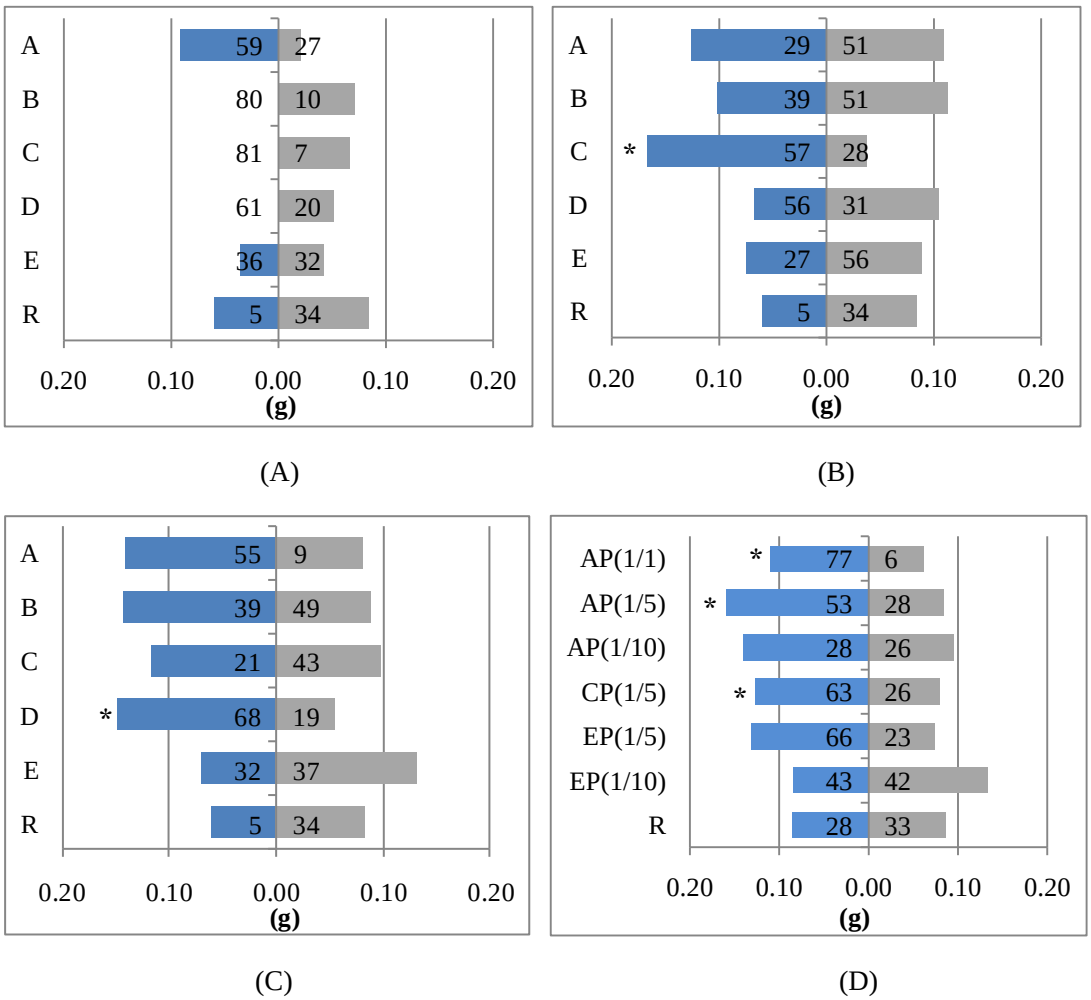

Fig.4 Consumption of wood blocks and the number of termites in soil choice-test with *Coptotermes formosanus*. (A) 1/1 concentration; (B) 1/5 concentration; (C) 1/10 concentration; (D) six prepared liquids for *C. formosanus*; Horizontal bars and numbers represent wood block consumption and the number of termites in treated/untreated containers, respectively. Asterisks indicate significant difference in consumption of wood blocks in the containers with treated soil in *t*-test ($P<0.05$). (R=reference control, P= phosphate)

Conclusion

Although it is difficult to conclude whether sport drinks have attracting and arresting effects on subterranean termite *C. formosanus*, some sports drinks attracted termites and the addition of phosphate influenced the feeding and recruiting behavior of termites in this study. Therefore, when prompt sports drinks are selected, applied at appropriate concentrations and mixed with some co-agents such as phosphate, sucrose and extracts from decayed wood, it is quite possible that they enhance effects as attractants and arrestants. These sports drinks or amended liquids in the field are readily used to pour around the bait station. On the other hand, it is possible they easily disperse by rain or other environmental factors and diminish their desirable effects in the field. These strongly suggest the necessity of field evaluation.

References

Bernklau, E. J., E. A. Fromm, T. M. Judd and L. B. Bjostad 2005 Attraction of subterranean termites (Isoptera) to carbon dioxide. *Journal of Economic Entomology* **98**(2), 476-484.

Cornelius, M. L. and A. R. LAX 2005 Effect of summon preferred food source on feeding, tunneling, and bait station discovery by the Formosan subterranean termite (Isoptera: Rhinotermidae). *Journal of Economic Entomology* **98**(2), 502-508.

Cornelius, M. L., and W. L. A. Osbrink 2008 Effect of bait supplements on the feeding and tunneling behavior of the Formosan subterranean termite (Isoptera: Rhinotermitidae). *Sociobiology* **51**, 497-511.

Cornelius, M. L., M. Lyn, K. S. Williams, M. P. Lovisa, A. J. D. Lucca Ⅱ and A. R. Lax 2009 Efficacy of bait supplements for improving the rate of discovery of bait stations in the field by Formosan subterranean termites (Isoptera: Rhinotermitidae). *Journal of Economic Entomology* **102**(3), 1175-1181.

Microsoft 2003 Excel statistics, Microsoft office personal edition. Mircrosoft, Tokyo, Japan.

Saran, R. K. and M. K. Rust 2005 Feeding, uptake, and utilization of carbohydrates by western subterranean termite (Isoptera: Rhinotermitidae). *Journal of Economic Entomology* **98**(4), 1284-1293.

Su, N. –Y. 2005 Directional change in tunneling of subterranean termites (Isoptera: Rhinotermitidae) in response to decayed wood attractants. *Journal of Economic Entomology* **98**, 471-475.

Waller, D. A., S. E. Morlino and N. Matkins 1999 Factors affecting termite recruitment to baits in laboratory and field studies. *In*: Wm. H. Robinson, F. Rettich and G. W. Rambo (eds), Proceedings of the 3rd International Conference on Urban Pests, Prague, Czech Republic: 597-600.