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# Acceptability of different sugars and oils to three tropical ant species (Hymen., Formicidae)

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With one table

## Abstract

Baits are generally more effective than insecticidal sprays and dusts for controlling ant infestations. It is important to use a highly acceptable food attractant in order for baits to be effective. We examined the acceptability of 6 sugars and oils to 3 ant species, *Pheidole megacephala* (Fab.), *Ochetellus glaber* (Mayr), and *Paratrechina longicornis* (Latr.). One of these sugars, melezitose, is a trisaccharide found only in the honeydew of homopterous insects. *P. megacephala* showed a significant preference for melezitose over glucose, maltose, and trehalose, but not over fructose and sucrose. *O. glaber* significantly preferred sucrose over maltose and *P. longicornis* did not show any significant preferences for the different sugars. *P. megacephala* showed a significant preference for olive oil. Neither *O. glaber* nor *P. longicornis* showed a preference for the different oils and there were very low numbers of *O. glaber* and *P. longicornis* workers attracted to oil-treated disks. Hence, oil-based baits would probably not be effective for controlling either of these latter two ant species.

## 1 Introduction

There are no indigenous ant species in Hawaii (ZIMMERMAN, 1970), but introduced ants have flourished due to a favorable climate, abundant food sources, and lack of predators (REIMER, 1994). Ants are pests in Hawaii in urban, agricultural, and natural environments, and several species are common household pests. Ants cause problems in pineapple, coffee, and sugarcane by tending homopterous pests (REIMER et al., 1990). They have also had a devastating impact on the native arthropod fauna which lack defenses against ant predation (COLE et al., 1992; REIMER, 1994). Observational evidence indicates that ants have already played a major role in decimating native arthropod populations in lowland ecosystems (HOWARTH, 1985). Controlling the spread of alien ant predators in Hawaii's pristine native ecosystems is therefore necessary in order to conserve endangered native arthropod species.

Many of the ant species established in Hawaii are considered to be cosmopolitan tramp species (REIMER, 1994). The three species included in this study, *Pheidole megacephala* (Fab.), *Ochetellus glaber* (Mayr), and *Paratrechina longicornis* (Latr.), share common attributes of tramp species such as polygyny, colony reproduction by budding, and the ability to colonize disturbed habitats and relocate nesting sites rapidly (PASSERA, 1994). These characteristics make it difficult to control ant infestations.

Toxic baits are generally considered to be more effective in controlling ant infestations than insecticidal sprays and dusts because baits are more likely to eliminate ant colonies by killing queens and brood, as well as foraging workers (WILLIAMS et al., 1990; KNIGHT and RUST, 1991; WILLIAMS and VAIL, 1993). Baits also require the use of less toxicant than spray or dust applications with significantly less potential for environmental contamination, which is an important consideration in controlling ant infestations in urban settings or in native ecosystems. However, baits need to be highly acceptable to ants to compete for the attention of foragers if other food sources are available.

In this study, we tested the acceptability of different oils and sugars as phagostimulants to ants. Homopteran honeydew is an important natural food source for ants. One of these sugars, melezitose, is a trisaccharide found only in the honeydew of homopterous insects (OWEN and WIEGERT, 1976; OWEN, 1978) and KISS (1981) suggested that homopterans synthesize melezitose to attract ants. The ant *Lasius niger* (L.) significantly preferred melezitose over a wide variety of mono- and disaccharide sugars (DUCKETT, 1974). The three ant species included in this study collect honeydew from homopterous insects. Therefore, baits will often need to compete with honeydew in the field. We tested the relative acceptability of melezitose with five other sugars in order to determine if melezitose was particularly attractive to these species.

## 2 Materials and methods

Ant colonies were collected at various locations on the island of Oahu and maintained in the laboratory at ambient conditions (23–25° C) in uncovered 30 by 16 cm plastic boxes. The sides of the boxes were coated with liquid teflon (Fluon, Northern Products, Woonsocket, RI), to prevent ants from escaping. Each box contained a 4.5 cm diameter plastic petri dish with a layer of plaster-of-paris in the bottom and a red cellophanecovered lid to provide a suitable nesting site for ants. Ants were able to freely enter and leave the dish through a hole in the lid. They were provided with a constant supply of water from a water-filled 15-dram plastic vial which contained small holes in the sides of the container and was positioned upside down in the ant box so that ants could collect water droplets when needed. Ants were provided with honey-water by soaking a piece of absorbant paper towel and placing it in a 4.5 cm diameter plastic petri dish. They were also provided with tuna fish (Coral Hawaiian, Bumble Bee Seafoods, San Diego, CA) and peanut butter (Skippy, Best Foods, Englewood Cliffs, NJ) as a source of protein and lipids.

Colonies of *P. megacephala* consisted of 400–500 minor workers, 50 major workers, and 1 queen in each nest box. Colonies of *O. glaber* consisted of 300–400 workers, 30–50 larvae of

various instars, and 3 queens in each nest box. Colonies of *P. longicornis* consisted of 400–500 workers and 1 queen in each nest box.

Multiple-choice food preference tests were performed in a second Fluon-coated 30 by 16 cm plastic box which was connected to the nest box with 1 cm diameter tygon tubing, 10 cm in length. Standard food items were removed at least 24 h before tests were performed. Test foods were applied by pipette to 2.3 cm diameter Whatman No. 3 filter paper disks. The six disks, treated with oils or sugar solutions, were arranged in a circle in the center of the second box. Trials were recorded on videotape (Sony, CCD-TR 101 Video Camera Recorder). For each trial, the number of ants on each disk was recorded at 30 second intervals for a five minute period. There were 6 trials for each experiment.

Between each trial, disks were replaced and the order of the disks was changed to control for any positional bias. There were 10 colony replicates of *P. megacephala* and *O. glaber* and 6 colony replicates of *P. longicornis*. The total number of ants on each food item was summed for each replicate. Data were subjected to analysis of variance (ANOVA) and means were separated by Tukey's Studentized Range test ($p < 0.05$) (SAS Institute 1987).

Ant preference for oils was tested by applying 50 µl of each oil by pipette to a filter paper disk so that the disk was saturated with oil. We used the following oils: canola (Wesson, Hunt-Wesson, Fullerton, CA.), corn (Mazola, Best Foods, Engelwood Cliffs, NJ), olive (Pompeian, Baltimore, MD), peanut (Hollywood, Pet Inc., St Louis, MO), safflower (Hollywood, Pet Inc., St. Louis, MO), soybean (Sigma Chemical, St. Louis, MO). Ant preference for sugars (fructose, glucose, maltose, melezitose, sucrose, and trehalose [Sigma Chemical, St. Louis, MO]) was tested by applying 100 µl of each sugar in 25% sugar water solutions by pipette to a filter paper disk so that the disk was saturated with sugar water.

A two-way choice test was also performed comparing the acceptability of the two most preferred sugars, melezitose and sucrose, to *P. megacephala*. Also, because soybean oil was not included in the initial experiment with *P. megacephala*, a choice test was performed to compare the preference of *P. megacephala* for soybean oil and olive oil, which was the most acceptable oil in the first experiment. Ant preferences, as represented by the numbers of ants on each disk, were compared using a *t*-test (SAS Institute 1987).

## 3 Results

*P. megacephala* showed a significant preference for melezitose over glucose, maltose, and trehalose, but not over fructose or sucrose (table 1). In the choice test comparing sucrose and melezitose, sucrose was significantly more acceptable than melezitose to *P. megacephala* ($t = 5.64$, $df = 9$, $P = 0.016$). *O. glaber* significantly preferred sucrose over maltose and *P. longicornis* did not show any significant preferences for the different sugars (table 1).

*P. megacephala* showed a significant preference for olive oil (table 1). In the choice test comparing soybean oil and olive oil, *P. megacephala* also significantly preferred olive oil ($t = 12.33$, $df = 9$, $P = 0.0009$). Neither *O. glaber* nor *P. longicornis* showed a preference for different oils (table 1). There were very low numbers of *O. glaber* and *P. longicornis* workers attracted to oil-treated disks.

## 4 Discussion

Our results do not support the hypothesis that melezitose is more attractive to ants that tend homopterans than other sugars. In a related study, *L. niger* showed a significant preference for melezitose over other sugars, including sucrose (DUCKETT, 1974). However, in our study, sucrose was more acceptable than melezitose to *P. megacephala* in a two-way choice test, and there was no significant difference in ant preference for sucrose or melezitose in the test comparing six sugars for all three ant species. We can conclude that sucrose-based baits would be at least as acceptable to all three ant species as the honeydew component, melezitose.

*Table 1.* Mean (± SD) numbers of ants in contact with treated filterpaper disks in multiple choice tests counted every 30 s for a five min period in each of six trials

| | Oils | | |
|---|---|---|---|
| | *P. megacephala* | *O. glaber* | *P. longicornis* |
| Canola | 9.5 ± 11.2b | 6.7 ± 10.3a | 1.3 ± 1.0a |
| Corn | 21.7 ± 15.9b | 2.4 ± 2.7a | 0.3 ± 0.5a |
| Olive | 46.2 ± 28.6a | 1.3 ± 1.6a | 0.0 ± 0.0a |
| Peanut | 9.5 ± 8.2b | 2.8 ± 4.6a | 1.0 ± 0.9a |
| Safflower | 9.1 ± 6.5b | 4.4 ± 6.3a | 1.3 ± 1.4a |
| Soybean | – | 2.2 ± 3.2a | 0.2 ± 0.4a |
| | Sugars | | |
| | *P. megacephala* | *O. glaber* | *P. longicornis* |
| Fructose | 21.5 ± 14.6ab | 23.9 ± 21.9ab | 9.5 ± 9.3a |
| Glucose | 4.8 ± 5.2b | 37.5 ± 26.9ab | 7.5 ± 8.8a |
| Maltose | 7.3 ± 6.5b | 13.2 ± 15.6b | 1.7 ± 1.8a |
| Melezitose | 50.1 ± 54.6a | 39.8 ± 23.7ab | 9.8 ± 8.1a |
| Sucrose | 40.1 ± 35.8ab | 47.6 ± 27.1a | 14.6 ± 15.2a |
| Trehalose | 6.7 ± 8.9b | 19.8 ± 25.9ab | 5.0 ± 5.7a |

Means within a column followed by the same letter are not significantly different (ANOVA; Tukey's studentized range test); Oil test: $F = 9.81$, $df = 4$, $P < 0.0001$ for *P. megacephala*; $F = 1.22$, $df = 5$, $P > 0.30$ for *O. glaber*; $F = 3.11$, $df = 5$, $P < 0.02$ for *P. longicornis*; Sugar test: $F = 4.34$, $df = 5$, $P < 0.002$ for *P. megacephala*; $F = 3.10$, $df = 5$, $P < 0.02$ for *O. glaber*; $F = 1.44$, $df = 5$, $P > 0.20$ for *P. longicornis*.

Olive oil was significantly more acceptable to *P. megacephala* workers than the other oils tested. WILLIAMS (1990) found that olive oil was significantly more acceptable to the Pharaoh's ant, *Monomorium pharaonis* (L.), than 18 other oils. Acceptance of oils could be, at least partly, related to their unsaturated fatty acid content. SANDERS et al. (1992) found that coconut oil was less acceptable to *P. megacephala* than soybean, safflower, and peanut oil. Coconut oil is composed primarily of saturated fats. VINSON et al. (1967) showed that unsaturated fatty acids, such as oleic and linoleic acids, were phagostimulants to imported fire ant workers. Olive oil is composed primarily of the monounsaturated fatty acid, oleic acid, and it had the highest proportion of oleic acid (71%) of the oils used in this study. Hence, oleic acid may be a stronger phagostimulant for *P. megacephala* than linoleic acid. However, the canola oil also contained a high proportion of oleic acid (64%). Thus, it is likely that there are other factors involved in determining ant attraction for olive oil.

There were relatively low numbers of foraging workers of *O. glaber* and *P. longicornis* attracted to any of the oil-treated disks. Oil-based baits would thus probably not be effective in controlling either of these two ant species. However, the relative attractiveness of oil-based baits de-

pends not only on the feeding habits of each ant species, but also on factors such as the size of the colony, the stage of the brood, and the availability of other food sources. Hence, foraging workers from large colonies with large amounts of brood might be more responsive to oils.

Development of effective baits will improve efforts to control ant infestations in urban, agricultural, and natural environments in Hawaii and other tropical locales. Our laboratory study provides insight into the feeding preferences of three common ant species; however, more research is necessary to determine the acceptability of these and other potential bait-attractants in the field.

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