FEEDING PREFERENCES OF WHITE-FOOTED ANTS, *TECHNOMYRMEX ALBIPES* (HYMENOPTERA: FORMICIDAE), TO SELECTED LIQUIDS

by

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ABSTRACT

Sucrose, fructose, glucose, and maltose in aqueous solutions were offered at selected concentrations in binary choice tests to white-footed ants (WFA) (*Technomyrmex albipes*) trailing on exterior building walls. Commercial ant baits and four NecDew™ formulae, a proprietary sweet bait, all without toxicants, were also tested against the sugar solutions. WFA foragers preferred $NecDew_4$ to sucrose solutions, and sucrose solutions (≥ 25%) were preferred over other sugars tested. In tests with solutions containing disodium octaborate tetrahydrate (DOT), $NecDew_4$ with 1% DOT was preferred over a commercial bait with 1% DOT. Additionally, no repellency was observed in 25% sucrose solutions containing up to 7% DOT.

KEY WORDS: sugars, borates, ant baits, NecDew™, Florida

INTRODUCTION

The white-footed ant (WFA), *Technomyrmex albipes* (Fr. Smith), was described from the island of Sulawesi, Indonesia (Smith 1861) and has spread to Japan, Australia, Africa, Hawaii (first recorded in 1911 by Swezey 1915), and recently to Grand Cayman Island, West Indies (unpublished record, 2003). Isolated infestations have been reported from Georgia, Louisiana, and South Carolina (unpublished records, 2004). The discovery of WFA in Florida was originally reported from Homestead in 1986 (Deyrup 1991). Collections of WFA are now confirmed in 20 counties in south and central Florida (unpublished records, 2004). The WFA is a nuisance pest species due to its presence in buildings and landscapes, often in massive numbers, resulting in distress to homeowners.

Four categories of chemical treatment are typically used for ant control: 1) aerosols, which are often used to control ants in wall voids; 2) liquid residuals, which kill ants on contact and leave a deposit on surfaces contacted by foragers; 3) granular materials which release insecticides slowly into soils and outdoor surfaces; and 4) baits. Baiting as a means of ant control has been studied previously with many pest species (Baker et al. 1985; Hooper-Bui and Rust 2000; Klotz and Moss 1996; Klotz and Williams 1995, Klotz et al. 1997, 1998, 2000; Oi et al. 2000; Silverman and Roulston 2001). In recent years there has been renewed interest in the use of baits because they deliver low volumes of toxic materials directly to targeted species. Ants that nest in protected harborages are often unaffected by sprays, but will emerge from cryptic, protective habitats to feed on toxic baits. Baits are easy to apply and require no mixing by the applicator. Baits do not unduly affect non-target insect species that are not attracted to the bait matrix, and they can be placed in containers which only allow access to target species. In order for a bait product to successfully control a target ant, it must not only be palatable to the ant, it should be preferred over competing food sources, and it must kill the ants that feed on it. The speed of kill is an important consideration, especially for ant species that share food via trophallaxis, such as Argentine ants (*Linepithema humile* (Mayr)), since a quick kill might not allow sufficient time for a toxicant to circulate throughout the colony (Klotz et al. 2000), but WFA do not perform trophallaxis, instead they feed nestmates via trophic eggs, (Tsuji et al. 1991; Yamauchi et al., 1991) therefore a toxicant for these ants need only delay mortality a short time until ants can recruit additional foragers to the bait. Mortality to ants feeding on trophic eggs laid by intoxicated ants is an interesting possibility that is beyond the scope of this study.

The feeding preferences of ants have not been studied extensively. Baker et al. (1985) performed choice tests for baits on Argentine ants and found they preferred 25% sucrose water over 25% honey water in the field where ants had access to honeydews. Krushelnycky and Reimer (1998) found that Argentine ants preferred 25% sugar water over water. Rust et al. (2000) examined seasonal feeding preferences and found that Argentine ants, when given a choice between carbohydrate and protein-based baits preferred the carbohydrates (20% sucrose or 20% honey water) over a one year period. Volkl et al. (1999) determined that workers of the formicine ant, *Lasius niger* Foerster, preferred 10% sucrose over 10% glucose, and trisaccharides over disaccharides and monosaccharides. Lanza (1988) demonstrated that numerous ant species preferred sugary solutions containing a complex mixture of amino acids over those without amino acids. Lanza et al. (1993) showed that *Solenopsis geminata* (Fabricius) preferred a sugary nectar mimic rich in amino acids over a similar solution with fewer amino acids whereas *Solenopsis invicta* Buren showed no such preference.

Koptur and Truong (1998) performed multi-choice preference tests of nectar from numerous flowers against 20% (w/v) solutions of fructose, glucose, sucrose, and a mixture of the three on various ant species. Nectars from *Brownea* sp. and *Clerodendrum myricoides* (Hochst.) which were not considered "exceptionally attractive nectars" were tested on WFA. Fructose was found to be significantly preferred by WFA over the nectar of *Brownea* sp., or other sugars, while, both the nectar and fructose of *C. myricoides* were significantly preferred over glucose and sucrose. Fructose was not significantly preferred over the mixture of the three sugars.

Sucrose is very palatable to most sweet feeding ants, readily available, relatively inexpensive, and is used in many commercial ant baits with an added toxicant, such as boric acid. Klotz et al. (2000) found there was a significant reduction in consumption of sucrose water with >1% (w/v) boric acid by the Argentine ant. Management recommendations for the use of 1% boric acid baits have been made for WFA control (Weissling et al. 1998). Some pest control operators in Florida who are following this guideline are reporting unsatisfactory results (J.W., pers. obs.) suggesting that control methods for one sweet-feeding ant species are not applicable for all sweet feeders.

As a guideline for formulating more palatable and, therefore, more effective WFA baits, this study compares the preference of WFA for common and experimental ingredients in liquid ant baits in varying concentrations with or without disodium octaborate tetrahydrate (DOT).

MATERIALS AND METHODS

Two-choice preference tests were performed between 27 March 2001 and 10 November 2003, on the exterior walls of the University of Florida Fort Lauderdale Research and Education Center, Broward County, FL. Two commercial ready-to-use ant baits and several sugar solutions were tested with and without active ingredients, including Uncle Albert's Super Smart Ant Bait© (1% (w/v) DOT (A Safe Pest Eliminators, Inc., Miami, FL)) and Drax Liquidator® (1% (w/v) orthoboric acid (Waterbury Companies, Inc., Waterbury, CT)). Sugar water solutions tested included: 10%, 15%, 20%, 25% (with and without 2% EtOH), 35%, 40%, and 50% (w/v) sucrose (Publix Supermarkets, Lakeland, FL), 25% and 50% fructose (Fisher Scientific, Pittsburgh, PA), 25% and 50% glucose (Fisher Scientific), and 25% maltose (Fisher

Scientific). Deionized water was tested against 10% sucrose. Four NecDew™ formulations (proprietary sweet bait containing an artificial nectar-honeydew made with sugar(s) and proprietary ingredients, University of Florida, Gainesville, FL) were also tested against sugars and commercial baits. $NecDew_1$ contained 20% sucrose (w/v), $NecDew_2$ contained 20% sucrose, 10% glucose and 5% fructose, $NecDew_3$ contained 35% sucrose and $NecDew_4$ contained 40% sucrose. Solutions of 25% sucrose were mixed with 98% DOT (Tim-bor®, U.S. Borax, Los Angeles, CA) in 1% increments from 1-7%.

Glass shell vials (6-ml) with Titeseal® plastic caps (Fisher Scientific) were modified for use as bait containers by drilling five 0.89-mm holes in the caps, inserting cotton dental wicks (4 x 1 cm, #2 medium cotton rolls, Crosstex International, Hauppauge, NY) which minimized bait evaporation and entrapment of ants, adding 4.5-ml bait solution, and attaching to the walls with adhesive putty (Handi-Tak®, Pacer Technology, Rancho Cucamonga, CA). Each choice test consisted of five bait vial pairs placed in 2 columns (Figure 1). Positions (left or right) of the vials were randomized so that ants had an unbiased chance of encountering either of the solutions being tested. Nine counts of ants on each wick were taken approximately every 30 minutes for 4.5 hours. When the numbers of ants could not be counted *in situ*, digital macro photographs were taken, and counts made from the image on a computer display. Numbers of ants on wicks were analyzed using *t*-Test and Mann-Whitney Rank Sum Tests at $P \leq 0.05$ (SigmaStat, SPSS Inc., Chicago, IL) to test for statistical differences between each pair of solutions being examined.

RESULTS

When comparing sucrose solutions with other liquids (Table 1), sucrose (10%) was highly preferred over de-ionized water ($P < 0.001$). Sucrose (25%) was preferred over 10%, 15%, and 20% sucrose. Although 40% sucrose was preferred over 25% sucrose ($P < 0.001$) there was no significant preference between 25% and 50% sucrose ($P = 0.112$). WFA showed no preference ($P = 0.968$) between 2% EtOH + 25% sucrose over 25% sucrose alone.

In comparisons between sucrose and other sugars, 25% fructose was preferred over 25% maltose ($P = 0.033$), 25% sucrose was preferred over 25% fructose ($P < 0.001$), and 40% sucrose was preferred over 40% glucose ($P= 0.002$). There were no significant preferences for 25% sucrose versus 25% glucose ($P = 0.463$), 25% sucrose versus 25% maltose ($P = 0.852$), and 50% fructose versus 50% glucose ($P = 0.817$).

Comparing sugar solutions with and without DOT and commercial products (Table 2), there were no significant preferences between 25% sucrose or 25% fructose versus Uncle Albert's Super Smart Ant Bait (no a.i.) ($P = 0.458$ and $P = 0.057$ respectively), or 25% fructose versus Drax (no a.i.) ($P = 0.580$). There were no significant preferences between Drax with 1% orthoboric acid versus 25% sucrose + 5% DOT or 40 % sucrose + 5% DOT ($P = 0.394$ and $P = 0.245$, respectively). There were no observed preferences with 1-7% concentrations of DOT in 25% sucrose solutions versus 25% sucrose ($P = 0.218$ to 0.916).

When the artificial nectar-honeydew, NecDew™, was tested with sucrose solutions (Table 3), 40% sucrose was preferred over $NecDew_1$ ($P = 0.002$), but $NecDew_1$ was preferred over 25% sucrose ($P <0.001$). There were no significant preferences between

$NecDew_1$ and $NecDew_2$ ($P = 0.844$) or $NecDew_2$ and $NecDew_3$ ($P = 0.713$). $NecDew_3$ was preferred over 35% sucrose ($P = 0.020$) and $NecDew_4$ was preferred over 40% sucrose ($P = 0.015$). $NecDew_4$ containing 1% DOT was highly preferred over Uncle Albert's Super Smart Ant Bait containing 1% DOT ($P<0.001$).

DISCUSSION

Since it is known that WFA collect plant nectars (Charles 1993, Hata and Hara 1992, Koptur and Truong 1998, Samways et al. 1982, Sulaiman 1997, Wheeler 1921) and tend honeydew producing insects (Carver et al. 2003), we tested products that were mostly liquid baits containing the same sugars found in nectars and honeydews (Auclair 1963, Gray 1952, Way 1963, Wilkinson et al. 1997).

Klotz et al. (2000) determined that baits containing >1% boric acid were significantly less preferred by Argentine ants and that there was no significant difference in preference between boric acid and DOT. In our study, baits containing up to 7% DOT were not repellent to WFA. One advantage of a 5% boric acid bait content is that this concentration of boric acid inhibited microbial growth in 25% sucrose solutions used in the laboratory (JW, unpublished observation). If this inhibitory effect remains consistent under field conditions, baits will remain microbe-free for longer periods thus eliminating the need to add antimicrobials that might be repellent to ants.

Comparing the sugars we tested, 40% sucrose was the most preferred, but a range of 25% to 40% is probably adequate for WFA baits. Because $NecDew_4$ without a.i. was preferred over 40% sucrose and $NecDew_4$ with 1% DOT was preferred over the commercial bait (Uncle Albert's Super Smart Ant Bait), $NecDew_4$ has been selected for further testing as a potential WFA control agent. This preference for NecDew is probably due to its similarity to nectars and honeydews that WFA frequently feed on.

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Table 1. WFA feeding preferences based on mean number ants/wick in binary choice tests.

SOLUTION	Grand Total on Wicks	Mean on Wicks	SD		SOLUTION	Grand Total on Wicks	Mean on Wicks	SD	P values
10% Sucrose *	229	5.09	4.56	vs.	water	9	0.20	0.41	<0.001
25% Sucrose *	248	5.51	5.62	vs.	10% Sucrose	80	1.78	1.74	0.001
25% Sucrose *	981	21.80	11.39	vs.	15% Sucrose	415	9.22	5.46	<0.001
25% Sucrose *	943	20.96	9.34	vs.	20% Sucrose	498	5.61	0.84	<0.001
25% Sucrose	251	5.58	4.90	vs.	40% Sucrose *	413	9.18	5.94	<0.001
25% Sucrose	35	0.78	1.70	vs.	50% Sucrose	71	1.58	2.66	0.112
25% Sucrose	117	2.60	3.61	vs.	25% Sucrose + 2% ETOH	101	2.24	2.77	0.968
25% Fructose *	119	2.64	3.80	vs.	25% Maltose	16	0.36	0.80	0.033
25% Sucrose *	383	8.51	9.83	vs.	25% Fructose	46	1.02	2.10	<0.001
40% Sucrose *	276	6.13	6.03	vs.	40% Glucose	20	0.44	0.69	<0.001
25% Sucrose	13	0.29	1.14	vs.	25% Glucose	1	0.02	0.15	0.463
25% Sucrose	9	0.20	0.63	vs.	25% Maltose	14	1.00	0.15	0.852
50% Fructose	15	0.33	1.09	vs.	50% Glucose	6	0.13	0.51	0.817

* Significantly preferred, *t*-Test and Mann-Whitney Rank Sum Test; P = 0.05

Table 2. White-footed ant feeding preferences when givena choice between sugars (with or without DOT) and commercial p (based on mean number ants/wick in binary choice tests).

SOLUTION	Grand Total on Wicks	Mean on Wicks	SD		SOLUTION	Grand Total on Wicks	Mean on Wicks	SD	P values*
25% Sucrose	314	6.98	6.76	vs.	Uncle Albert's (no a.i.)	367	8.16	7.72	0.458
25% Fructose	44	0.98	1.54	vs.	Uncle Albert's (no a.i.)	28	0.62	1.76	0.057
25% Fructose	76	1.69	2.63	vs.	Drax (no a.i.)	57	1.27	2.50	0.580
Drax	206	4.58	6.93	vs.	25% Sucrose + 5% DOT	251	5.58	8.81	0.394
Drax	374	8.31	6.00	vs.	40% Sucrose + 5% DOT	448	9.96	7.27	0.245
25% Sucrose	223	4.96	4.52	vs.	25% Sucrose + 1% DOT	209	4.64	4.87	0.569
25% Sucrose	420	9.33	3.91	vs.	25% Sucrose + 2% DOT	464	10.31	7.70	0.916
25% Sucrose	395	8.78	5.54	vs.	25% Sucrose + 3% DOT	398	8.84	3.94	0.620
25% Sucrose	554	12.31	5.39	vs.	25% Sucrose + 4% DOT	626	13.91	6.76	0.218
25% Sucrose	522	11.60	9.90	vs.	25% Sucrose + 5% DOT	367	8.16	4.82	0.465
25% Sucrose	523	11.62	11.30	vs.	25% Sucrose + 6% DOT	517	11.49	7.99	0.480
25% Sucrose	483	10.73	8.05	vs.	25% Sucrose + 7% DOT	503	11.18	6.08	0.358

* *t*-Test and Mann-Whitney Rank Sum Test at P= 0.05

Table 3. White-footed ant feeding preferences when given a choice between NecDew™ (artificial nectar-honeydew) with sugars and commercial products (based on mean number ants/wick in binary choice tests).

SOLUTION	Grand Total on Wicks	Mean on Wicks	SD		SOLUTION	Grand Total on Wicks	Mean on Wicks	SD	P values
40% Sucrose *	1094	24.31	7.60	vs.	$NecDew_1$	845	18.78	8.66	0.002
$NecDew_1$ *	547	12.16	5.04	vs.	25% Sucrose	364	8.09	4.89	<0.001
$NecDew_1$	571	12.69	4.88	vs.	$NecDew_2$	561	12.47	5.79	0.844
$NecDew_2$	834	18.53	7.85	vs.	$NecDew_3$	936	20.80	13.40	0.713
$NecDew_3$ *	1088	24.18	14.28	vs.	35% Sucrose	750	16.67	8.33	0.020
$NecDew_4$ *	1453	32.29	17.13	vs.	40% Sucrose	1041	23.13	12.02	0.015
$NecDew_4$ + 1% DOT *	961	21.36	8.52	vs.	Uncle Albert's	393	8.73	8.69	<0.001

* Significantly preferred, t-Test and Mann-Whitney Rank Sum Test; P = 0.05

FIGURE CAPTIONS

Fig. 1. Set up for two-choice, random-order preference test with 5 replications. White-footed ants are seen foraging on and between vials.

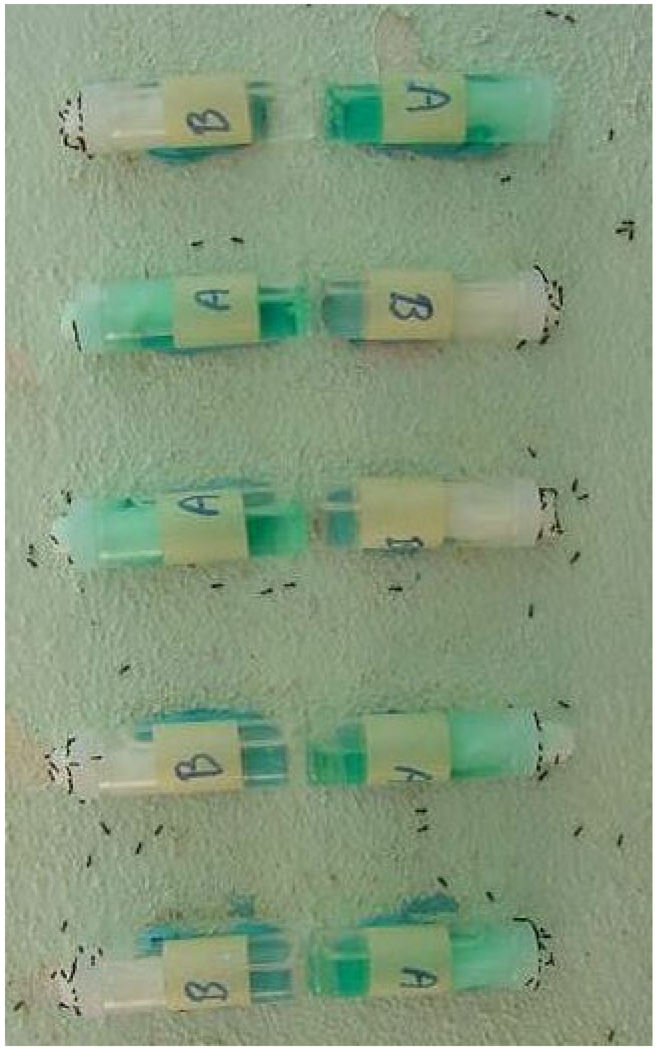

Fig.1