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EFFECTS OF TASTE STIMULI (QUININE AND SUCROSE) IN PELLETED, GRANULATED, AND WAX BLOCK BAITS ON FEEDING PREFERENCES OF NORTHERN POCKET GOPHERS (*THOMOMYS TALPOIDES*)

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ABSTRACT: A two-choice, taste preference study was conducted using 18 northern pocket gophers to evaluate pelleted sorghum, granulated sorghum, and wax block baits containing either 0.01 to 0.05% quinine or 0.10 to 5.0 % sucrose. Bait consumption was significantly higher across treatments ($P \leq .001$) for granulated sorghum, followed by pelleted sorghum, and wax blocks. Gophers also showed a high frequency of moving the granulated bait in their cheek pouches to be deposited at alternate locations within their cages. Although increasing sucrose concentration did not produce significantly ($P \geq .10$) enhanced consumption for any of the baits, a trend toward increasing preference with increased concentration was noted for the wax block bait. During quinine tests, bait consumption was again significantly highest ($P \leq .01$) for granulated sorghum followed by pelleted sorghum and wax block. Quinine treatment also failed to significantly ($P \geq .10$) alter bait consumption across the tested concentrations. However, there was a minor trend toward decreasing preference with increasing concentrations in the wax block group. Data indicated that pelleted bait had the advantage of producing more consistent consumption levels without the animals carrying bait in their cheek pouches for caching and subsequent spillage. Although the wax block baits were most influenced by the taste treatments, consumption levels were extremely low. In comparison with most wild rodent species, northern pocket gophers were found to be insensitive or indifferent to both taste stimuli over a wide concentration range.

KEY WORDS: pocket gophers, baits, preference, taste, sucrose, quinine, *Thomomys talpoides*

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INTRODUCTION

In the Pacific northwest, northern pocket gophers (*Thomomys talpoides*) have caused extensive damage to newly reforested areas (Borrecco and Black 1990), and have been cited as the major vertebrate pest species on national forest lands (Evans 1987). The development of a highly attractive bait material for the control of damage by this species could lead to improved baiting efficacy along with lowered levels of toxicant needed, or to the more efficient oral delivery of non-lethal control agents such as reproductive inhibitors (Miller 1997). Irritants or taste repellent substances applied to food sources could also have a potential for retarding pocket gopher re-invasion rates after control operations similar to the demonstrated repellent effects of predator odors (Sullivan et al. 1990).

Numerous food habits studies (Ward and Keith 1962; Ward 1977; Cox 1989; Burton and Black 1978; Cox 1989; Bonar 1995) have indicated that there are several naturally preferred plants (e.g., mountain dandelion root, onion grass bulbs, lupines) that could be exploited as sources of flavor extract additives for dry bait material. Seasonal aspects of these food habits should also be considered when attempting to improve bait palatability. The selection of the appropriate preference test method and food base material should be based on reliable and sensitive laboratory preference test procedures with bait flavor agents added at controlled concentrations. The current study was an initial investigation of three base materials and two standard taste substances chosen to represent sweet and bitter taste (sucrose and quinine), each evaluated at three concentrations. Many plant species contain these or similarly-flavored substances in varying concentrations throughout their root, leaf, and stem systems.

METHODS

Animals

Thirty pocket gophers (*Thomomys talpoides*) were trapped near Wellington, Colorado and transported in a temperature-controlled vehicle to an animal research holding facility. They were then transferred to individual stainless steel cages (34 x 18 x 18 cm) with wire mesh floors (13 mm) after being dusted for ectoparasites with a pyrethrum-containing flea and tick powder. Eighteen male gophers were selected for the food base taste preference tests. All animals underwent a 14-day quarantine period before they were tested. Throughout the quarantine and test period, the gophers were maintained on carrots, apples, alfalfa cubes, and Purina® laboratory rodent chow pellets with water available *ad libitum*.

Bait and Taste Stimulus Materials

Pelleted milo baits were formulated with ground sorghum, cellulose, and Avicell®. The sorghum was first ground to a fineness of flour that could pass though a 0.5 mm screen. For sucrose AR® and quinine hydrochloride additives (Mallinckrodt, Inc., Baxter, Scientific Products, Denver, CO), the materials were throughly mixed in dry form with a commercial electric food mixer (Kitchen Aid) in 1000 g batches for five minutes before water was added. The mixture was then further stirred in the processing machine for another 10 minutes before being run through a pelleting machine and dried in a laboratory oven at 65°C. The granulated material was made in an identical manner except for the pelleting operation. Instead, the mixed milo material was oven dried and broken apart and collected as bait material that passed through course sieves between 2 mm and 10 mm. Wax block baits were made from a commercial candle wax (Chevron No. 139) that was brought up to melting point for mixing with taste ingredients and then allowed to cool and solidify in 2 cm diameter x 3 cm cylindrical molds. Molded wax baits were tested in this form in the food preference cups.

Food Containers

Tested bait products were evaluated in two stainless steel food cups per each cage (total of 36 cups). These were held in place by screw-type pinch clamps attached to the front of the cages. All cups were weighed and tared so that the initial amount of bait material offered to each gopher was 30.00 g per cup.

Preference Test Procedure

Briefly, the preference testing technique involved exposing the foods (30 grams quantities) in each of two 5-cm diameter by 4-cm deep stainless steel cups spaced 5 cm apart inside the front portion of the individual cages. The initial test food (whole milo) was offered to the gophers for a 2-hour period after a previous 4-hour food deprivation interval (8:00 hr to 12:00 hr MST). Food consumption was determined by weighing the contents of each food cup at the end of each daily feeding trial. After the 2-hour test, animals were allowed to feed *ad libitum* for 18 hours before the next food deprivation interval. Because the animals were relatively inactive in their home cages, this mild food deprivation was assumed to pose only a slight level of stress. The animals were weighed every day to monitor for potential body weight loss problems or other signs of poor health. Before preference testing began, animals were acclimated to feeding on the whole milo from the food cups for four days.

Food Base Selection

This phase of the work was designed to determine which of the three food base formulations would generate the most sensitive and reliable taste preference data with northern pocket gophers in the laboratory.

Pocket gophers were randomly assigned to three groups (n=6/ea) to receive one of the bait materials consisting of: pelleted milo, granulated milo, or wax block. One food cup containing 30 g of one of the three standard food bases and a second (alternate-treated) cup containing the same food base plus sucrose treatment at the 0.1, 1.0, or 5.0% levels were offered to the animal groups successively in ascending order over two-day intervals. All animals were preference tested for 2 hr each day in succession for each concentration, with treated versus untreated food cup positions alternated daily. The same procedure was then used for two-choice preference tests of quinine hydrochloride treatments at 0.01, 0.1, and 0.5% levels presented successively in ascending order. Percent preference values for treated baits were calculated by generating T/(T + U) fractions, with T equal to the treated bait consumed and U equal to the untreated bait consumed (spillage values subtracted from each separately), and multiplying by 100.

Data Analyses

Data for mean treated bait consumption and percent preference for treated bait for each animal were analyzed as two-way repeated measures analyses of variance for each taste substance with food base (3) and additive concentration (3) as the main factors. When significant ($P \leq 0.05$) differences were detected for a factor, Duncan multiple range tests were used for comparisons of individual means.

RESULTS AND DISCUSSION

Sucrose

As indicated in Table 1, there was relatively more consumption of the granulated bait material compared to the pelleted sorghum and wax block baits throughout the tests at the higher sucrose concentrations (i.e., 1.0% and 5.0%). However, consumption of both treated and untreated granulated bait increased at these higher sucrose levels, thus reducing the degree of preference the animals showed for sucrose treatment. One explanation of this effect was that animals offerred granulated bait form consumed more bait, but also picked bait up in their cheek pouches and carried the material to different locations within their cages. Sometimes there was mixing of the two baits by the gophers in the food cups by this means. This factor could have produced some extra measurement error, but was not verified as a major error source with food color added to the two bait materials.

An analysis of variance showed no significant effect for sucrose concentration ($F=1.936$; $df=2,34$; $P>0.10$). There was a significant preference among groups for the granulated sorghum bait based on mean treated bait consumption data ($F=8.209$; $df=2,34$; $P<.001$). Based on the two-day means, the granulated material was consumed the most (1.58 $\pm$ 1.34 grams) followed by pelleted (0.97 $\pm$ 0.40 grams), and finally, wax block bait (0.37 $\pm$ 0.62 grams)($p \leq .05$). Based upon the percent preference comparisons, the wax block bait was, however, the most enhanced by the addition of sucrose taste treatments as shown in Figure 1. This tendency, though not reliable from a statistical standpoint ($p \geq .10$) with six animals per group, could possibly indicate that the northern pocket gopher's preference threshold for sweet taste was lowest when offered in the wax block form. Conversely, the bait enhancer effect potentially generated by sucrose could have been partially masked in baits when offered in the granulated and the pelleted forms.

Quinine

Granulated sorghum was again consumed the most (1.56 $\pm$ 1.05 grams) followed by pelleted (0.69 $\pm$ 0.28 grams) and wax block baits (0.13 $\pm$ 0.25 grams) (see Table 2). This effect was shown to be statistically reliable ($F=19.69$; $df=2,34$; $P<.01$) and was sustained on the second test day as shown in Table 2. Analysis of variance of treated bait consumption data indicated no significant change in bait intake as concentrations were varied from 0.01 to 0.50 percent quinine ($F=0.079$; $df=2,34$; $P>.924$). In addition, the degree of preference or repellency generated by bitter-tasting quinine was not significant statistically in pocket gopher two-choice tests for any of the three bait forms (Figure 2).

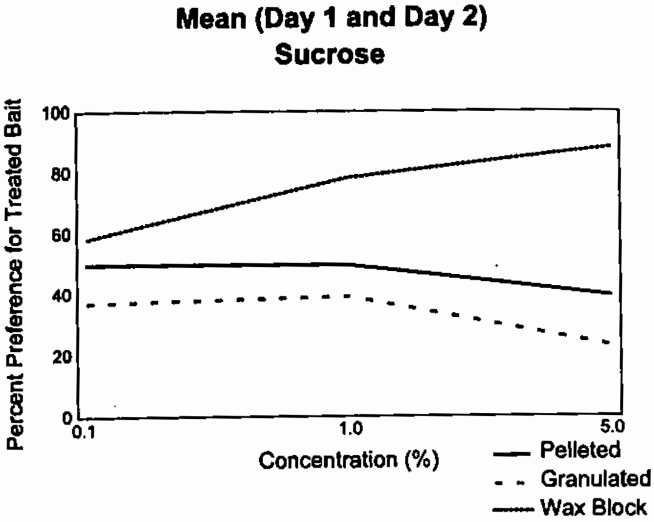

Figure 1. Mean percent preference for treated versus untreated bait material for three sucrose concentrations in three bait bases.

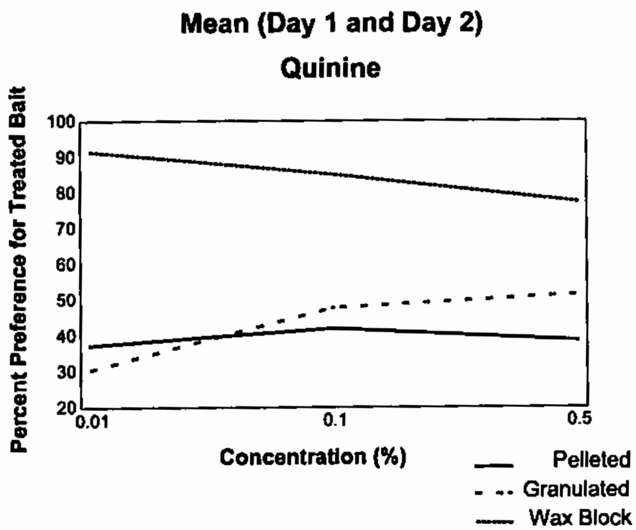

Figure 2. Mean percent preference for treated versus untreated bait material for three quinine concentrations in three bait bases.

Although again not significant with only six animals per group, there was a trend toward decreasing preference for the wax block baits treated with higher levels of quinine (Figure 2). This could have been an indication that pocket gophers, when minimally food-deprived for 4 hours, tended to have more sensitivity to bitter quinine taste in the flavored wax block bait form compared to the pelleted and granulated sorghum bait forms.

It is interesting that pocket gophers show discrimination among plant and root materials (Cox 1989) in their specific habitats. They are, however, much less affected by quinine and sucrose taste additives when compared with wild Norway rats, ground squirrels and chipmunks (Hani et al. 1997). The range of levels tested in this study have been demonstrated to produce extreme changes in preference for most above-ground rodents and squirrels as contrasted to the shallow curves generated in the present study (i.e., Figures 1 and 2).

Bait Development Implications

Pocket gopher baiting efficacy with a mechanical burrow builder has been evaluated (Sargent and Peterson 1963) for plains pocket gopher (*Geomys* spp.) control using several different grain bases (i.e., cracked corn, milo, oats, soybeans and wheat). The only difference in detected field bait acceptance by *Geomys bursarius* was during summer months when soybeans were less accepted. Mountain pocket gophers (*Thomomys* spp.) have not been reported as having an equal acceptance of these grain baits, but, most likely all would be readily accepted also. With non-grain baits (e.g., carrots, prunes, raisins), pocket gophers tended to select high moisture content items rather than items of a particular size as bait material (Miller and Howard 1951). Whole carrots were taken to nest and caching chambers in the burrows without being broken or chewed into smaller particles to be stored in the gopher's cheek pouches.

The current study has confirmed that mountain pocket gophers can carry and store certain forms of bait in their cheek pouches, particularly when offered in the granulated form. Although consumption was also highest for this material, a reliable estimate of the amount consumed by individual gophers would be quite difficult to predict and measure under field conditions. The pelleted milo had an advantage in this respect and could prove superior to whole milo in terms of consistency of consumed treatment level per bait particle. Wax block was poorly accepted and would have to be mixed with a suitable grain such as milo or wheat to achieve improved utility in baiting applications. The wax material does have an advantage, however, in terms of capabilities for bait flavor enhancement to improve bait acceptance.

Extracts from preferred plant materials (e.g., mountain dandelion [*Agoseris*) roots, onion grass [*Melica*) bulbs, lupines [*Lupinus*], western yarrow [*Achilia*]) could be potentially added to wax block material or pellet bait formulations to further improve acceptance by mountain pocket gophers. Advantages of high acceptance include: lowered levels of toxicant needed for control, improved baiting efficacy, and, possibly, reduced hazards to potential non-target species.

LITERATURE CITED

BONAR, R. E. 1995. The northern pocket gopher—most of what you thought you might want to know, but hesitated to look up. USDA For. Serv. Tech. Serv. TE02E11. Baker City, OR. 62 pp.

BORRECCO, J. E., and H. C. BLACK. 1990. Animal damage problems and control activities on national forest lands. Proc. Vertebr. Pest Conf. 14:192-198

BURTON, D. H., and H. C. BLACK. 1978. Feeding habits of Mazama pocket gophers in south and central Oregon. J. Wildl. Manage. 42:383-390.

COX, G. W. 1989. Early summer diet and food preferences of northern pocket gophers in North Central Oregon. Northwest Sci. 63:77-82.

Table 1. Daily consumption level comparisons in grams for northern pocket gophers offered pelleted, granulated, and wax block baits ($\bar{x} \pm$ s.d.). Three concentrations of sucrose-treated (T) versus untreated (U) material were tested in separate animal groups for each type of bait.

Day 1 Group		Concentration 0.1%	1.0%	5.0%
Pelleted	(T)	1.32 ± 0.07	1.09 ± 0.57	0.81 ± 0.35
Pelleted	(U)	1.14 ± 0.04	0.90 ± 0.25	1.17 ± 0.37
Granulated	(T)	0.89 ± 0.42	2.78 ± 1.98	2.21 ± 2.18
Granulated	(U)	0.87 ± 0.56	1.93 ± 3.32	2.38 ± 1.77
Wax Block	(T)	0.13 ± 0.45	0.57 ± 0.71	0.39 ± 0.69
Wax Block	(U)	0.17 ± 0.21	0.10 ± 0.19	0.10 ± 0.08
Day 2 Group		**Concentration 0.1%**	**1.0%**	**5.0%**
Pelleted	(T)	1.12 ± 0.45	0.72 ± 0.38	0.67 ± 0.41
Pelleted	(U)	1.31 ± 0.10	1.00 ± 0.13	1.09 ± 0.23
Granulated	(T)	0.76 ± 0.43	1.43 ± 0.97	2.59 ± 2.48
Granulated	(U)	2.46 ± 2.11	5.96 ± 5.86	6.95 ± 5.80
Wax Block	(T)	0.44 ± 0.86	0.20 ± 0.34	0.59 ± 0.95
Wax Block	(U)	0.16 ± 0.44	0.08 ± 0.05	0.02 ± 0.00

Table 2. Daily consumption level comparisons in grams for northern pocket gophers offered pelleted, granulated, and wax block baits ($\bar{x} \pm$ s.d.). Three concentrations of quinine-treated (T) versus untreated (U) material were tested in separate animal groups for each type of bait.

Day 1 Group		Concentration 0.1%	1.0%	5.0%
Pelleted	(T)	0.57 ± 0.04	0.88 ± 0.35	0.61 ± 0.21
Pelleted	(U)	1.18 ± 0.28	1.01 ± 0.20	0.82 ± 0.27
Granulated	(T)	1.32 ± 1.08	1.64 ± 0.78	0.82 ± 0.84
Granulated	(U)	2.70 ± 2.31	2.57 ± 2.98	0.73 ± 0.86
Wax Block	(T)	0.20 ± 0.28	0.16 ± 0.32	0.08 ± 0.10
Wax Block	(U)	0.03 ± 0.03	0.02 ± 0.02	0.02 ± 0.01
Day 2 Group		**Concentration 0.1%**	**1.0%**	**5.0%**
Pelleted	(T)	0.78 ± 0.39	0.61 ± 0.38	0.54 ± 0.32
Pelleted	(U)	1.08 ± 0.35	1.02 ± 0.34	1.02 ± 0.27
Granulated	(T)	0.92 ± 0.30	1.35 ± 0.58	0.75 ± 0.34
Granulated	(U)	2.35 ± 1.89	1.03 ± 1.10	0.75 ± 0.76
Wax Block	(T)	0.24 ± 0.32	0.13 ± 0.21	0.03 ± 0.20
Wax Block	(U)	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.01

EVANS, J. 1987. Efficacy and hazards of strychnine baiting for forest pocket gophers. Pages 81-83 *in* D. Baumgartner, ed. Animal Damage Management in Pacific Northwest Forests. Washington State University, Pullman, WA.

HANI, A. E., J. R. MASON, D. L. NOLTE, and R. H. SCHMIDT. 1997. Flavor avoidance learning and its implications in reducing hazards to nontarget animals. Fourth Annual Conf. Wildlf. Soc. Snowmass Village, CO. (Abstract)

MILLER, L. A. 1997. Delivery of immunocontraceptive vaccines for wildlife management. Pages 49-58 *in* T. Kreeger, ed. Contraception in Wildlife Management. USDA APHIS Tech. Bull. No. 1853. Denver, CO.

MILLER, M. A., and W. E. HOWARD. 1951. Size of bait for pocket gopher control. J. Wildl. Manage. 15:62-68.

SARGENT, A. B., and B. R. PETERSON. 1963. Pocket gopher control in Minnesota with the mechanical burrow builder. Bureau of Sport Fisheries and Wildlife report to the Minnesota Department of Agriculture. 19 pp.

SULLIVAN, T. P., D. R. CRUMP, H. WIESER, and E. A. DIXON. 1990. Responses of pocket gophers (*Thomomys talpoides*) to an operational application of synthetic semiochemicals of stoat (*Mustela erminea*). J. Chem. Ecol. 16:941-949.

WARD, A. L. 1977. Diets (natural and synthetic): Geomyidae. Pages 79-87 *in* M. Rechcigl Jr., ed. CRC Handbook Series in Nutrition and Food. Vol. 1. CRC Press Inc., Cleveland, OH.

WARD, A. L., and J. O. KEITH. 1962. Feeding habits of pocket gophers on mountain grasslands, Black Mesa, CO. Ecology 43:744-749.