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Evaluation of Two Oral Baiting Systems for Wild Rodents

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ABSTRACT: Tetracycline hydrochloride (TC)-treated peanut butter or rodent chow baits were distributed during March 1990, on separate 0.53 ha sites in Oglethorpe County, Georgia (USA). Rodents were trapped on a control site prior to bait distribution and on two baited sites 6 days post-distribution. Cleaned skulls from euthanized mammals were grossly examined for TC florescence using an ultraviolet (UV) light. Mandibles were sectioned and examined for TC fluorescence using an ultraviolet light microscope. All 21 cotton rats (*Sigmodon hispidus*), four eastern harvest mice (*Rithrodontomys humulis*), and two golden mice (*Ochrotomys nuttalli*) captured on the control site were negative for TC fluorescence. On the peanut butter bait site, mandible sections from 29 of 32 (91%) cotton rats, three of three (100%) eastern harvest mice, two of three (66%) golden mice, zero of five (0%) white-footed mice (*Peromyscus leucopus*), one of three (33%) short-tailed shrews (*Blarina brevicauda*), and zero of two (0%) least shrews (*Cryptotis parva*) were positive for TC. Results from the rodent chow bait site indicated that 18 of 25 (72%) cotton rats, zero of three (0%) eastern harvest mice, two of seven (29%) golden mice, zero of four (0%) white-footed mice, and zero of four (0%) least shrews were positive for TC fluorescence in mandible sections. These results suggest that a large portion of a free-ranging small rodent population can be administered biological markers or vaccines using baits.

Key Words: Biomarker, field study, *Ochrotomys nuttalli*, oral baiting, *Peromyscus leucopus*, *Reithrodontomys humulis*, rodents, *Sigmodon hispidus*, tetracycline.

Rodent baits have been used primarily to deliver poisons (Sterner et al., 1996) or repellents (Rogers, 1978) for population control or to reduce damage to crops or other resources. The use of baits to deliver medications to wildlife populations began with attempts to deliver oral rabies vaccines to foxes (Baer et al., 1971); several types of baits currently are in use for this purpose in Europe (Brochier et al., 1995), Canada (Johnston et al., 1988), and the United States (Fox, 1990). Development of techniques for the oral delivery of medications to species such as raccoons (*Procyon lotor*) (Linhart et al., 1991), and mongooses (*Herpestis javanicus*) (Creekmore et al., 1994) may create a new technology for addressing disease and parasite problems associated with small rodent populations as well. Biological markers placed in baits can be used to determine which animals consume baits and thus be used to evaluate different baits and baiting strategies (Creekmore et al., 1994). This study was conducted to evaluate the effectiveness of two types of baits for delivering a biomarker, and hence a potential vaccine or drug, to small rodents.

The study area in Oglethorpe County, Georgia, (USA; 33°52′N, 83°21′W) was planted in loblolly pine (*Pinus taeda*) 5 yr prior to the bait trial. Understory species included broom sedge (*Andropogon virginicus*), blackberry (*Rubus* spp.), and honeysuckle (*Lonicera japonica*). In March 1990, three 0.53 ha sites spaced approximately 100 m apart were selected and randomly assigned as control or treatment areas.

Tetracycline hydrochloride (TC) (United States Biochemical Corporation, Cleveland, Ohio, USA) is an antibiotic which chelates with bones and teeth and has been used as a biomarker for several species (Linhart and Kennelly, 1967; Crier, 1970; Van Brackle et al., 1994). Tetracycline is visible in bone and teeth within 24 hr of ingestion (Van Brackle et al., 1994) and produces a vivid yellow fluorescence when viewed using ultraviolet (UV) light.

Two bait types were evaluated. The first bait incorporated peanut butter into a 2.5

cm × 0.95 cm plastic bubble normally used as packing material (Network Sales Inc., Doraville, Georgia, USA). Tetracycline hydrochloride was used as a marker, and was added to the peanut butter at 15 mg/g. Corn oil was added to the heated TC/peanut butter until the mixture reached a consistency that could be injected with a syringe through a 14 gauge needle. Baits were made by injecting 4 to 5 g of TC/peanut butter/corn oil into plastic bubble packing material. The sheets of filled bubbles were frozen and later cut apart into separate baits. Baits were kept frozen until time of distribution. The second bait type consisted of commercially prepared 2.0 × 1.3 cm rodent chow pellets (Ziegler Brothers Inc., Gardners, Pennsylvania, USA) containing 15 mg TC mixed with the bait material at the time of pellet production.

Both treatment areas received 290 TC-treated baits (548 baits/ha). The two baited sites were separated by a 0.53 ha control site where no baits were distributed. Twenty-four percent of the bait locations were marked with flagging tape to allow monitoring of bait uptake. Flagged baits were checked for disturbance on days 1, 3, and 6 post-distribution.

Rodents were sampled on the control area prior to bait distribution in order to test for evidence of naturally occurring fluorescence. Trapping was initiated on the treated areas 6 days after bait distribution. Sherman live traps (H. B. Sherman Traps Inc., Tallahassee, Florida, USA) placed on a 6.1 × 6.1 m spacing (247 traps/ha) were used to trap rodents. Traps were baited with a birdseed mixture and were checked daily. Captured rodents were euthanized using CO_2, and sex and species were recorded. Cleaned skulls from captured mammals were grossly examined under UV light and mandibles were sectioned and examined using ultraviolet light microscopy (Fletcher et al., 1990). In samples containing deposits of TC, a fluorescent yellow band was evident in the dentin lining of the pulp cavity of the teeth or surrounding the Haversian canals of the bone. Of 290 TC-treated baits distributed on each of the treatment sites, 69 peanut butter baits and 67 rodent chow baits were flagged for subsequent observation. After 24 hr, 26% of the peanut butter baits and 22% of the rodent chow baits were eaten or missing. By 6 days post-distribution, the cumulative totals for missing peanut butter and rodent chow baits were 100% and 92%, respectively. Treatment groups were compared using a Fisher's Exact Test (Sokal and Rohlf, 1981).

Ants (Formicidae) were active on the peanut butter baits within 24 hr. Infestation rates of flagged peanut butter baits remaining on days 1 and 3 were 45% and 78%, respectively. Ant damage was present in only one (2%) of the rodent chow baits surveyed.

Control site trapping resulted in the capture of 21 cotton rats (*Sigmodon hispidus*), four eastern harvest mice (*Reithrodontomys humulis*), and two golden mice (*Ochrotomys nuttalli*) during 200 trap nights. All mandible sections from these rodents were negative for fluorescence.

Bait acceptance rates were calculated for the rodents captured on the two baited areas. For the peanut butter bait distribution site, 32 cotton rats, three eastern harvest mice, three golden mice, five white-footed mice (*Peromyscus leucopus*), three short-tailed shrews (*Blarina brevicauda*), and two least shrews (*Cryptotis parva*) were captured during 800 trap nights. On the rodent chow bait distribution site, 25 cotton rats, three eastern harvest mice, seven golden mice, four white-footed mice, and four least shrews were captured during 800 trap nights. Gross visual exam of cleaned skulls was negative for all animals sampled from both the peanut butter and rodent chow bait sites. The results of the UV microscopic examination of mandible sections are given in Figure 1.

Although not statistically significant ($P = 0.069$), peanut butter baits (91%) appeared more effective than rodent chow baits (72%) in marking cotton rats. These

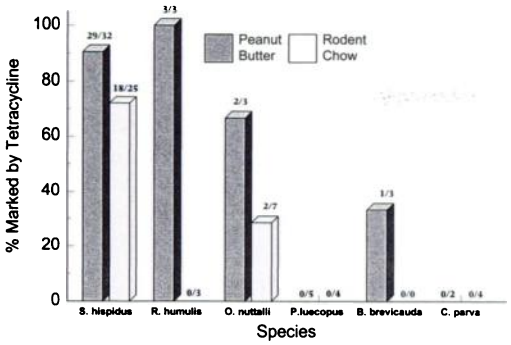

FIGURE 1. Percentage of small mammals marked by tetracycline incorporated in peanut butter baits and rodent chow baits in Georgia, 1990.

acceptance rates compare favorably with three bait trials using oat groats (87, 96, and 95%) to deliver demethylchlorotetracycline to three species of rats (*Rattus* spp.) in Hawaii (Nass et al., 1971).

A bird seed mixture was used during capture attempts because past experience has proven it attractive to a wide variety of small mammals, and it was felt that baiting traps with peanut butter would bias the results. Bait acceptance rates appeared to differ greatly among species and were lower for white-footed mice and shrews for both types of baits. These lower acceptance rates by smaller species could possibly be attributed to competition with cotton rats for baits or differences in food preferences.

Nonmechanical production of peanut butter baits was labor intensive and would become impractical for large scale baiting trials. Rodent chow baits were commercially manufactured and easily distributed, but they proved less attractive. Future trials incorporating a synthetic attractant such as peanut butter essence or carbon disulfide (Bean et al., 1988) to the rodent chow bait might increase acceptance rates.

Ants are a major seasonal pest throughout much of the United States. Bait fouling due to ants or other insects has been noted during bait trials for wild pigs (*Sus scrofa*) (Fletcher et al., 1990) and raccoons (Hable et al., 1992). During this trial peanut butter baits sustained moderate to heavy ant infestations, whereas ant damage to rodent chow baits was insignificant. However, ants did not deter a large percentage of the rodent population from consuming baits. Future trials that incorporate synthetic attractants in rodent chow baits may increase the amount of ant infestation. The use of a bait additive such as dimethyl phthalate (Anderson and Ohmart, 1977) to repel insects might reduce bait fouling and increase the amount of time baits are available for target species.

The biomarker TC proved effective for marking small rodents when incorporated into baits at a rate of 15 mg/g of bait material. The fluorescence produced by TC in mandible sections was clearly evident using UV light microscopy. However, gross inspection of cleaned rodent skulls under UV light failed to show UV fluorescence in animals that were positive by UV microscopy. The use of oral baits incorporating biomarkers has application not only to evaluate vaccine, medication, or antiparasitic drug delivery, but also as a means of marking local rodent populations to study movement patterns. This would be a particularly useful technique where commensal rodents have been implicated as disseminators of diseases affecting humans, livestock or poultry.

Many details of oral bait acceptance by small rodents remain to be determined. Improvements of existing baits to increase consumption and reduce insect fouling are needed. However, this study demonstrates the feasibility of marking populations of small rodents with baits containing TC.

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