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Poster Presentation

Efficacy of Milorganite® as a Non-Venomous Snake Repellent

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Abstract: The objective of this study was to determine the effectiveness of Milorganite® as a potential repellent for non-venomous snakes. Milorganite® is the biosolids by-product left from the activated sludge process from the Milwaukee Metropolitan Sewer District. Within a climate-controlled building, two triangular enclosures consisting of panels (2.4 × 1.2 m) resulting in 2.6 m^2 floor surface area, were secured to plastic floor covering and provided with cypress mulch and a container of water. Corners of the enclosure were demarcated using a 63.5-mm monofilament line placed 10 cm above the floor, providing a .09-m^2 visible triangle of floor surface area. Round metal containers (8.3 × 3.0 cm) were secured to a board and individually placed within each enclosure corner. Treatments consisted of a control, or the addition of 250 mg or 500 mg Milorganite® within respective metal containers, within each corner. Wild-caught snakes (n=20), including rat, corn, king, black racer, and pine snakes, were placed individually within an enclosure for a 24-hour period. Activity of the snake was digitally recorded using an infrared camera placed above an enclosure. Treatment application was repeated for each individual snake. The amount of time each snake spent within the respective enclosure corners or outside the demarcated areas during the 24-hour period was utilized as an indication of the effectiveness of Milorganite® as a repellent. During the 1440-min trials, snakes spent more time ($p<.01$) in the control corner (559.9 ± 98.9 min) or outside the demarcated areas (548.49 ± 89.1 min) compared to the 250-mg Milorganite® (214.5 ± 70.1 min) or 500-mg Milorganite® (117.2 ± 21.6 min) -treated areas. While not different ($p>.05$), there was a trend toward a dose-response effect of the Milorganite® treatment levels. Results of this study indicate Milorganite® demonstrated potential as a snake repellent.

Key Words: Milorganite®, non-venomous snakes, repellent, snakes

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INTRODUCTION

While the desire to repel snakes from an area is not a new concept, identification of compounds that are effective has been limited. Flattery (1949) tested materials ranging from DDT, rotenone, arsenic, chlordane, nicotine sulfate, and various gases. Extensive testing of home remedies, including moth balls, sulfur, cedar oil, lime, coal tar, creosote, liquid smoke, king snake musk, and artificial skunk scent, has been documented (San Julian and Woodward 1985). While several of these compounds were lethal, none were reported to be effective as a repellent in either of these studies. Numerous fumigants, pesticides, toxins, and natural aromatic oils from woody plants have been tested on brown treesnakes (*Boiga irregularis*), with results ranging from no effect, to classification as an irritant, or being lethal (Clark and Shivik 2002, Savarie and Bruggers 1999).

One of the first commercially marketed repellents, Dr. T's Snake-A-Way (28% sulfur, 7% naphthalene, 65% inert ingredients), has been found to be virtually ineffective on numerous species of venomous and non-venomous snakes (Moran et al. 2008, Ferraro 1995, Marsh 1993). Naphthalene is a common ingredient linked to many snake repellent efforts, and while effectiveness has yet to be established, this common aromatic compound elicits toxicity effects predominantly to the eyes and lungs and has been demonstrated to cause damage to kidney, brain, and liver tissue of those exposed, including humans (Stohs et al. 2002).

Numerous compounds tested as deterrents were based on influencing the olfactory senses of snakes. Chemical sensitivity of the olfactory system in snakes is reported to be the most important sense in prey detection, orientation, and sexual behavior (Muntean et al. 2009). The tongue itself may increase odor-sampling area and directly transfer contacted chemical to a highly developed vomeronasal system for analysis (Muntean et al. 2009, Parker et al. 2008). Based on gene analysis of olfactory receptors, it was predicted that snakes rely heavily on the olfactory receptor system as a method of odor detection (Byerly et al. 2010).

As indicated by Clark and Shivik (2002), identification of repellents that are effective with minimal toxicological risks to humans and the environment would be ideal. Milorganite® is the biosolids by-product left from the activated sludge process from the Milwaukee Metropolitan Sewer District (Milwaukee, WI). EPA toxicology reports provided by the manufacturer indicate limited risk to individuals or the environment (http://www.milorganite.com/). Anecdotal evidence of its effectiveness as a repellent for numerous species is reported. It has been documented to reduce damage from white-tailed deer to ornamental plants and to horticultural and food crops (Gallagher et al. 2007, Stevens et al. 2005). The compound likely elicits its effect through the olfactory system. Based on this evidence, the objective of this study was to determine the effectiveness of Milorganite® as a potential repellent for non-venomous snakes.

METHODS

This experiment was conducted at Berry College, located in northwest Georgia, during May - August 2011, with the approval of the Berry College Institutional Animal Care and Use Committee and under the Georgia Department of Natural Resources scientific collecting permit. Within a climate-controlled building, 2 triangular enclosures consisting of smooth-sided 63.5-mm plywood panels (2.4 × 1.2 m) were erected and placed on a plastic covering, resulting in a 2.6 m^2 floor surface area. A 63.5-mm wire mesh (46 cm × 2.5 m) was secured to the top edges of each panel enclosure to prevent potential vertical escape of snakes. The edges of the panels in contact with the plastic floor covering were secured with packaging tape to prevent snakes from attempting to escape underneath panels. Cypress mulch (2.5 cm depth) was applied to the flooring within each enclosure as bedding. A container of water was placed in the center of each enclosure. Corners of the enclosure were demarcated using 63.5-mm monofilament line placed 10 cm above the floor in such a manner to provide a 0.09-m^2 visible triangle on the floor surface. Round metal containers (8.3 × 3.0 cm) were secured to a 20 × 20-cm board and individually placed within the 3 corners of each enclosure. A day/night infrared camera (SN502-4CH; Defender Inc., Cheektowaga, NY) was mounted approximately 3 m above each enclosure and provided an image of the entire floor area of respective enclosures.

Wild-caught snakes (n = 20), including rat (*Elaphe* spp.), corn (*Elaphe guttatus*), king (*Lampropeltis* spp.), black racer (*Coluber constrictor priapus*), and pine (*Pituophis melanoleucus*) snakes, were collected throughout the experimental period. Individual snakes were maintained within 38-L aquariums with secure covers and were provided shelter and water. Snakes typically spent 72 hours or less in captivity and were released following the treatment period. Treatments consisted of a control or the addition of 250 mg or 500 mg Milorganite® within respective metal containers in the corners of each enclosure. Treatments were repeated for each individual animal tested. The treatment period consisted of individual snakes placed within an enclosure for a 24-hour (1440-min) period, with activity recorded by the video cameras. The amount of time each snake spent within the respective enclosure corners as demarked by the monofilament line (0.09 m^2) and outside of the corners (2.33 m^2), during the 24-hour period, was utilized as an indication of the effectiveness of Milorganite® as a repellent. Any part of the animal appearing by video image to be transected by the monofilament line was considered to be within that respective corner. Univariate procedures of IBM SPSS 20.0 (SPSS 2011) were utilized to determine differences in time spent among the treatment corners and area outside of the corners.

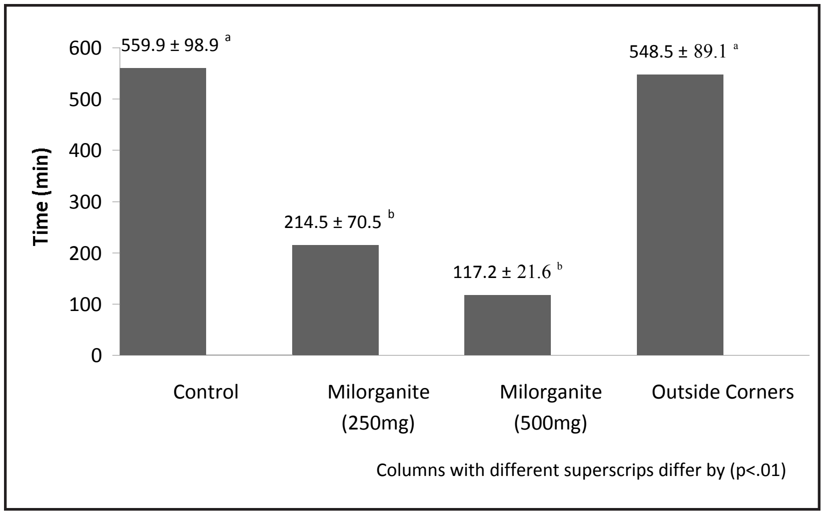

Figure 1. Average time (minutes) snakes spent in Milorganite treated corners, control, or the area outside.

RESULTS AND DISCUSSION

Results of this study indicate Milorganite® has potential as a repellent for non-venomous snakes (Figure 1). Snakes spent less time ($p<.01$) in the 250 mg Milorganite® (214.5 ± 70.1 min) and 500 mg-Milorganite®-treated corners (117.2 ± 21.6 min) than either the control corner (559.9 ± 98.9 min) or the remaining floor surface area (548.5 ± 89.1 min) within the enclosure. While not different ($p>.05$), there was a dose-response trend in the amount of time snakes spent in the low Milorganite® treatment (250 mg) compared to the higher Milorganite® (500 mg) levels. Since no loss of Milorganite® was recorded following each trial, it would be assumed that repellency effect was a result of olfactory influence and not consumption of the compound.

The triangular design of the enclosure provided 2.6 m^2 of total floor surface area. Demarcation of corners using the monofilament line as a marker resulted in 3 0.09-m^2 triangular treatment areas and subsequently an area of 2.33 m^2 outside of treatment corners. It was predicted that snakes introduced into this artificial environment with little cover would spend much of the 24-hour treatment period near the walls of the enclosure and tend to rest in corners, where contact with 2 walls might provide the sense of protection. Ferraro (1995) indicated that confinement studies that removed the snake from the natural environment and allow only 2 choices failed to give reliable accurate results. We agree that field test trials have the potential to give more accurate results, due to the limited behavioral alteration and stress. However, the enclosure used in the current study did provide more than 2 options for snakes. The design also did not require the snake to come in direct contact with the repellent product. While the corners of each area were physically identical, clearly there was a preference for the control corner or areas outside of corners, as compared to the Milorganite®-treated locations.

As indicated previously, Milorganite® treatments were replaced for each 24-hour trial. Thus, neither duration of effectiveness nor potential for habituation of snakes to the product were examined. However, based on this experiment, Milorganite® demonstrated potential as a repellent for non-venomous snakes.

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