Household Ingredients to Control Ant Populations

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Abstract: Ant infestation is a common issue worldwide. These insects are a nuisance and pose a threat to children, pets, and the elderly. Although pesticides prove to be the most efficient form of killing these insects, the chemicals found in them can be harmful to humans. In addition, ants are becoming more and more resistant to pesticides, meaning that harsher chemicals are becoming necessary. This experiment studies inexpensive, non-toxic household ingredients that can be used as alternative pest control methods. It was hypothesized that the black pepper solution would result in the greatest number of ant deaths. The ant subjects used were identified as *Tetramorium caespitum* (Hymenopter: Formicidae, L.), more commonly known as pavement ants, belonging to the order Hymenoptera and family Formicidae. The specimens were collected using two different baits: honey and peanut butter, of which peanut butter proved to be a more successful bait. Ants were placed in three containers with three different solutions of ground cumin, black pepper, and cinnamon. The ants were observed, and results were collected at different time intervals. Upon review of the data, ground black pepper seemed to control the sample population the best. Therefore, it was concluded that the most effective household ingredient tested was black pepper.

Keywords: ants, pesticide, pest control, non-toxic

Insects interact with humans frequently and can often become a nuisance. Ants will invade indoor spaces when the weather is too hot, too dry, or too wet. Worker ants also migrate indoors in search of food. This becomes a problem when stinging ants invade a home, endangering young children, pets, or bed-ridden people (Drees and Summerlin 2011). Different species have specific preferences for nest location and food choice. They also swarm during different times of year. Common indoor ant species are *Monomorium pharaonis* (Hymenoptera: Formicidae, L.) and *Solenopsis invicta* (Hymenoptera: Formicidae, Buren) (Drees and Summerlin 2011).

Fire ants, or *S. invicta*, make up 56% of all ant population in the state of Texas (AntWeb 2015). Due to their painful sting, they are of significant medical importance. If fire ant mounds are disturbed, hundreds of workers will quickly emerge and sting. A single ant can sting repeatedly, causing burning, itchy, fluid-filled welts on the skin. Though fire ant stings are not life threatening for most people, secondary infections can occur if the skin is broken (Drees et al. 2019). It is estimated that 2% of people stung by fire ants will experience a life-threatening allergic reaction. Children are more prone to fire ant hypersensitivity, putting them at a greater risk if stung. (Steigelman and Freeman

2013). *S. invicta* also cause problems in agriculture by invading crop fields. High levels of colonization can put the harvesters at risk of bites (Adams et al. 1977). Fire ants also invade homes, lawns, outdoor electrical equipment, pavements, and other buildings (Drees et al. 2019).

Ants of the genus *Camponotus*, commonly known as carpenter ants, excavate wood to make their nests, which can cause structural damage to homes and other buildings (Klotz et al. 2009). This damage can become costly and can devastate low-income households and establishments. Chemical or other means are necessary to prevent colonization and eradicate existing carpenter ants from buildings.

Pesticides are often used as a universal cure for ant infestations, contributing to the increase of pesticide resistance. When ants become resistant to pesticides, they become harder to kill, requiring stronger, more potent chemicals to eliminate them. Single chemical pesticides specifically are known to increase pesticide resistance in both the target pest and other pests that are not being targeted (Delnat et al. 2019). Using combinations of pesticides usually has less harmful effects, but the use of these mixtures is not frequently documented (Delnat et al. 2019).

The most effective method of control is treating ant nests with insecticide directly. If the nest cannot be found, baits can be used to attract the ants and reveal their nest. Baits are mixed with boric acid to kill the ants that encounter it (Drees and Summerlin 2011). However, boric acid can cause skin irritation, nausea, vomiting and diarrhea in humans if ingested. Children and infants are especially sensitive to boric acid and may experience nervous system effects if exposed to large amounts (Boone et al. 2012).

Using natural pest control methods can reduce human exposure to harmful chemicals and prevent increased pesticide resistance. Natural alternatives to chemical pesticides are also better received by the general public, and result in less backlash.

The species used in this experiment was *T. caespitum*, which do not typically bite humans. They do however pose a medical threat due to their ability to infest food sources. This can be especially detrimental to low-income households where food is limited, and a loss of food could not be replaced due to financial insufficiency.

We hypothesized that the natural methods would be effective, but not as effective as traditional chemical methods. We also hypothesized that out of the three solutions tested, black pepper would show the greatest results.

Materials and Methods

Specimen Collection. A honey and peanut butter bait was used to gather specimens from three ant colonies. Test colony one was located at the coordinates 30.629847, -96.359131. Test colony two was located at 30.628607, -96.359765. Test colony three was located at 30.629839, -96.359304. The specimens were allowed to feed on the bait for approximately 20 minutes before being collected. Test colony one yielded 66 ants.

Test colony two yielded 231 ants. Test colony three yielded 164 ants. The ants were allowed to rest in an apartment building set to 25° Celsius for approximately three hours.

Solutions Preparation. Ground cumin (Morton & Bassett Spices, San Francisco, California), ground black pepper (McCormick & Co., Inc., Hunt Valley, Maryland) and ground cinnamon (Walmart Stores, Inc., Bentonville, Arizona) were each weighed to four grams on a digital scale (Model 5105598, Garden City, New York). Two hundred milliliters of bottled water (Kirkland Signature/Costco Wholesale Corp., Issaquah, Washington) was measured using a Pyrex measuring cup (CP-8507, Pyrex, Greencastle, Pennsylvania). The water and spices were mixed, and the three solutions were filtered through a two-ply paper towel (Kirkland Signature/Costco Wholesale Corporation, Issaquah, Washington).

Solution Application. Ten specimens from each colony were collected into separate plastic, cylindrical containers (YSD2532, Newspring, Mount Carmel, Pennsylvania). The plastic containers were placed on top of a white bowl to provide better visualization of the ants. Each solution was sprayed onto the ants approximately 24 inches away from the plastic container using a spray bottle (Equate, Salmiya, Kuwait). The nozzle of the spray bottle was released 180° before spraying. Only one spray from the bottle was applied to the containers. The cumin solution was applied to the colony. Plastic wrap and a rubber band were used to prevent the ants from escaping. The plastic wrap was removed when measuring ant deaths and to vent moisture from the containers. The number of dead ants was measured from each container at the following time intervals: 20 minutes, 1 hour, 3 hours, 12 hours, and 24 hours.

Results

The experiment was conducted in three different localities in Reveille Ranch Apartments in Bryan, Texas. While collecting ants a period of at least three days of non-rainy weather was allowed before setting up the peanut butter and honey traps.

After 20 minutes in each location a total number 461 ants were collected. Test colony one (TC1) yielded 66 ants. Test colony two (TC2) had 231 ants. Test colony three (TC3) captured 164 ants. The specimen collected were identified as *T. caespitum*. The collections in each location in comparison to the total number of ants is shown as percentages in Fig. 1.

After solution application, four ants were killed when treated with the water/cumin mixture (Fig. 2), six ants were killed when treated with the cinnamon/water mixture (Fig. 3), and eight ants were killed when treated with the black pepper/water mixture (Fig. 4).

Fig. 1. Percentages of *T. caespitum* collected per test colony (TC) in Reveille Ranch.

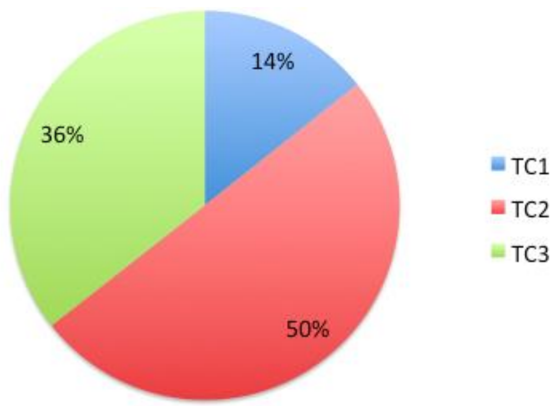


Fig. 2. Number of ants killed per hour when sprayed with cumin/water solution.

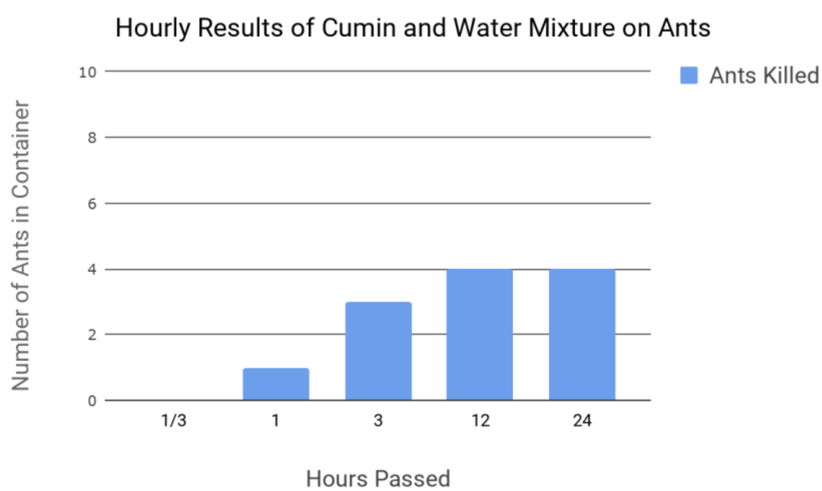


Fig. 3. Number of ants killed per hour when sprayed with cinnamon/water solution

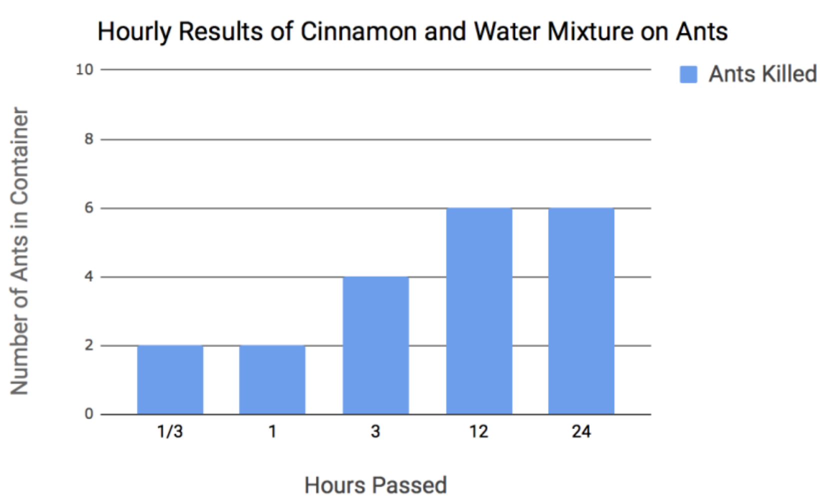
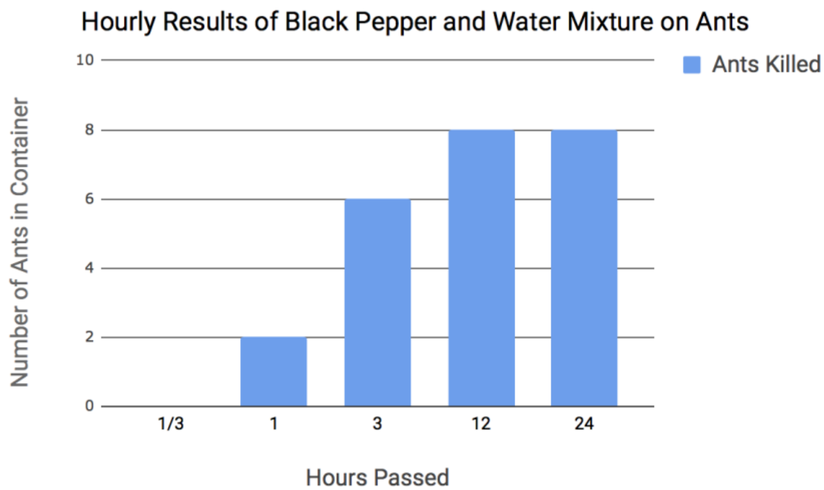


Fig. 4. Number of ants killed per hour when sprayed with black pepper/water solution.



Discussion

Along with being considered an efficient insecticide, black pepper, or *Piper nigrum*, can be used in cosmetics, perfumery, the kitchen and even in medicine. Black pepper is a pungent spice that is a result of the presence of volatile oil and the alkaloid piperine (Parthasarthy and Zachariah 2008). Piperine is what causes black pepper's 'spiciness' which is an advantage of being used as an insecticide as it repels and kills household ants (Parthasarthy and Zachariah 2008). Piperine is the most abundant and the most recognizable compound in the *P. nigrum* shoot. The alkaloidal effects on various insect species is still being studied, and has been primarily focused on disease vectors and species that are economically important, such as *Culex quinquefasciatus* and *Aedes aegypti* (Samuel et al. 2016). *T. caespitum*, the organisms mainly discussed in this paper, could arguably be an economically important species seeing as they can invade food sources and be of financial destruction to those who may not be economically stable (Vitone and Lucky 2014). Out of the three spices used in the mixtures, the black pepper was the most lethal over the 24-hour period. In comparison the black pepper and cumin did take more time to kill 20% of the test colony at one hour (Fig. 4) (Fig. 2), while the cinnamon solution had a faster effect eradicating 20% in the first 20 minutes alone (Fig. 3).

The cumin mixture resulted as the least effective household insecticide from the time intervals of 3 to 24. The test colony exposed to the cumin solution had the lowest mortality rate after a 24-hour exposure period at 40% (Fig. 2). On the other hand, cinnamon had 60% death rate (Fig. 3) and black pepper 80% (Fig. 4), making it the most effective of all. Cumin essential oil can be used as an antimicrobial against strains of bacteria such as *Staphylococcus aureus* and *Listeria monocytogenes*, has exhibited antifungal properties against some strains of penicillin. Along with these lethal properties, the vapor of distilled essential oil of cumin has a high mortality rate when fumigated with eggs of certain insects such as *Tribolium confusum* (Coleoptera: Tenebrionidae, Jacquelin du Val), a beetle, and *Ephestia kuehniella* (Lepidoptera: Pyralidae, Zeller), a moth (Parthasarthy and Zachariah 2008). Though the cumin solution was proven to not the most effective pesticide, it is still a potential cost-effective household item that can be used to reduce small numbers of *T. caespitum*.

Cinnamon is also highly accessible to the public and available in many stores. Based on the results, cinnamon was the second most effective spice tested. A very important observation made from the result was that even though cinnamon might not have killed as many ants when compared to black pepper, cinnamon did have a nearly instantaneous effect, killing the ants in a third of the time it took black pepper to begin taking effect. This is due to antioxidants, antimicrobial, and insecticidal properties of cinnamon (Rao et al. 2014). Extracted cinnamon essential oils have been used to kill three different species of mosquito larvae in a previous study. It was shown that essential oils to have great insecticidal effects against *Culex quinquefasciatus* (Diptera: Culicidae, Say) *Aedes albopictus* (Diptera: Culicidae, Skuse) and *Armigeres subalbatus* (Diptera: Culicidae, Coquillett) (Cheng 2009). Cinnamon has also proven itself to be an effective defender of fruit crops as the cinnamaldehyde in cinnamon has lethal effects against pests, like *Acanthoscelides obtectus* (Coleoptera: Chrysomelidae, Say), and has been known to be an antifeedant against flies like *Ceratitis capitata* (Diptera: Tephritidae, Wiedemann) (Parthasarthy and Zachariah 2008). The insecticidal and antifungal properties of cinnamon are caused by the aromatic and acidic compounds from the bark. The aromatic nature of these compounds with water attracts the insects by release of a strong odor and the acidic compounds kill the ants (Rao et al 2014).

There were several challenges during the experiment. For test colony one, the sample size was small, which indicates a weak test colony. Moreover, some of the ants died from being stuck to the honey, which reduced the number of viable samples for the experiment. Spice granules would also get stuck in the nozzle of the spray bottles. This could be prevented by using different bottles with a wider spray system or more thoroughly mixing the solutions.

Potential improvements to this experiment include obtaining stronger and larger test colonies form different locations. The test colonies that were used during the experiment were ten ants large and were all collected at the Reveille Ranch apartment complex in College Station, Texas. Expanding the location of the collection could improve and solidify conclusions when it comes to the effectiveness of these household insecticides on the species *T. caespitum* originating from various locations. Other test colonies could potentially be collected from other apartment complexes in College Station, Texas or from other environmentally diverse areas of Texas. The execution of the experiment could have been improved treating the test colonies in a completely flat-based container such as a beaker. The container that was used for treatment of the test colonies was a cylindrical container with a raise in the middle of the base. The raise in the base lead to pooling of the solution around the dipped edges of the container, which could have caused the specimen to drown rather than be affected by the spice solution.

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