

Evaluation of Beer Preference in American Cockroaches *Periplaneta americana* (Linnaeus) (Blattodea: Blattidae)

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Abstract: Cockroaches (Blattodea) are common worldwide pests that can have a negative effect on public health by transmitting pathogenic bacteria to humans and contributing to asthma problems. Cockroaches have developed a growing rate of behavioral resistance, and resistance to chemical insecticides, so it has become more important to use less toxic methods of population control in order to mitigate the development of resistance. One such method of control is to use beer-soaked bread as a bait for cockroach traps. Four different bait mixtures were made from the combination of bread with DI water, 25% sugar water, a non-hoppy beer, or a very hoppy beer. The number of cockroach visits to each bait was recorded and data were analyzed to determine any sort of preference the American cockroach, *Periplaneta americana* (Linnaeus) (Blattodea: Blattidae) may have for the two different beers. Overall, the cockroaches most preferred the sugar water bait, however, data suggests that there was still a significant ($p=0.022251$) difference in preference for the non-hoppy beer over the very hoppy beer. This data could potentially improve the efficacy of using beer as a cockroach bait, but further studies are required in order to support this conclusion with other species of cockroach.

Keywords: *Periplaneta americana*, cockroach bait, beer and bread, hops content

The American cockroach, *Periplaneta americana* (Linnaeus) (Blattodea: Blattidae), and the German cockroach, *Blattella germanica* (Linnaeus) (Blattodea: Ectobiidae) are two of the most common cockroaches worldwide. They are able to infest any type of building, and they have an

increasing trend of infestation worldwide (Nasirian). While cockroaches are often considered a nuisance pest and are associated with filth, prior studies have shown that cockroaches can pose as a threat to public health due to the important role cockroaches play in the transmission of pathogenic

bacteria to humans (Wahab et al.). In addition, data suggests that a cockroach infestation can directly affect the development of asthma (Nasirian).

Given their growing rate of infestations and their potential to negatively affect human health, cockroach populations need to be controlled. One effective and commonly used control method for cockroach populations are toxic gel baits (Porusia et al.). However, the continued use of toxic baits has provided for a strong and persistent selection pressure that has induced rapid evolution of behavioral resistance in multiple cockroach populations (Wada-Katsumata et al.). Also known as glucose-adverse cockroaches, behaviorally resistant cockroaches possess an adaptation in which their gustatory receptor neurons (GRNs) perceive sugar differently. In normal, non-resistant cockroaches, glucose stimulates only the sugar-GRN whereas in the resistant cockroaches, glucose stimulates both the sugar-GRN and the bitter-GRN which then suppresses the responses of the sugar-GRN making glucose seem to taste bitter. In one study, 7 out of 19 field collected German cockroach populations possessed some amount of glucose-adverse cockroaches (Wada-Katsumata et al.). The rapid emergence of glucose aversion can impede pest control efforts and affect foraging and mate-choice in adapted cockroach populations which can then further the rate of infestations (Wada-Katsumata et al.).

In addition to being behaviorally resistant, prior studies have shown that cockroaches

have become resistant to some chemical insecticides as well. One study tested the effects of malathion (a common insecticide spray) on multiple different populations of American cockroaches and found that all populations showed resistance to malathion (Tahir et al.). A similar study done in Iran tested the susceptibility of twenty different insecticides on four different cockroach species, including German and American cockroaches. This study emphasized their struggle with just the lack of susceptible strains of cockroaches being a major challenge in the assessment of data and concluded that a comprehensive national program for monitoring susceptibility of household pests to insecticides is of great concern and is highly recommended (Rahimian et al.).

Considering the growth in cockroach resistance development, chronic cockroach infestations, and the potential health impact insecticide applications can have, there is an increased necessity for the least toxic technologies and integrated pest management strategies (IPM) used to control cockroach populations in order to minimize insecticide use, increase long-term efficacy, and slow down insecticide resistance development (Wang and Bennett). In a study that compared the number of cockroach visits to either toxic gel bait or to natural food, it was found that neither field nor laboratory strains of *P. americana* were fully attracted to the gel baits when other foods were available around their harborage (Porusia et al.). This suggests that a cockroach trap using a natural food source as bait is just as attractive as a commercially sold gel bait, without the

addition of toxic chemicals. Beer soaked bread is a common non-toxic bait used in many do-it-yourself cockroach traps that can be found on the internet. Beer is an attractive bait to cockroaches because beer releases ethanol which conveys food fermentation (Karimifar et al.). In a study that evaluated the efficacy of various cockroach traps and baits, beer with bread was found to be the most attractive bait used to increase sticky trap catches, increasing trap catches by 34-fold over the unbaited control (Bennett and Wang). The study at hand aims to understand the possible preference American cockroaches might have for different types of beer in order to further the effectiveness of using beer as a simple, cheap, non-toxic bait for trapping cockroaches.

Materials and Methods

Adult Roach Colony. Fifty adult American cockroaches were delivered from www.carolina.com (item #143644) and kept in a 10-gallon glass tank with a wire mesh lid. The roaches were given about an inch of Eco Earth compressed coconut fiber expandable substrate (Zoo Med San Luis Obispo, California) for bedding and a cork log for shelter. Cockroaches were not provided with any food or water before or during the experiment, except whatever might have been in their delivery containers.

Trap Preparation. The exterior of regular mouth, 16oz glass Mason Jars (Ball Corporation Broomfield, Colorado) were sprayed with Gorilla heavy duty spray adhesive (Gorilla Glue Company

Sharonville, Ohio) and then rolled in sand obtained from a volleyball court in College Station, Texas, USA. The jars were left to dry overnight. In each sand coated jar, one tablespoon of bait liquid and approximately a cubic inch of wheat bread (Hill Country Fare HEB San-Antonio, Texas) were added. Four different types of bait liquid were used: A) DI water. B) Sugar water (25% sugar (HEB San-Antonio, Texas), 75% DI water. C) Non-hoppy beer-Budweiser (Anheuser-Busch St. Louis, Missouri). D) Very-hoppy beer-Dogfish head 90 Minute Imperial IPA (Dogfish Head Craft Brewery Milton, Delaware).

Trap Placement. For each of the 10 trials, traps were randomly assigned to one of the four corners of the cockroach enclosure. The traps were observed for fifteen minutes per trial. During each trial, the traps were checked every 5 minutes and the number of roaches in each trap were recorded. In between each trial, traps were emptied, wiped out, and refilled; careful to use the same jar for repeating bait types.

Data Analysis. Using the data recorded, an ANOVA (analysis of variance) test was done to provide the significance in the difference of bait preference. All statistical analyses were performed using Excel for Windows 10 (Microsoft Corporation Redmond, Washington).

Results

The comparison of the efficiency of the different baits showed that *P. americana* had a significant ($p=0.007866$) difference in bait preference. Overall, *P. americana* most preferred the sugar water and bread bait mixture. However, data shows that there was still a significant ($p= 0.022251$) difference in preference for the non-hoppy beer over the very hoppy beer.

In trial 1, the non-hoppy beer and the water attracted 3 cockroaches each and the sugar water attracted 2 cockroaches (Figure 1). In

trial 2, the non-hoppy beer attracted 1 cockroach and the sugar water attracted 2 cockroaches. In trial 3, the non-hoppy beer attracted 1 cockroach, and the sugar water and water attracted 2 cockroaches each. In trial 4, the sugar water attracted 1 cockroach and the water attracted 2 cockroaches. In trial 5, the non-hoppy beer and the sugar water attracted 1 cockroach each. In trial 6, the sugar water attracted 1 cockroach. In trial 7, the non-hoppy beer attracted 1 cockroach and the water attracted 2 cockroaches. In trial 8, the sugar water attracted 2 cockroaches. In trial 9, the sugar water and the water attracted 1 cockroach each. In trial 10, the sugar water attracted 1 cockroach. Throughout all of the trials, the very hoppy beer did not attract any cockroaches, while the non-hoppy beer attracted a total of 7 cockroaches, the sugar water attracted 13 cockroaches, and the water attracted 10 cockroaches (Table 1). The non-hoppy beer

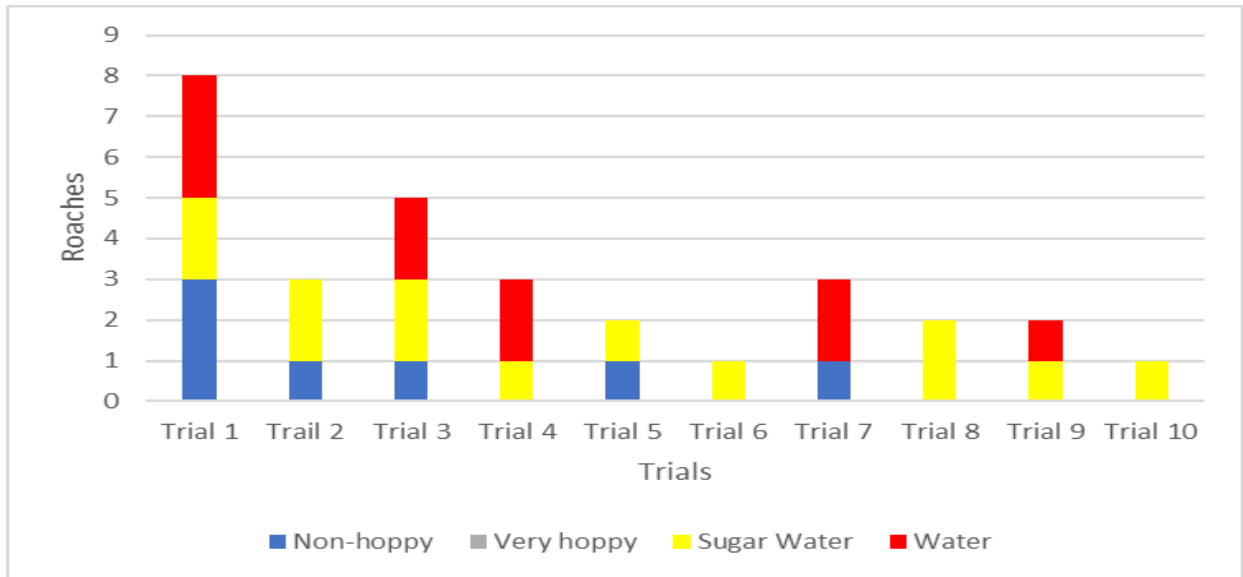


Fig. 1. Number of cockroaches in each trap per each trial.

trial 2, the non-hoppy beer attracted 1 cockroach and the sugar water attracted 2 cockroaches. In trial 3, the non-hoppy beer attracted 1 cockroach, and the sugar water and water attracted 2 cockroaches each. In trial 4, the sugar water attracted 1 cockroach and the water attracted 2 cockroaches. In trial 5, the non-hoppy beer and the sugar water

averaged 0.7 ± 0.9 cockroaches per trial, the sugar water averaged $1.3\pm .456$ cockroaches per trial, and the water averaged 1 ± 1.33 cockroaches per trial.

Table 1. The comparison of total number of cockroaches and average number of cockroaches per bait type

	Non-hoppy	Very hoppy	Sugar Water	Water
Total # of Cockroaches	7	0	13	10
Average # of Cockroaches \pm SD	0.7 ± 0.9	0	$1.3\pm .456$	1 ± 1.33

Discussion

Cockroaches are a major worldwide pest that can cause negative effects on human health (Wahab et al.). Given their increasing trend of infestations and their threat to public health, it is necessary to control cockroach populations (Porusia et al.). However, due to their increase in resistance, it is better to use low toxic methods as means to control cockroach populations (Wang and Bennett). Beer soaked bread has been proven to be an affective bait for cockroach traps (Bennett and Wang). This study aimed to identify any preference American cockroaches might have for different types of beer.

Beer types were distinguished by their “hoppy-ness” or their hop acid content. The female flowers of the hop plant are used as a preservative and as a flavoring agent in beer (Kalita et al.). The hopping strategy adopted by brewers impacts on the nature, temporal profile and intensity of bitterness perception in beer. Beers high in polyphenol and hop acid contents were perceived as having ‘harsh’ and ‘progressive’ bitterness, whilst beers that had evidently been conventionally hopped were ‘sharp’ and ‘instant’ in their bitterness. Beers containing light-stable hop products (tetrahydro-iso- α -acids) were perceived as ‘diminishing’, ‘rounded’ and ‘acidic’ in bitterness (Oladokun et al.). The beers used in this experiment were chosen for their distinctly different levels of hop acid content.

Data shows that the overall preferred bait type for *P. americana* was the sugar water

given that at 13, it had the highest total number of cockroaches. This was not the expected result according to the prior data from the sticky trap and bait test where bread soaked beer was most effective in increasing the number of cockroaches caught on the sticky traps (Bennett and Wang). This could be due to faults in the experiment such as the short trial observation time, the somewhat confined space of the enclosure, or because the cockroaches used in the experiment were not starved prior and therefore just might not be as hungry. However, data suggests that there was still a significant ($p=0.022251$) difference in preference of *P. americana* for the non-hoppy beer over the very hoppy beer.

This information is important because it shows that not all beer is equally as effective when used as a bait for cockroaches. At least in the case of American cockroaches, a less hoppy beer will be much more attractive as a bait. Future studies are necessary in order to further the knowledge of the preferences cockroaches have for different types of beer.

This experiment should be repeated with different species of cockroach including both glucose adverse and non-adverse strains of *B. germanica* to see if the preference towards non-hoppy beer is confirmed in other species. In addition to different species tests, a variation of this experiment should be run with beers of varying brewing styles in order to further narrow down the most attractive beer to cockroaches. This information has the potential to give insight on the specific diet and taste preferences of various cockroach

species, and those preferences can be used to enhance future cockroach control methods.

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