

FOOD ACCEPTANCE OF THE EASTERN CHIPMUNK (*TAMIAS STRIATUS*) IN RESPONSE TO
VARIOUS TOPICAL APPLICATIONS

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ABSTRACT – In order to establish whether or not the eastern chipmunk (*Tamias striatus*) had the ability to taste and reject different distasteful topical applications, quinine hemisulfate, chili powder, and trans-2-hexanal were added to sunflower seeds. These were offered to chipmunks twice a day at a test site and at a control site. Though no significant difference was found for any of the three when compared with a control, only seeds with high dosages of trans-2-hexanal were rejected, suggesting that chipmunks' threshold flavor recognition is high.

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KEY WORDS – Eastern chipmunk, *Tamias striatus*, sunflower seed, quinine hemisulfate, chili powder, sriracha, trans-2-hexanal.

INTRODUCTION

The eastern chipmunk, *Tamias striatus*, is a diurnal sciurid that travels and forages across a territory near its home burrow. As a central-place forager, it returns to a small area in the center of its home range often to deposit food (Lacher and Mares, 1996; Kramer and Nowell, 1980; Bowers, 1995). This activity is called “caching” and occurs at the chipmunk’s most heavily used center, called its “core area.” A core area extends approximately 15 m from the center and usually contains the chipmunk’s principal home site and refugia (Yahner, 1978). While core areas are mutually exclusive, foraging sites tend to overlap greatly (Dunford, 1970; Humphries et al. 2002). Core areas are fairly stable; in contrast, home ranges are very plastic and are adjusted based on factors such as season, food density, and mate availability (Yahner, 1978; Lacki et al., 1984; Lacher and Mares, 1996).

On average, chipmunk activity tends to be highest within a 25 m radius from the center of its home range, and daily foraging does not tend to range for more than about 80 m away (Clarke et al., 1993). Temporal differences reported by Snyder (1982) recorded peak activity from 0900 to 1300, peaking at 1100 to 1200. Forbes (1966b) recorded greatest activity on bright, warm, quiet days and Mares et al. (1976, 1982) established that increased food abundance decreased home range size, though population density was not inversely related to home range sizes.

Beechnuts appear to be the preferred food of chipmunks, and acorns second; beyond this, little is known regarding chipmunk food preferences and factors affecting preferences (Payre, 1993). Some studies have been done and found that insects are occasionally part of its diet and even more rarely small chipmunks. The olfactory ability of chipmunks was the lowest of several granivorous rodents studied by Wall et al. (2003). In contrast, as a diurnal mammal, it retains at least dichromatic vision (Yokoyama and Yokoyama, 1996). Therefore, it should be able to distinguish primary colors such as red, yellow, and blue from each other though this visual acuity is not as broad as human capabilities.

This study examines the eastern chipmunk's ability to distinguish flavors associated with artificial colors on sunflower seeds. Personal experience and notes from Klugh (1923) appeared to validate this as a possibility.

METHODS AND MATERIALS

Test Times: Two trials were run for a period of nine days: one in the morning and one in the afternoon. A wooden board with the food randomly dispersed on it would be placed at the appropriate site at the start of the trial and removed at the end of a 1 hr period. We observed the chipmunks eating during random trials to ensure chipmunks, not some other creature, were indeed eating our food.

The Sites. Our control and test sites were located about 80 m apart and designated Site 1 and Site 2, respectively (Figure 1). We did not expect any home range overlap at all because the chipmunks in this area were well fed by humans and probably had decreased home ranges in response. Both sites were located in a floor of dead leaves, in scattered small plants, about 1 m away from a tree, and about 1 m from the road.

Sunflower seeds. We mixed 25 mL of water, six drops of food coloring, and sunflower seeds together, letting the combination soak for two to eight hours. After the seeds were sufficiently colored, we drained the liquid let them dry. When we were ready to use them, we used gloves and spoons to randomly distribute them on the boards for each location. For the quinine portion, we dissolved one teaspoon of quinine hemisulfate salt with the blue sunflower seed mixture (QB) to add bitterness to the seeds. An extra coat of quinine was added to the seeds after QB dried for QBC. When testing chili powder, we used Sriracha to soak the sunflower seeds, turning them red (CR), which we compared with the plain red sunflower seeds. Finally, for the last test, we obtained trans-2-hexanal and added it to blue-colored sunflower seeds (2B) in increasing doses. The number of drops used will be indicated with a number after "2B," ie 2B6 indicates 6 drops.

RESULTS

As evident in Figures 2, 3, and 4 respectively adding quinine hemisulfate, chili powder, and trans-2-hexanal did not reveal any significant preferential consumption of the seeds. All of the seeds were eaten with and without the quinine and chili powder. A disparity between the control seeds and adding a topical chemical existed for trans-2-

hexanal, but this difference was not statistically significant (*Independent Samples t-test*; $N = 5$; $p\text{-value} = 0.355$).

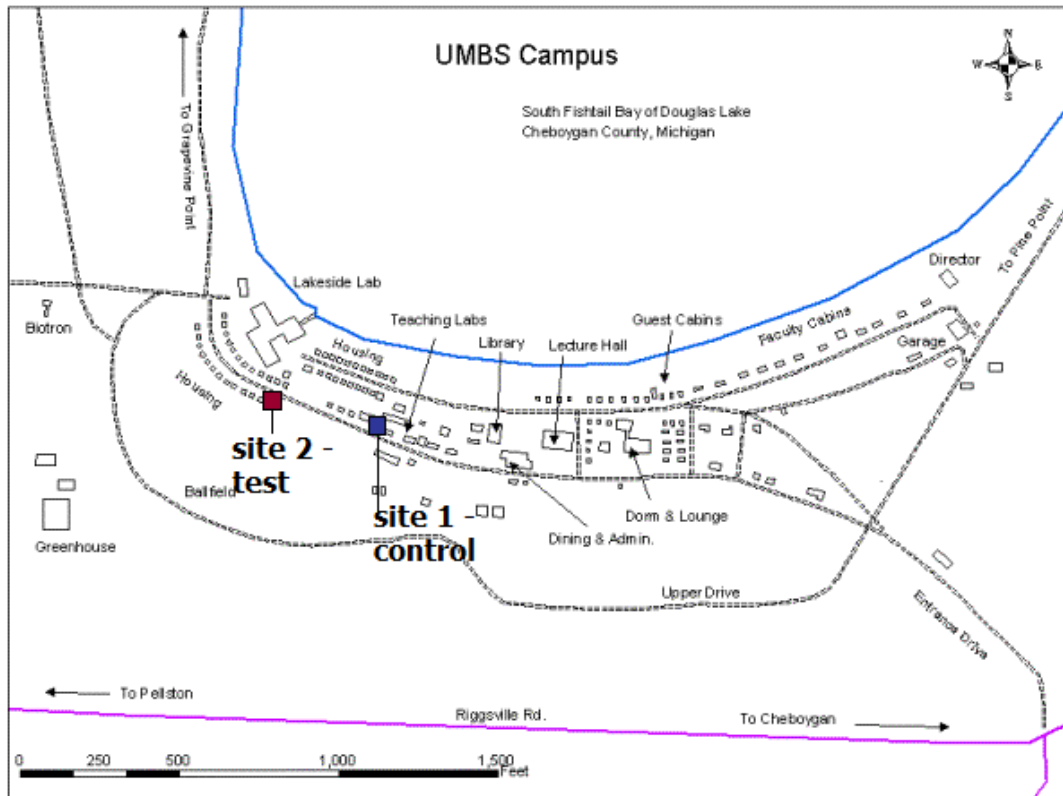


Figure 1. Map of the University of Michigan Biological Station. Test site 1 and 2 are indicated on the image. Courtesy of the UMBS website (<http://sitemaker.umich.edu/umbs/files/campus.gif>).

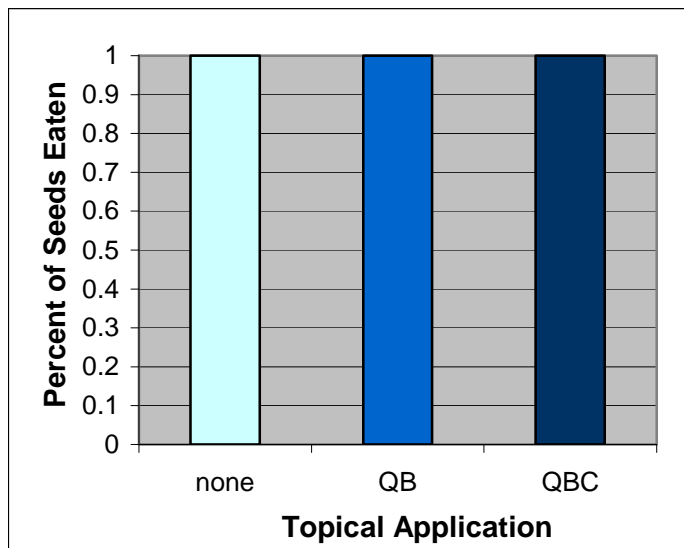


Figure 2. Difference in percent of seeds eaten in three types of topical applications – plain blue seeds (none), quinine hemisulfate (QB), and quinine with an extra coat applied afterward (QBC). $N = 8$.

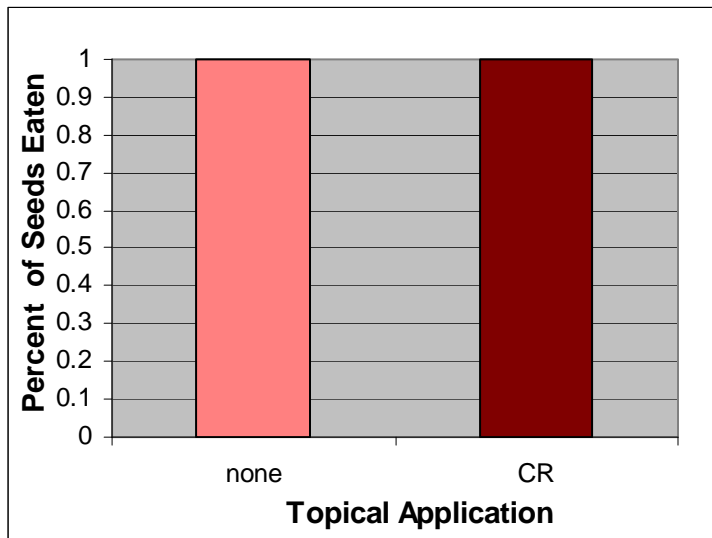


Figure 3. Difference in percent of seeds eaten in two types of topical applications: plain red seeds (none) and chili powder (CR). N = 8.

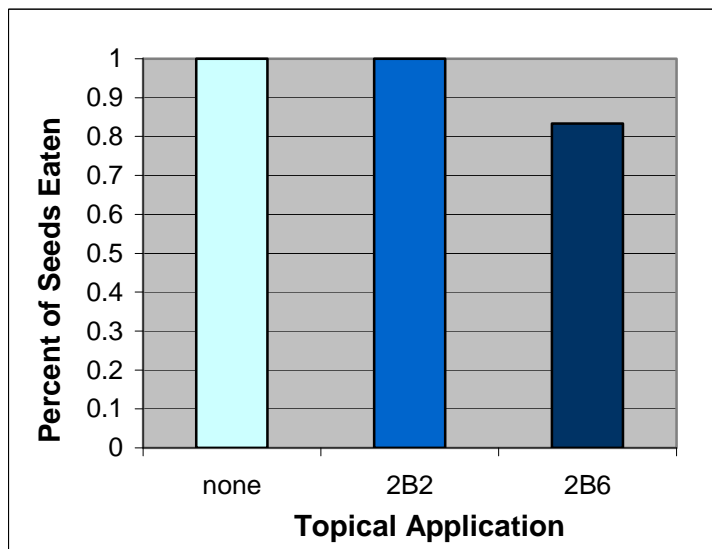


Figure 4. Difference in percent of seeds eaten in three types of topical applications – plain blue seeds (none), two drops of trans-2-hexanal (2B2), and six drops of trans-2-hexanal (2B6). N = 7.

DISCUSSION

Animals are generally able to distinguish between distasteful and palatable food, else they would waste energy on eating food that was not beneficial for them. This is reasonable considering concepts such as optimal foraging theory, as it would be costly to spend time and energy collecting food that ultimately is not as valuable to survival. Also, adaptations such as this illustrate how aposematic signals evolved as consumers

learned to associate certain hues with poison. Since chipmunks' primary diet consists of nuts and the UMBS chipmunks in particular have been exposed to a wide variety of colorful human food, it was expected that *Tamias striatus* at UMBS would have lost this concern with eating colored foods. This allowed the use of different colors on sunflower seeds to discriminate between "types" of seeds. Given that Wall et al. (2003) showed chipmunk olfactory ability was not very strong, this study chose instead to categorize "types" by associating them with gustatory differences. Since there were no differences between percentage of seeds consumed whether QB, QBC, or CR were added, it was concluded that greater disparity was required for chipmunks to make a gustatory distinction. Observation on random days confirmed that it was mostly likely chipmunks eating the seeds every day, which ruled out other animals such as black squirrels were skewing the results.

The slight difference in percentage eaten with and without 2B added showed that chipmunks might be able to recognize some tastes. Snyder (1982) found that chipmunks eat insects during certain life stages, so the recognition of 2B seemed reasonable because this was the chemical that certain insects squirt as a defense to being eaten. Even within these results however, 2B needed to be in high doses for the chipmunks to recognize, as it took at least six drops mixed with eighteen seeds for the chipmunks to begin avoiding the seeds. These observations also correspond with the initial conclusion made from adding quinine hemisulfate and chili powder: chipmunk gustatory ability appears to be fairly weak, or they have been habituated as a result of being fed at UMBS. Another possibility is that chipmunks, as central place foragers that cache their food, do not taste the food they initially bring back to their core areas. If the food is not consumed until the chipmunks enter torpor, there would be no visible, immediate effect to analyze within such a short period of time. The fact that chipmunks cache their food could be useful in determining ingredients that could be used to control them in highly infested areas. If a slow-degrading chemical that made food in its vicinity rot could be put into the chipmunks' food before they entered torpor, the chipmunks would not have enough food to survive through winter and would starve.

Variables that could not be controlled included weather, subtle differences in test sites, time constraints, and human influence on how hungry the chipmunks may have been. Lack of studies on chipmunk flavor recognition also hindered the experiment. If given more time and resources, we would have liked to test the effects of increasing dosage in a closed environment to reduce confounding variables. Being able to tag,

watch, and identify which chipmunk visited at the sites would also be beneficial to collecting accurate data in case any differences are evident among individual chipmunks. All in all, our experiment would be a good indicator of how to conduct a study dealing not only with chipmunk preference of natural foods, as many studies have done, but of chipmunk flavor recognition.

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