Alternative Honey Bee Nutrition – Beyond Sugar Syrup

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Abstract

Feeding honeybees syrup of cane-sugar or HFCS during a nectar dearth fails to provide honeybees with the nutrients found in nectar. This study tests feeding honeybees using syrup enriched with infusion of flowers from *Tilia* sp. The Linden flower was chosen for its attributes as a natural miticide and its medicinal benefits to honeybee immune health.

Twelve colonies were randomly divided in three groups: controls, cane-sugar-syrup, Linden flower infusion of cane-sugar-syrup. Honeybee health variables were measured including varroa infestations, carbohydrate consumption, and winter survival rates.

From April-October 2012, fed colonies were offered 104lbs (47.2 kg) syrup or Linden-infused-syrup /colony. The consumed amount/colony ranged between 67.25-95.5 lbs (30.5-43.3kg). GC-MS analysis of honey revealed sucrose levels between 0.16-3.91.

The highest survival rate from April-December was found to be the colonies fed the Linden-infused syrup (100% survived) while only one control colony survived (25%) during the same time period. Seventy-five percent of the sugar-syrup fed colonies were alive prior to winter but none were alive by March. Currently the only colony continuing to survive was treated with Linden infused-syrup.

There was a non-significant trend towards fewer mites in the colonies treated with linden-infused sucrose: controls 201.3 $\pm$ 280.0, sucrose syrup 157.7 $\pm$ 121.1, and linden-infused sucrose syrup 99.8 $\pm$ 99.7. Weak colonies, those with the smallest number of bees, had fewer mites ($p=0.03$). The effect of colony strength on the total mite count was not the same across treatment. More mites were observed in weak untreated (control) colonies than the treated (linden-infused or plain sucrose syrup feed) colonies ($p=0.047$).

While linden-infused sucrose syrup may have a positive impact on colony health and survivorship, a larger sample size would be required to determine if the impact is statistically significant. As expected, the number of mites in a colony is influenced by how many bees are in the colony. It is interesting that small colonies had more mites if they were untreated than if the were treated. These observations indicate the importance of supplementing colonies with sucrose syrup or otherwise ensuring sufficient forage. We expect supplementation with Linden infusion may provide beekeepers with a method to improve colony survivorship as the honey stores going into winter was less in the non-infused groups compared to the infused group.

Introduction

The general practice of feeding honeybees syrup made of refined sugar cane, beet sugar, HFCS or other artificial solutions, while highly economical in dearth periods of the year, fails to provide honeybees with the broad range of nutrients they might find in natural forage. This method of manipulating the honeybee diet is widely taught to novice beekeepers and practiced in the United States.

Michurin Biology and Pavlov Physiology have demonstrated that “feeding is a kind of mentor and the quality of the food is the factor that influences the formation and growth of the bee” (1). A diet containing significant amounts of empty calories could lead to poor health in honeybees and contribute to the appearance of various opportunistic conditions, e.g., colony collapse (or “CCD”), or worsen the impact Varroa mites and a range of other diseases that afflict colonies managed by commercial and small scale beekeepers.

The high annual death rate of honeybee colonies appears to be an indicator that our agricultural practices are not sustainable. Many stresses, including the transport of colonies long distances, the lack of adequate and diverse forage, exposure to in-hive and agricultural pesticides, are contributing our inability to sustainably manage honey bee colonies. Supplementing nectar to increase the availability of carbohydrates is a relatively easy method to counter some of the stresses experienced by bees but calories without nutrients are problematic.

Linden flowers and leaves (*Tilia cordata*) is a medicinal/nectar plant containing Farnesol, a volatile oil, which gives Linden flowers its characteristic smell. This compound is antibacterial and natural pesticide/miticide. Linden contains flavonoid glycocides, including hesperidin and quercitin, saponins, condensed tannins, mucilage, manganese salts. Lindin is also abundant in other flavonoids such as astragalin, isoquercitin, kempferitin, quercitin, tiliroside, hydroxycoumarins (2). In vitro, flavonoids have been shown to have antiviral activity (3).
Additional biological activity attributed to flavonoids include anti-inflammatory and anti-microbial activity (4, 5, 6).

Therefore, we chose to evaluate the impact of Linden-infused sucrose syrup on the health and survivorship of honey bee colonies.

Methods

Linden Hill Farm and Apiary, a ten-acre farm in Towaco, New Jersey U.S.A. has five acres of natural meadow with pollen and nectars sources including asters, *Echinacea*, bee balm, mints, viburnums, clover, dogrose, goldenrod, ironweed, yarrow, wild grape, chokeberry, red raspberry, blackberry, and bilberry bushes. Apple, cherry, maple, and catalba trees are early sources of nectar and pollen. A 60X60 field has been sown with buckwheat and seeded with annual sunflower to provide late pollen sources. As a small-scale tree farm specializing in *Tilia* species (common names include basswood, linden, lime), there are over 50 seedlings

planted on the property. The area around the farm is suburban.

The bee house has east-facing entrance and all hive entrances face south, west, and north. An enclosed bee house protects colonies from pests, e.g., bears, wind and winter freezing while allowing access to the inside of the hives year-round. To aid foragers in locating their hive, distinctive markings were attached above each hive entrance.

Twelve 1.3 kg (3 lbs) packages were purchased from a reputable apiary and installed on April 11, 2012. Deep boxes with 1 frame of drawn comb and the remaining 9 frames of beeswax coated plastic foundation were used. All colonies were provided with screened bottoms. Medium 10-frame supers were added as needed. Queens were released from queen cages after 3 days.

The health of the colonies was assessed in several ways. Samples of 50 bees collected in alcohol from each of the 12 hives were sent to the USDA Agricultural Research Service in Bethesda, Maryland to provide a baseline of Varroa, Nosema and tracheal mites. Sticky boards, an Integrative Pest Management (IPM) method, were used for a five-day period monthly on all hives to monitor Varroa mites (7). The total number of mites on each sticky board was counted by the study's technical advisor, Dr. N. Ostiguy of Penn State University. She was blind to the assignment of treatments. Each colony was inspected monthly for chalkbrood, American and European foulbrood and other diseases.

Treatments were randomly assigned to colonies and were as follows:
Group 1: Four colonies were fed a 1:1 (April-August) or 2:1 (September and October) Linden (*Tillia cordata*) infused sucrose syrup. The infused syrup was prepared using 16 Linden teabags per 3.7 l (1 gal) sucrose syrup. Group 2: Four colonies fed 1:1 (April-August) or 2:1 (September and October) sucrose syrup. Group 3: Four colonies were not provided with any supplemental feed (controls). Feeder pails (7.5 l or 2 gal) were placed directly onto the frames in colonies assigned to either group 1 or 2. Syrup was applied once in April, June, July and August, three times in May and twice in October.

On July 8-10,2012 the honey was extracted manually from 10 out of the twelve hives. Samples were submitted to an independent lab for sugar profile testing using Gas Chromatography/Mass Spectrometry (GC-MS) to check for relative sugar percentages.

Data Analysis: Data were analyzed using SAS (version 9.3).

Results

No tracheal mites were observed in the bees sampled from each colony. While subclinical levels of *Nosema* sp. were detected in each colony at the time of

installation into the hives, all but one colony was negative for *Nosema* at time of death. The decline occurred even though no colonies were treated to reduce *Nosema* infection.

By November 2012, 50% of the untreated (no sucrose syrup), 25% of sucrose syrup treated and none of the Linden-infused sucrose syrup treated colonies were dead. These differences were not statistically significant (p=0.71). Only one colony – Linden-infused sugar syrup treated – survived winter and continues to survive.

There was a non-significant trend toward fewer mites in colonies treated with Linden-infused sugar syrup as compared to the sucrose only or no syrup (control) colonies, 99.8 ±99.7, 157.6 ±121.1, 201.3 ±280 mites, respectively. In a two-way ANOVA a significant an interaction was observed on the total mite count between treatment group and colony strength (p=0.047). Weak colonies, those with the smallest number of bees, had fewer mites (p=0.03). The effect of colony strength on mite numbers was not the same across treatment groups. More mites were observed in the weak untreated (control) colonies than in the Linden-infused or sucrose only treated weak colonies.

Unsurprisingly, the amount of sucrose detect in honey is greater if the bees are fed sucrose syrup (p=0.059). It is interesting that the variation in detectable sucrose is greater when the sucrose syrup has been fed (Figure 1).

Conclusions

While linden-infused sucrose syrup did not have a significant impact on mite populations, size of colony or survivorship, but there was a trend in this direction. The sample size was insufficient to be able to detect a difference among treatment groups if a difference existed. Because of the availability of natural sources of linden and the proximity of plentiful nectar and pollen forage, differences among treatment groups may have been reduced in this study.

Current standards in the United States allow up to 8% sucrose in honey before it is considered adulterated (8). In our sucrose syrup treated colonies the quantity of sucrose detected was never above 5%. While this sucrose amount was greater than that found in colonies not provided an artificial nectar supplement, the quantity of sugar syrup provided (up to 30 kg/colony) to colonies was substantially less than the amount recommended for use by some American beekeepers, 45-136 kg/colony.

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Only one colony survived winter – a linden-infused syrup treated colony. Nearly all colonies dying overwinter contained sufficient quantities of honey to be able to conclude starvation was not the primary cause of death. The total number of mites per colony, a typical predictor of colony death, could not explain the observed losses.

Further study of the impact of sucrose syrup infused with natural plant products

seems to be warranted. Environmental conditions that increase the potential differences in supplemental nectar nutrients along with large numbers of colonies in each treatment group may provide clearer information on the role of micronutrients in colony health and survivorship.

References

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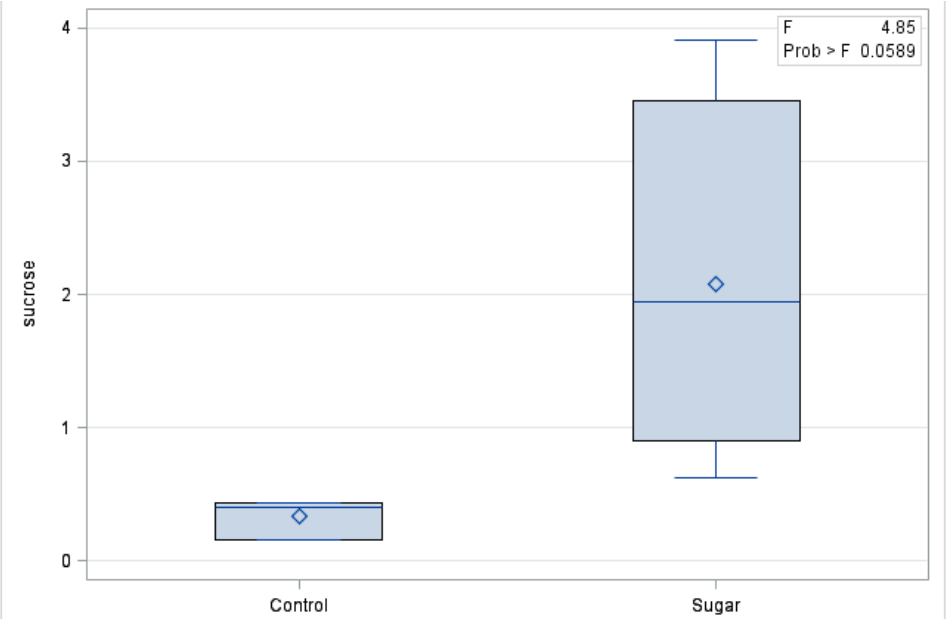

Figure 1: Sucrose detection in honey – Colonies provided sucrose syrup had significantly more sucrose in their honey than colonies not provided an artificial nectar supplement (p=0.059).