You Are What You Eat: Food-Drug Interaction in Honey Bees (*Apis mellifera*)

Allison Kelley,[1] Liao Ling-Hsiu,[2] and May Berenbaum[2]

Parkland College, Champaign, Illinois[1] Department of Entomology, College of Integrated Biology, University of Illinois at Urbana-Champaign[2]

PRECS Phenotypic Plasticity Research Experience for Community College Students

Introduction and background

- The honey bee (*Apis mellifera*) metabolizes many phytochemicals in nectar and pollen by cytochrome P450 detoxification enzymes (P450s). [1] Quercetin and *p*-coumaric acid are two common phytochemicals in bee food and both are known to upregulate P450 detoxification genes.
- P450 enzymes are also responsible for detoxification of many pesticides.
- This research examined how quercetin and *p*-coumaric acid in combination with the pesticides propiconazole and chlorantraniliprole may affect honey bee survival.
- Propiconazole is a common fungicide that is used during blooming season in almond orchards, while bees are pollinating the flowers.
- Chlorantraniliprole is an insecticide that is usually applied in a tank mix with propiconazole in almond orchards.
- Our results will help to determine how phytochemicals in food affect toxicity of pesticides to bees that are managed pollinators in agroecosystems. Findings may be used to approach the problem of declining bee health across the country.

Methods and Materials

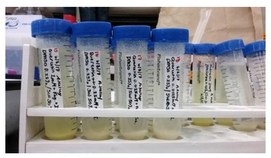
Bees

- Took brood frames from hives and kept frames in incubator (34ºC and 50%RH) for collecting one-day old bees.

Cages

- Constructed observation cages with different diets for survival testing.
- 32 oz. observation cup containing 25 bees used for the tests.
- Each cage received one tested diet.
- Fresh sugar water and water feeders supplied daily.

32oz. Observation cup containing 25 bees. Photo taken 6/17



Fed Food and Drug

- Phytochemicals quercetin and p-coumaric acid were used in combination with pesticides chlorantraniliprole and propiconazole. They were used because they induce transcription of a P450 gene subfamily (CYP6AS) responsible for xenobiotic metabolism.
- **18 diets were tested:**
  - 2 phytochemicals in four concentrations:

    Quercetin and p-Coumaric acid; 4 concentrations based on levels in nectar and pollen.
  - 1 pesticide combination

    90 ppm propiconazole plus 40 ppm chlorantraniliprole
  - 50% sugar water, 0.25% DMSO and 1 casein : 12 carbohydrate was the basic diet fed to all bees tested.

Replication

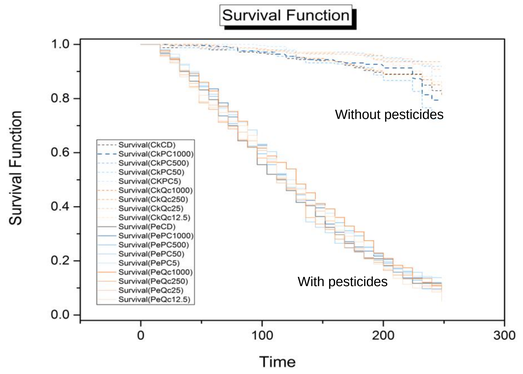
- 3-4 replicates were done per hive. Three hives were tested. In this research, total 4500 bees in 10 replicates were tested.

Observed survival

- Bee mortality was recorded to determine survival rate every 8hrs.

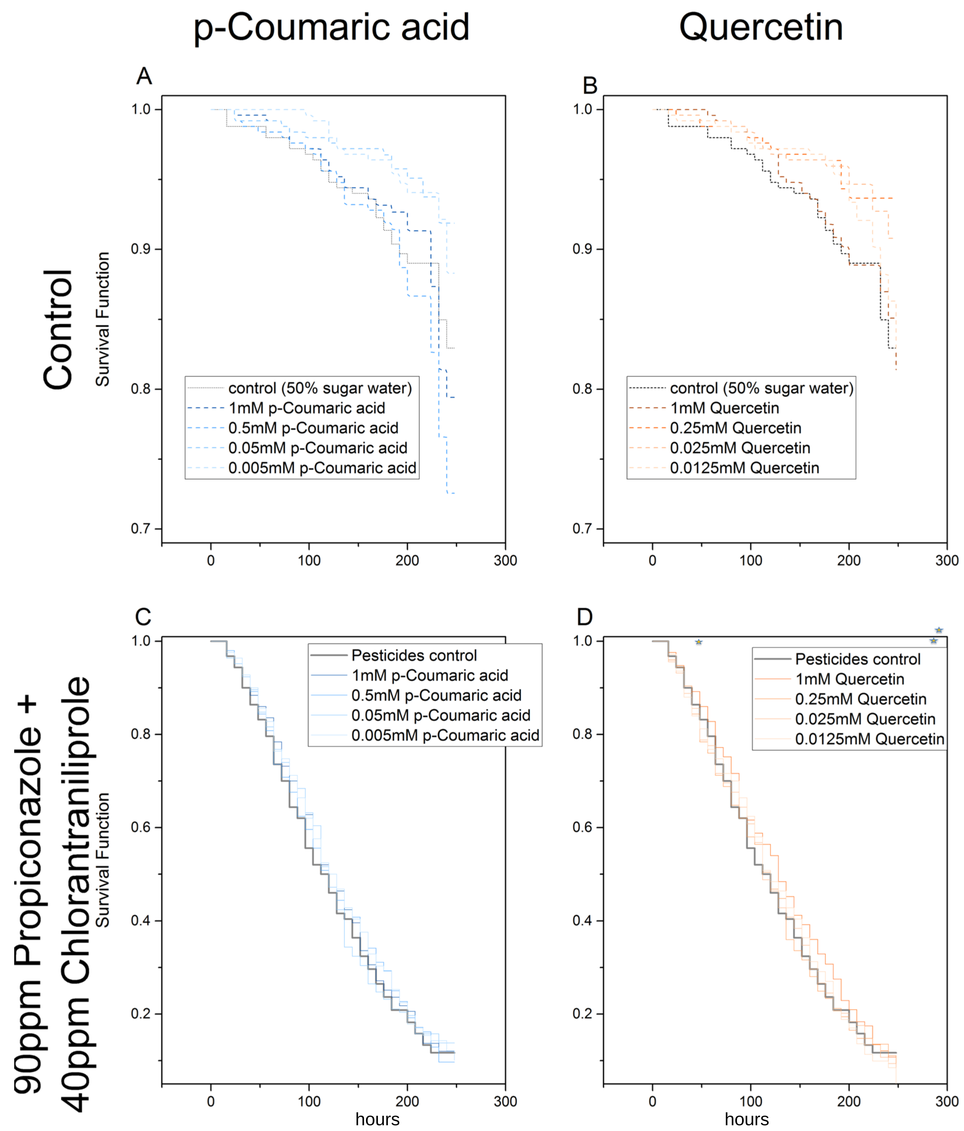
Results

- Consumption of pesticides reduced bee lifespan significantly with or without phytochemicals present.
- Quercetin (orange line) and *p*-coumaric acid (blue line) alone increased bee lifespan in pesticide-free diets at some but not all concentrations tested (Fig A and B).



Bees without pesticide food survived longer than bees with pesticide food.

Key
Ck – Control
CD – Sugar water
Pe – Pesticide combination of 90ppm propiconazole and 40ppm chlorantraniliprole
PC – p-coumaric acid (5-1000mM concentration)
Qc – quercetin (12.5-1000mM concentration)



Conclusions

- As expected, the combination of fungicide and insecticide routinely used in almond orchards for pest management lower honey bee survival rate significantly. **No synergistic effects were observed between the tested chemicals (Fig C and D).**
- Consuming either **phytochemical in the absence of pesticides can prolong longevity** at certain concentrations.

Future Work

- Additional studies are needed to determine the range of pesticide concentrations that affect bee health.
- At lower concentrations, with lower pesticide-induced mortality, synergistic interactions with phytochemicals may be detectable.

References

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