Impact of Dietary Phytochemicals on Metabolism and Detoxification of Pesticides in Honey Bees

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PROJECT SUMMARY

Objectives for current year:

1. Determine how fungicides used in almond production influence toxicity of dietary flavonoids by using adult rearing assays with quercetin and other phytochemicals in the presence and absence of pesticides, measuring survival, longevity, ATP generation and flight capacity.
2. Determine how ingestion of the phenolic acid p-coumaric acid (PCA), which upregulates cytochrome P450 gene expression and enhances detoxification, influences pesticide toxicity, using LC_{50} assays of pesticides on diets with and without PCA. We will also conduct a series of experiments to test the ability of PCA to influence pesticide detoxification capacity by assessing survival and longevity in the presence of pesticides.
3. Use *in silico* high-throughput screening of diverse pesticides and phytochemicals to develop a predictive algorithm for *a priori* prediction of risks associated with application during bloom.

Background, Results, Discussion

Effects of dietary phytochemicals on longevity in the presence and absence of pesticides. We conducted longevity assays to quantify the impacts of quercetin and PCA, alone and in combination with pyrethroids and a dietary source of protein, on worker longevity. Both phytochemicals enhanced longevity of workers, a finding that reinforces the importance of natural phytochemicals in the honey bee diet. Moreover, dietary quercetin ameliorates toxicity of two pyrethroids, β-cyfluthrin and bifenthrin, when consumed together

Effects of a dietary phytochemical on fungicide suppression of flight performance in honey bees. Boscalid is a fungicide, frequently found as a hive contaminant, that interferes with fungal energy production via inhibiting succinate dehydrogenase in the mitochondrial complex II. The effects of dietary quercetin, with and without boscalid, on levels of ATP in flight muscles of foragers and on forager flight performance were investigated. ATP levels in flight muscles of quercetin-treated foragers were higher than in foragers from a paired-control colony (37.46 ± 22.89 vs 10.29 ± 9.75 pmol/mg protein, respectively), as was the frequency of wing-flapping (exercise intensity) (183.27 ± 2.93 Hz vs 171.65 ± 2.48 Hz). This finding confirms that consuming quercetin increases energy production per unit time and potentially facilitates faster flight. In contrast, foragers consuming boscalid alone exhibited the lowest frequency of wing-flapping compared with paired hives treated with both boscalid and quercetin and a solvent-treated control hive (189.34 ± 2.36 Hz vs 201.31 ± 1.40 Hz vs 195.95 ± 1.82 Hz;). Thus, consuming quercetin can eliminate the adverse effects of boscalid on flight performance, a finding that reinforces the importance of natural phytochemicals in the diet.

Effects of quercetin on pesticide toxicity
We tested one neonicotinoid (imidacloprid) and two pyrethroids (β-cyfluthrin and bifenthrin) to examine effects of quercetin on forager detoxification capacity. Quercetin enhanced tolerance to the two pyrethroids but in a preliminary trial tolerance to imidacloprid at 500 ppb was not enhanced. To identify sublethal effects that may not be detectable in a survivorship assay, a flight treadmill test was designed to examine interactions between quercetin and pesticides in flying foragers. Foragers consuming quercetin together with pesticides increased the number of flight bouts, tolerated a higher accumulated pesticide dose and exhibited delayed onset of paralysis relative to foragers consuming pyrethroids alone. In sum, quercetin enhances forager tolerance of pyrethroids. This finding also reinforces the importance of phytochemicals in the diet of managed honey bees.

For More Details, Visit

- Poster location 119, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2017) at Almonds.com/ResearchDatabase
- Related Projects: 16-Poll16-J. Johnson/Pettis; 16-POLL17-R. Johnson16-POLL19-Cox-Foster