



Escuela de Ciencias e Ingeniería



Optimized nutrition for managed bees

A scalable solution to pesticide exposure

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IP available

Background



Hunger is a major global problem. More than 800 million people (twice the population of South America) is undernourished. Increasing crop yields has been a cornerstone to fight food insecurity.



High yields depend on pest free healthy crops and effective pollination



Agrochemicals are used for enhancing crop yield and controlling pests.



Pollinators increase fruit quantity and quality.

Yet, pesticides produce lethal and multifactorial sublethal effects.

Can we protect managed pollinators while relying on a rational use of pesticides?

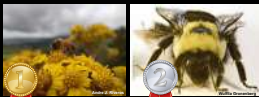
Technology aims

To offer a **nature based** solution for protection of managed pollinators against sublethal realistic field levels of insecticides with different mechanisms of action.

Species evaluated

Honey bees

Bumble bees



Major world managed pollinators

Metabolites administered

Rutin, Quercetin, p-coumaric acid, kaempferol.

Insecticides tested

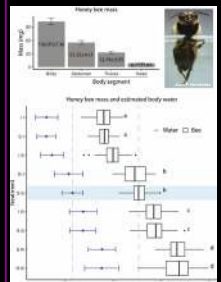
Imidacloprid, Deltamethrin, Fipronil.

Proxies evaluated

Learning, memory, decision speed, sucrose sensitivity, motor control, sting response, cellular immune response, humoral immune response, resilience to parasites, thermic resilience, osmotic equilibrium, ionic equilibrium, hive health, mortality.

Examples

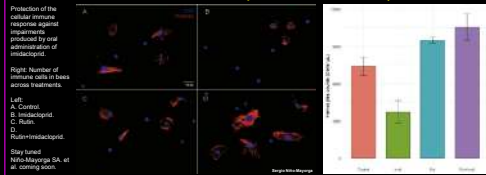
Water balance protection and recovery in Africanized honey bees



Imidacloprid protected the water balance of bees intoxicated with the neurotoxic insecticide (and co-intoxicated or prophylactically administered with the botanicals). Top: Protection of water balance (body weight). Bottom: Water content (mean±SD) and total body weight (body weight of bees exposed to different treatments). The order of letters (p < 0.05) indicates the significance of differences among groups.

Slavov, Hernández et al. coming soon. See also: Hernández et al. 2020. *Front. Physiol.* 11:595951. Hernández et al. 2022. *Int. J. Org. Biol.* 7(1): 040118

Protected cellular immune response in Africanized honey bees



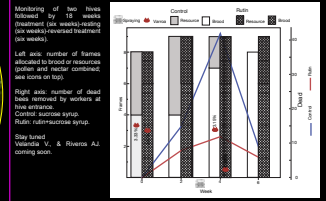
Protection of the cellular immune response against parasitism produced by oral administration of imidacloprid.

Right: Number of bees with CIR across treatments.

Left: A. Control; B. Imidacloprid; C. Fipronil; D. Deltamethrin.

Slavov, Niño-Mayorga SA, et al. coming soon.

Monitoring of colony health, Varroa presence and mortality



Monitoring of bee hives followed by 18 weeks (treatment six weeks), testing the weekly-renewed treatment (six weeks).

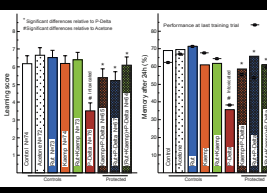
Left axis: number of bees affected by Varroa (broken and nectar combined, see notes on top).

Right axis: number of dead bees removed by workers at hive entrance.

Control: sucrose syrup; Ruto: rotenone syrup.

Slavov, Hernández V, & Riveros AJ. coming soon.

Cognitive protection in Africanized honey bees



Significant differences relative to P-values.

*Indicates significant differences.

See: Riveros AJ, & Gonzalez W. (2022). *J. Exp. Biol.* 225:17.

See also: Niño-Mayorga and Slavov, García LM, et al. 2024. *PLoS One* 19(1): e0244338.

Slavov, Hernández et al. 2022. *J. Exp. Biol.* 235:4338.

Cognitive protection of bumble bees



Cognitive protection of bumble bees (B. impatiens) against parasitism produced by intoxication with fipronil and imidacloprid.

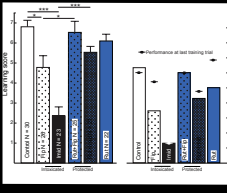
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See also: Niño-Mayorga and Slavov, García LM, et al. 2024. *PLoS One* 19(1): e0244338.

Slavov, Hernández et al. 2022. *J. Exp. Biol.* 235:4338.

Cognitive protection in North American bumble bees



Cognitive protection of North American bumble bees (B. impatiens) against parasitism produced by intoxication with fipronil and imidacloprid.

*Indicates significant differences.

See: Riveros AJ, & Gonzalez W. (2022). *J. Exp. Biol.* 225:17.

See also: Niño-Mayorga and Slavov, García LM, et al. 2024. *PLoS One* 19(1): e0244338.

Slavov, Hernández et al. 2022. *J. Exp. Biol.* 235:4338.

Overview of technology: A liquid composition based on secondary metabolites from plants (primarily flavonoids). The administration enhances resilience against insecticides as early as one day following administration.



Easy administration in syrup or pollen patty

Natural composition

Resilience against low temperatures

Supports coexistence of Agriculture & Apiculture

Enhanced immune response

Enhanced resilience against parasites

Cognitive and motor protection

Supports water and ionic balance

We are a research lab based in Bogotá (Colombia). In our country (and probably in yours too), the sociological conflict between agriculture and beekeeping is on the rise. We strive to ameliorate this conflict through education (Highschool-Doctoral), outreach (beekeepers, communities, corporations) and research (from bioinformatics to field tests), ultimately supporting conservation and food security.

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BACKGROUND: The decline of managed and wild bee populations is a global concern due to their critical pollination services. Among the causes, insecticides play a major role, with both lethal and sublethal effects. Sublethal impacts are particularly critical because of the subtle impairment of individuals, later translated into the deterioration and collapse of entire colonies.

Problem: Addressing the effects on insect pollinators, multiple countries have banned and restricted major neuroactive insecticides. However, legislation alone is insufficient, it is slow, temporary and local. Worse, it may drive the insecticide market and encourage the use of alternative products prone to evolution of resistance by pests. Hence, ensuring food security amid pollinator decline and potential pest outbreaks requires urgent, multilevel strategies. This presentation summarizes key findings on how targeted nutrition can protect managed bees from pesticide exposure.

METHODOLOGY: Nutrition is a key factor in bee health, and specific nutrients have been studied for their potential to enhance resilience against insecticides and environmental stressors. Over the past eight years, we have tested plant-based metabolite compositions designed to protect cognitive, motor, and immune functions in managed bees. These formulations have been evaluated against insecticides with different mechanisms of action, targeting a broad spectrum of protection.

Results and CONCLUSIONS: Our research demonstrates impairments in learning, memory, motor control, temperature regulation, sensory sensitivity, and immune function caused by the neonicotinoid imidacloprid, the pyrethroid deltamethrin, and the phenylpyrazole fipronil. Our compositions provided protection ranging from 40% to 100%, leading to the development of a specific formulation that offers prophylactic protection when administered via pollen patties or syrup. These findings support the idea that managed bees can be shielded from realistic pesticide exposure through targeted plant-based nutrition. This research opens avenues for precision nutrition approaches to improve pollinator health.

Practical implications for beekeepers and stakeholders: Our compositions: 1. Are easily administered to managed bees via pollen patties or sucrose syrups, 2. Contain specific doses of plant-derived molecules, eliminating contamination concerns. 3. Are protected by intellectual property rights (patents and PCT), 4. Are available for entrepreneurial beekeepers and stakeholders interested in technology transfer and product development.