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PP-392 [Bee Biology]

Honey Bee Vitality, LLC

APIX Biosciences™

Washington State University

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A nutritionally complete Pollen Replacing Feed protects honeybee colonies during stressful commercial pollination — requirement for isofucosterol

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A steady supply of nutritionally adequate pollen from diverse flower sources is crucial for honeybee colonies. However, climate instability, large-scale agriculture, and the loss of flower-rich landscapes have made this supply increasingly scarce and unpredictable, threatening both apiculture and sustainable crop pollination.

We developed a nutritionally complete Pollen Replacing Feed that supports continuous brood production from May to October (more than 108 days) in honeybee colonies in tented enclosures, without access to pollen and nectar. This represents more than six cycles of brood production and more than two full replacements of all worker bees in the colony.

The complete Pollen Replacing Feed has a Feed Conversion Ratio that is c. 30% better than pollen and is in line with that of commercial shrimp and chicken livestock feed (1.8 kg diet required to produce 1 kg of honeybees). Colonies fed a (third party) commercial diet severely declined in brood production after 36 days and died out.

Honeybees cannot synthesize or interconvert sterols and source them from pollen. Six sterols make up 90% of the total sterols in honeybees. Prior to this research, it was not known whether individual sterols are functionally interchangeable or are essential nutrients which cannot be fully interchanged.

Omitting isofucosterol, the third most abundant sterol in honeybees, from this complete Pollen Replacing Feed containing all six major honeybee sterols in concentrations and ratios similar to pollen, causes significant reductions in brood production and neuromuscular dysfunction in adults and identifies isofucosterol as a critical micronutrient for honeybees. In contrast, omitting 24-methylene cholesterol, the most abundant honeybee sterol, does not significantly affect brood production and, surprisingly, bees with no 24-methylene cholesterol in their tissues are viable.

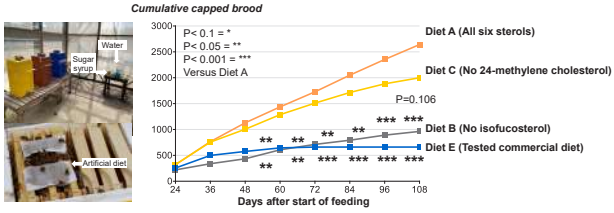
In a season-long experiment investigating the commercial pollination of blueberry and sunflower fields, a treatment group fed two versions of the diet overcame the detrimental effects of nutritional stress, unlike colonies that did not receive supplemental feed (“unfed” group) and colonies that received a third-party commercial pollen protein supplement.

Finally, extensive field trials, both in number of colonies and in geographic diversity, were conducted over two consecutive winter seasons in the U.S. to assess the impact of the new diet on survival and colony strength for almond pollination. The results show that colonies fed the new diet had 48–63% lower mortality over two years when compared to best-in class commercial pollen protein supplement used by beekeepers.

This research shows that:
- It is possible to make a nutritionally complete Pollen Replacing Feed for honeybees, with a Feed Conversion Ratio that is in-line with other livestock and c. 30% more efficient than pollen.
- Isofucosterol is a newly identified essential micronutrient for honeybees.
- Supplementary feeding with a nutritionally balanced Pollen Replacing Feed can address the root causes of honeybees' growing nutritional deficiencies, supporting their health and their vital pollination services.

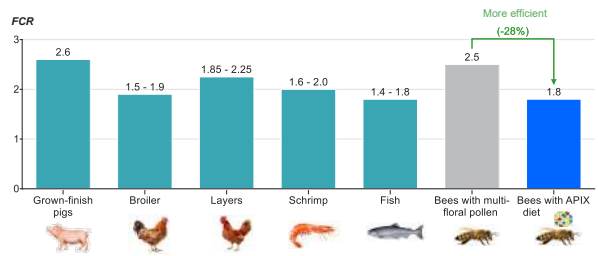
Deep nutrition research identifies isofucosterol as an essential micronutrient for honeybees in a nutritionally complete Pollen Replacing Feed

A recent study published in the Proceedings of the Royal Society B: Biological Sciences, April 2025: https://doi.org/10.1098/rspb.2024.3078



- 96 new equal colonies were kept in tents and fed water, sugar syrup and a diet from May to October measuring capped brood, consumption, and bee quality every 12 days.
- Colonies fed a diet from which isofucosterol was omitted but still included the five other main sterols, significantly reduced brood production and caused neuromuscular dysfunction in adult bees.
- In contrast, colonies fed the complete Pollen Relacing Feed containing all six main sterols found in bees maintained continuous brood production over six brood cycles (May to September), compared to only just over two cycles with a standard commercial diet.

This new Pollen Replacing Feed delivers a Feed Conversion Ratio that is better than pollen, in-line with other livestock industries



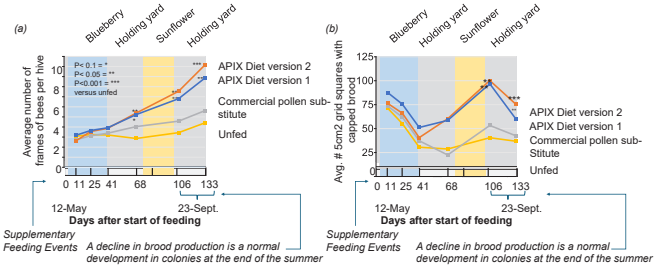
- The Feed Conversion Ratio is defined as the number of kg of feed required to make 1 kg of livestock.
- The lower the Feed Conversion Ratio, the more efficient the feed is converted into livestock. This is a key management tool in livestock nutrition management.
- The results of the tent study show that the newly developed complete Pollen Replacing Feed for honeybees has a Feed Conversion Ratio that is c.30% better than pollen.

Extensive field validation in commercial beekeeping conditions shows APIX Biosciences' new pollen-replacing feed is a step change versus existing honeybee nutrition products and a valuable tool for beekeepers

Colonies fed the new diet overcome nutritional stress in commercial pollination of blueberry and sunflower

A recent study published in the Proceedings of the Royal Society B: Biological Sciences, April 2025: https://doi.org/10.1098/rspb.2024.3078

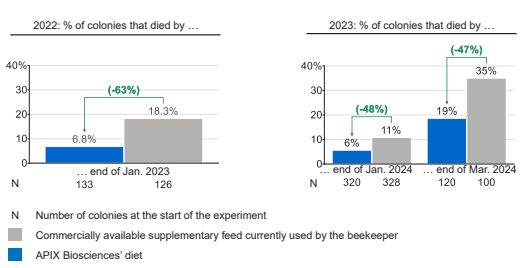
- In a field trial in the U.S. diets were fed to colonies serially pollinating two crops known to present nutritional challenges for honeybees, namely blueberry and sunflower. The colonies were all established from new packages, sent to blueberry pollination, followed by a period in a holding yard and subsequently moved into sunflowers.
- The 64 colonies were split into four groups: APIX Biosciences' diet version 1 and diet version 2, a pollen protein supplement currently available on the market, and the last group remained unfed.
- Colonies supplemented with the diets developed by APIX Biosciences consistently and substantially outperformed those given current commercial pollen protein supplement and those receiving no supplemental feed. The commercial pollen protein supplement had no beneficial effect.
- This can ensure stronger colonies going into winter and higher pollination income for beekeepers.



Colonies fed the new diet in commercial beekeeping operations have lower winter mortality and are stronger in early spring

With 259 colonies in five locations in the fall of 2022 and 648 colonies across nine California locations in the fall of 2023, managed by professional beekeeping operations:

- Colonies were split into two groups: one fed the APIX Biosciences diet, the other fed the commercial protein supplement currently used by each respective beekeeper.
- Colonies fed the APIX Biosciences diet had on average 47–63% lower winter mortality.
- This directly improves the percentage of colonies ready for early spring pollination (e.g. almonds), the resulting pollination income for beekeepers, and the number of splits that can be made in spring.



PP-392 [Bee Biology]

A nutritionally complete pollen-replacing diet protects honey bee colonies during stressful commercial pollination - Depletion of isofucosterol and 24-methylene cholesterol from this diet identifies isofucosterol as an essential micronutrient

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A steady supply of nutritionally adequate pollen from diverse flower sources is crucial for honey bee colonies. However, climate instability, large-scale agriculture, and the loss of flower-rich landscapes have made this supply increasingly scarce and unpredictable, threatening both apiculture and sustainable crop pollination.

We developed a nutritionally complete pollen-replacing diet that supports continuous brood production from May to October in honey bee colonies in tented enclosures, fed exclusively on this diet (no access to pollen and nectar). This represents more than six cycles of brood production and more than 2 full replacements of all worker bees in the colony. The diet has a Feed Conversion Ratio that is 30% better than pollen and similar to that of commercial shrimp and chicken livestock feed (1.8 kg diet/kg honey bee produced). Colonies fed a (third party) commercial diet severely declined in brood production after 36 days and died out.

Honey bees cannot synthesize or interconvert sterols and source them from pollen. Six sterols make up 90% of the total sterols in honey bees. To date it is not known whether individual sterols are functionally interchangeable or are essential nutrients. Omitting isofucosterol, the third most abundant sterol in honey bees, from a complete diet containing all six major honey bee sterols in concentrations and ratios similar to pollen, causes significant reductions in brood production and neuromuscular dysfunction in adults and identifies isofucosterol as a critical micronutrient for honeybees. In contrast, omitting 24-methylene cholesterol, the most abundant honey bee sterol, does not significantly affect brood production and, surprisingly, bees with no 24-methylene cholesterol in their tissues are viable.

In a season-long experiment in the commercial pollination of blueberry and sunflower fields (two crops that are nutritionally deficient for honey bees) and intermittent storage in bee-yards, a treatment group fed a nutritionally “Complete Diet” overcame the detrimental effects of the season-long nutritional stress, unlike colonies in “No Diet” and “Commercial Diet” groups. This field study suggests that feeding a complete, pollen-replacing diet to nutritionally stressed colonies can address the root causes of honey bees’ growing nutritional deficiencies, supporting their health and their vital pollination services.