

Honey Bee Nutrition Basics

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Honey bees are well known for their production of honey, but the importance of nutrition on their health and survival is a growing field. A well-nourished bee from the start of its larval development has a higher likelihood of withstanding other stressors and having an extended lifespan. However, honey bee nutrition is complex and dynamic due to changing needs with development and variation in the environmental supply. Beekeepers are keenly aware of the importance of nutrition in honey bees, as nutritional conditions shape caste determination in females (workers versus queens), and an optimal balance of nutrients is essential for a honey bee colony to thrive.

Nutrients are categorized as macronutrients and micronutrients, with macronutrients needed in large quantities and micronutrients required in smaller amounts. Both are vital for the development and health of individual bees and the colony, which is often referred to as a superorganism. Macronutrients include carbohydrates, proteins and lipids, while micronutrients include vitamins, minerals, phytosterols and phytochemicals. Floral resources supply them, but during periods of dearth, when the availability of floral nectar and pollen is limited, beekeepers can manage needs with supplemental feeding or strategic plantings.

MACRONUTRIENTS

Carbohydrates

Carbohydrates in the nectar of flowers are the primary energy source for honey bees; however, bees may also collect honeydew secretions from sap-feeding insects. Nectar is collected by foraging worker bees (female) and stored in the crop or “honey stomach” until they return to the colony and unload it to a receiver bee.

A colony of 50,000 bees needs approximately 700 pounds of sugar per year. Surplus honey is often taken from colonies by beekeepers during the summer but anticipating the needs of a colony over the fall and winter has been harder to predict with changing weather and climate patterns.

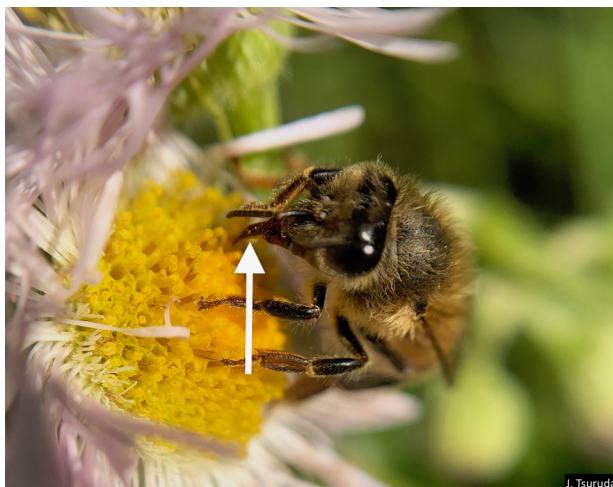


Figure 1. A worker honey bee forages for nectar from an aster. The white arrow points to her proboscis, the straw-like mouthpart that is used to bring liquid into the mouth.



Figure 2. When a nectar forager returns to her colony, she unloads the collected nectar to a receiver bee, who then finds a cell to store and process the nectar into honey. Honey is stored in cells for feeding the colony during times of the year when floral resources are lacking.



Figure 3. Carbohydrates are also crucial for the production of wax (via glands on the underside of the abdomen), which is used to build the honeycomb.

Lipids

Lipids, specifically fatty acids and ratios of proteins to lipids, have been receiving more attention recently. Lab research on bumble bees has revealed higher scores of health and survival when individuals were fed specific ratios of proteins to lipids, and field research has shown bumble bees optimally foraging on flowers with ratios similar to those in the lab study. So far, research on honey bees has not shown similar results of nurse bees preferring the most nutritious pollens; however, more research is needed to better understand how honey bees forage for and utilize the nutrients available across the landscape and seasons.

MICRONUTRIENTS

Phytosterols

Sterols are important nutrients for insects, as they play a critical role in molting. When fed to caged honey bees, phytosterol 24-methylenecholesterol, which is derived from plants, was shown to increase survival and brood production compared to those fed other phytosterols.

Phytochemicals

Phytochemicals are other types of nutrients produced by plants. Phenolic acids, flavonols, alkaloids and terpenoids are commonly found in plant nectars, and p-coumaric acid has been shown to up-regulate genes with detoxification properties. There is high variation in type and concentration of phytochemicals across floral resources. The concentration of phytochemicals can be an important factor, with some showing a positive effect at one dose and a negative effect at a different dose.

Vitamins and minerals

These are also important micronutrients for honey bees. Vitamins and minerals are present naturally in pollen but may also be included in supplements.

Protein

Pollen, also from flowers, is the main source of protein for honey bees; however, the protein content can vary from 2.5-61 percent. Ten essential amino acids have been identified for honey bees, which must be acquired through their diet. Approximately 125 pounds of pollen is needed annually for a colony of 20,000 bees; however, this varies depending on the protein content and amino acid profiles of commonly collected pollens.

Ample availability of high-quality pollen has been shown to have several positive effects such as lowered susceptibility to gut parasites, lower pathogen levels, increased overwintering success, higher measurements of immunity and increased quality of semen. Such a diet results in bees more resilient to stressors such as pesticides, stress and disease.



Figure 4. A foraging honey bee returns to the colony with pollen on her hindleg. She will unload the pollen into a cell where it will be packed down and processed by other worker bees. A variety of pollen colors reflect foraging efforts on multiple plant species.



Figure 5. Providing adequate space is vital to the growth and efficiency of a colony. As shown here, pollen is being stored in an area of brood due to a lack of space for stored pollen.

SUPPLEMENTAL FEEDING AND CONSIDERATIONS

The abundance and/or quality of floral resources varies across seasons and landscapes, so beekeepers may decide to provide additional nutrition to their colonies. Floral resource dearths typically determine when to feed the colony additional protein or carbohydrates. Nectar dearths are especially predictable in the late summer and fall, and during inclement weather. Carbohydrates are typically fed as liquid syrup in the early spring (1 part sugar to 1 part water), and as solid sugar or fondant during the winter. Pollen supplements and substitutes, commonly made of natural pollen commonly and/or whey or soy, are typically provided to boost colony strength by enhancing brood production. However, some studies have reported that colonies perform better when they are provided real pollen as opposed to a pollen supplement. Beekeepers should be cautious when feeding in the early spring as colonies may produce more brood than they can properly incubate during cold weather spells.

Another way to provide supplemental feed to honey bees is by providing additional foraging resources through plantings. This is especially helpful in cropping systems where large acreage can be planted. While many planting lists are available for different types of landscapes, there is little information about the quality of the nutrients provided. Instead, lists are commonly developed based on attraction and visitation. Forthcoming research will help improve the ability to choose plantings based on the nutritional composition (e.g., protein, amino acid profiles, phytosterols and phytochemicals) and the attractiveness to different types of pollinators. Until then, providing more abundant, diverse and high-density plantings of floral resources across different landscapes will help support diverse pollinator populations. Check out these USDA resources on programs that help support honey bees and other pollinators through plantings and designs for pollinator gardens:

- <https://directives.sc.egov.usda.gov/OpenNonwebContent.aspx?content=38006.wba>
- <https://www.nrcs.usda.gov/sites/default/files/2022-09/PollinatorGardens.pdf>

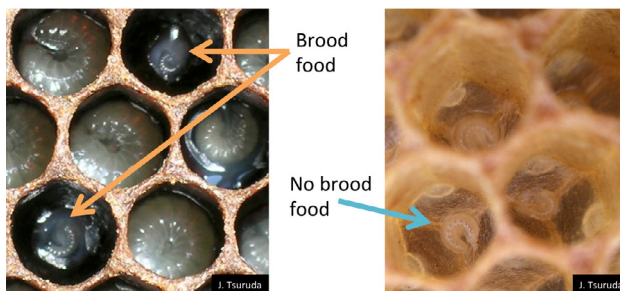


Figure 6. Young, developing bees, called larvae, are fed a liquid diet called brood food that is high in essential amino acids, while adult bees consume a predominantly carbohydrate diet. Symptoms of starvation can be seen in larvae and adults; beekeepers should look for both during routine hive inspections. Developing bees should appear in a pool of liquid brood food, especially during younger developmental stages. Lack of brood food for young larvae is a sign of starvation.



Figure 7. Although not always true, dead, inward-facing adult bees can be indicators of adult starvation. This situation is more commonly seen and reported during the winter season.



Figure 8. When feeding pollen supplements or substitutes in patty form provide smaller portions that will be consumed in a few days. Large patties will be uneaten for several days and will encourage growth of small hive beetle populations. The white arrow points to small hive beetle eggs laid in a protein patty. Small hive beetles are especially problematic in the southeastern United States.

TAKEAWAY POINTS

- Nectar and pollen are the primary food resources collected by honey bees.
- Nutritional needs change as honey bees develop.
- Supplemental nutrition can be provided to colonies through direct feeding during resource dearths or through supplemental plantings in areas prone to dearths.
- Optimal nutrition can mitigate the effects of honey bee stressors.
- Honey bee colonies are dynamic and complex, resulting in unique needs and management compared to other livestock systems.
- More research is needed to better understand the optimal nutrition of honey bees and the nutritional benefits of different floral resources.

More information and details can be found in the review publication:

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