

***Apis mellifera* Nutrition**

Manage *Apis mellifera* hives in a manner that places the interests of the honey bees ahead of the personal interests of the beekeeper. A strong colony is a healthy colony.

Bees are totally dependent on plants for their food. And those plants are totally dependent on the weather for growth and flowering. And bees are totally dependent on the weather to access their food. Therefore, every beekeeper needs to be a weather, water, and plant watcher, as well as a bee-watcher.

DIET REQUIREMENTS:

Honey bees require a diet of **carbohydrates** (sugar in nectar or honey), **amino acids** (protein from pollen), **lipids** (fatty acids, sterols), **vitamins**, **minerals** (salts), and **water**. These nutrients must be present in the right ratio for honey bees to survive and thrive.

LIPIDS:

Honey bees obtain a sterol, 24-methylene cholesterol, from pollen because of their inability to synthesize it directly. Sterol is the precursor for the molting hormone, which regulates growth required at the time of each molt. Winter colony bees are physiologically different from their sister summer bees. These winter bees use lipids for developing good fat bodies in the dorsal and ventral layers to survive the winter, and to be able to sustain the provision of brood food during the coming spring should pollen sources be scarce, or bad weather prevent foraging.

VITAMINS:

Nurse bees are thought to need vitamin B complex for brood rearing: thiamine, riboflavin, nicotinamide, pyridoxine, pantothenic acid, folic acid, and biotin. Ascorbic acid (vitamin C) also seems essential for brood rearing.

MINERALS:

The mineral requirements of honey bees are poorly understood. Excessive levels of sodium, sodium chloride, and calcium have been shown to be toxic to honey bees. Pollen and nectar contain minerals. Dark honey contains higher levels of minerals. The optimal ash concentration for maximum brood rearing seems to be at 0.5% - 1%. Pollen with more than 2% ash inhibits brood production.

WATER:

Honey bees forage for water to dilute honey so that it can be added to brood food; to cause evaporative cooling when the ambient hive temperature exceeds 95° F.

Understand the significance of jelly, and you will understand the soul of the bee colony. Randy Oliver

The nurse bees convert pollen and nectar to make a fluid called “jelly”, secreted by their hypopharyngeal glands. Royal jelly is 67% water and 32% dry matter. The dry matter is composed of 12.1% carbohydrates, 4.0% lipids, 12.9% proteins, and 1.1% ash. These percentages vary slightly in different seasons. RJ also contains many trace minerals, some enzymes, antibiotic components, and trace amounts of vitamin C. Larvae can survive on an artificial medium without RJ or proteins for three to four days, but then die one to two days before defecation (see illustration: Developmental Times and Stages). The queen, larvae, drones, nor older workers digest pollen to any extent themselves but are dependent upon nurse bees (3-15 days old) to feed them jelly (adults are able to serve themselves nectar and honey).

Nectar = Carbohydrates = Energy Source

Honey bees can detect and evaluate the sweetness of nectar sources. The amount and sugar content of nectar is dependent on the plant species and the environment, especially weather conditions. Nectar concentration are 5% to 75%, most range 25% to 40%. Nectar can be fed directly to brood and adults, but it is more commonly processed into honey first. Carbohydrates are converted to glucose which fuels nearly all bee cells, with carbon dioxide and water as by-products. Glucose is also converted to body fats and stored.

Adult bees utilize:

sucrose maltose
glucose melezitose
fructose trehalose

Adult bees cannot digest:

arabinose raffinose *lactose *mannose *stachyose
melibiose xylose *galactose *rhaminose

Note: *Toxic to honey bees causing a reduction in their longevity.

Foragers add the enzymes invertase and glucose oxidase to nectar during foraging, so some digestion is already occurring before nectar is brought back to the hive. Both the forager and the receiver use their **proventriculus** (meaning “in front of the stomach”) to remove pollen grains, dust, and infective spores from the nectar. This one-way backflow from the midgut prevents contamination of the honey stomach. Therefore honey is not “bee vomit.” Nurse bees add the enzymes diastase, invertase and glucose oxidase from their **hypopharyngeal glands** to the nectar in their crop. Nectar then is evaporated to less than 18% moisture to protect yeast from developing (see illustration: Internal Organs of a Worker Bee).

Pollen = Colony Productivity

Foraging bees are unable to discriminate between highly nutritive pollen and that which has low nutritional value. A combination of pollen sources is far more important than the food value of an individual source. There is a noticeable difference in the levels of glucose oxidase (GOX) in bees fed polyfloral diets. GOX converts glucose in nectar into gluconic acid which makes honey acidic, and hydrogen peroxide to fight against pathogens.

Amino acids are obtained from pollen only, because honey bees do not have any other sources of protein. Brood rearing decreases and workers live shorter-than-normal lives without protein. Nutritional value of pollen may be defined more accurately by the amino acid composition than by protein content. The amino acids in **greatest need** are isoleucine 4.0%, valine 4.0%, and leucine 4.5%; **intermediate needs** are arginine 3.0%, lysine 3.0%, threonine 3.0%, and phenylalanine 1.5%; **lowest needs** are methionine 1.5%, tryptophan 1.0%, histidine 1.5%. Pollen usually contains 6% to 28% protein. **These 10 amino acids must be balanced for bees to fully use what is available in the pollen** (see illustration: Amino Acids Line Graph).

Nectar is collected in excess due to the fact that a huge reserve of honey is needed for over wintering, but pollen reserve is managed for a few days to a week. Inclement weather could cause a total loss of pollen stores, while honey stores would only be lowered by a few percent. **A shortage of pollen significantly reduces the amount of brood reared and thus fewer worker bees emerging two to three weeks after the pollen shortage.** A colony will collect more pollen if it has more brood pheromone, more queen pheromone, or is genetically disposed to collect more pollen. High pollen hoarding lines leaves no room to rear brood. A low pollen line will perish without supplemental pollen feed. **A shortage of pollen reserves will force the workers to reduce larval protein demand through brood cannibalism, early capping of older larvae and focus nursing efforts on older larvae while neglecting younger larvae.**

The pollen grain has a tough outer layer made up of several layers of chemically and mechanically resistant material (polymers). There is a very small opening in the pollen grain called a micropore, which will be the gateway for the sperm to leave the pollen grain if it ever gets to a stamen of a flower. Honey bees do not have chewing, tearing, grinding mouthparts, so trying to break open a pollen grain is a losing prospect. The forager adds a lot of its own saliva and flower nectar to bind pollen together into the little dough ball seen on her pollen basket called corbicula. These bacteria and yeasts enter the micropore that starts digestion through a lactic acid fermentation process, reducing starch from 2% to 0%, converting sugars and fiber, and reducing ash and pH. This fermentation releases pre-digested food that was at one time the sperm of a plant.

Nest workers convert deposited pollen into bee bread by moistening loose pellets with regurgitated honey and saliva, packing it into cells by pushing the pellets with their mandibles. A final thin layer of honey covers the cell to preserve the bee bread for many months until needed. To further isolate the brood from any pathogens in raw pollen, the bee bread is then eaten and digested by nurse bees and converted into royal jelly. The nurse bee is able to feed a purified, sterilized, and highly digestible food to the queen and larvae thus eliminating the huge amount of excrement inside the hive. Should a larva sicken or die, it is removed by mid-aged undertaker bees which no longer engage in feeding of the brood.

The young workers (first 7-10 days) get most of their protein from pollen they themselves remove from cells and eat. Pollen is essential to ensure their hypopharyngeal and mandibular glands develop, plus preventing a shorter-than-normal life span. Hypopharyngeal gland development is necessary for young adult bees, both to produce the special brood food to feed the brood, and later to secrete wax during the comb building phase of their lives (12-18 days after emergence as adults). In early August/September, the adult worker bees and the newly developing bees feed very heavily upon pollen; this brings their hypopharyngeal glands back into the plump condition (like a young nurse bee) that will enable them to feed the spring brood (see illustration: Internal Organs of a Worker Bee).

Drone larvae are fed more than worker larvae with brood food that contains a greater range of proteins. Young drones beg food from young workers, and are fed a mixture of brood food, pollen, and honey until the drone's flight muscles strengthen and they reach sexual maturity usually within 12 days.

No artificial diet has been found to replace the honey, pollen, and glandular secretions fed to the larvae.

“When should I feed my bees?” There is only one right answer: “When they need food.”

Bees should be fed under the following conditions: colony is in danger of starving; installing a package, nucleus or hiving a swarm; requeening, or rearing queens; supplying medications.

Food, nectar and pollen, come from plants and primarily flowers of flower plants. Honey bees collect nectar and pollen outside of the colony from flowers. Food is stored neatly and cleanly in cells within the colony. Food is not found scattered about anywhere inside or immediately outside the hive on hive parts, pieces of bottom board, or on the ground. Any food found in these areas would be considered trash, rubbish, garbage. What look like the bees “eating” the beekeeper provided feed could simply be them removing this perceived trash from their colony.

Artificial Feed Protein

A good pollen feed for honey bees should have the same features as fresh pollen:

1. **Palatability – bees readily consume it.**
2. **Digestibility – it is easily digested by bees.**
3. **Balance – it has the correct amino acid balance and enough crude protein.**

A purchased pollen **supplement** contains pollen; a pollen **substitute** does not. Care should be considered using soybeans as a pollen substitute – 40% sugars in soybeans are toxic to bees. Mega Bee, Feed Bee and Honey-B-Healthy/Amino-B Booster are non-soy based. Pollen feed with low fat content is less likely to be consumed by honey bees. A total lipid concentration within a pollen supplement is recommended to be 5% to 8%.

Spring pollen supplement can be an insurance guard against effects of varroa parasitism and nosema infection. Feed pollen patties when you can ensure a continuous feeding of them. There needs to be at least two to three 50° F days weekly, not during an abnormal warming, but when there is a definite, continuous warming trend.

Drying Fresh Pollen Pellets. Dry in the sun for a few days, in a warm oven, or with a lamp or food dryer. Heat to 120° F for the first hour to kill yeast spores, and then dry for 24 hours at 95° to 97° F. The pellets are dried when they do not crush when rolled between the fingers and do not stick to each other when squeezed. Store them in closed containers at room temperature. **Freezing Pellets.** Place fresh, cleaned pollen pellets in a container and store them at 0°F until ready to use; they will be moist when defrosted. **The freshly trapped pollen from you hives must either be dried or frozen immediately.**

Artificial Feed Syrup

Unheated honey is best for feeding bees. Syrup from white cane sugar is a second choice of feed. Honey bees cannot digest raw sugar, molasses, brown sugar, or sorghum, because these contain impurities and can cause dysentery in bees. Unmarked white sugar is usually produced from sugar beets and may be genetically modified (GM). Depending on the bees' exposure to proteins expressed by GM, tests showed they had trouble learning to distinguish between the smells of flowers and exhibited a shorter-than-normal life span. GM is also called by less inflammatory names: PNT (plants with novel traits), high yield, none conventional, herbicide tolerant, pedigreed, and the most politically correct term is hybrid.

Spring Feed = 1:2 (1 part sugar : 2 parts water) **Autumn Fee = 2:1** (2 parts sugar : 1 part water)

As long as you are supplying the bees with new foundation or top-bars to be built into comb, their need for nectar or your sugar syrup must continue until all comb needed for their entire hive is completely drawn. Only then does the colony have the room to expand and room to store food for the winter. Feeding does not make lazy bees.

A hive that is fed granulated sugar must also have access to water in order to convert the sugar into a usable form of food. This is true to a lesser degree with the sugar and candy board. If the sustained temperatures are not about 45° F you will have a hard time getting honey bees to take any kind of liquids, either in or out of the hives.

High fructose corn syrup (HFCS) comes in different varieties; HFCS 90 (90% fructose & 10% glucose), HFCS 55 and HFCS 45. Most of the fructose found in fruit and **honey is in the form of L-fructose or levulose**; the **fructose in HFCS is D-fructose** which has a different chemical structure. Corn syrup contains two types of sugar that are mildly toxic to honey bees; stachyose and farinose.

HMF (hydroxymethylfurfural) is a compound that is formed in honey and HFCS when fructose degrades after being exposed to heat while in the presence of an acid. **High levels of HMF have been shown to cause ulceration of the honey bee gut leading to dysentery issues and premature death.** HMF is indigestible and toxic to the honey bee above 30 ppm (parts per million). Honey heated to about 122° F experiences a relatively low increase in HMF. Honey has a high increase of HMF when heated up to about 144° F, and honey becomes seriously impaired with excess HMF when exposed to temperatures of 180° F and above. The international tolerance of HMF in honey is 40 mg/kg (or 4mg/100g) which can be reached after 230 days at 68° F.

If you decide to use HFCS as bee feed, purchase HFCS syrup produced using the enzyme hydrolysis process that tends to result in less HMF ending up in the syrup and avoids the opportunity for mercury contamination as opposed to acid hydrolyzed inverted sugars. HFCS purchased as bee feed should be used up ASAP and stored at temperatures well below 120° F in order to limit the build-up of HMF that occurs with time and temperature.

Approximate Weight of FULL Frames

- 1 deep frame = 6 pounds
- 1 shallow frame = 2.5 pounds
- 10 deep frames = 60 plus pounds
- 10 shallow frames = 25 – 30 pounds.

Read not to contradict nor to believe, but to weigh and consider. Francis Bacon