

Honey



Question 1: What is honey?

Answer: Honey is a sweet and viscous fluid that honey bees produce. Most people have a jar of honey in the kitchen, but they probably don't use it very often. In the days before the development of refined sugars, honey was of great importance because it was the primary sweetener available. Honey is *hygroscopic*, meaning it pulls moisture from the air, so baked goods made with honey tend to stay moist. This property of honey creates an unfavorable environment for bacteria and mold, drawing water from inside their cells and causing them to die of dehydration. Honey is also quite acidic, which further prevents spoilage and inhibits germs. Archaeologists have found edible honey that is over three thousand years old from the tombs of Egyptian pharaohs, and experts believe that honey had an important role in many civilizations and cultures.

Over 181 chemical substances have been identified in honey, although it varies from hive to hive, depending on the nectar source. Honey is roughly 38 percent fructose, 31 percent glucose, and may contain maltose, sucrose, and other complex carbohydrates. It usually contains vitamins B6 and C, thiamin, niacin, riboflavin, and pantothenic acid, and it may have traces of essential minerals such as calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, zinc, and several different amino acids. It also contains antioxidants and is fat free.

Honey that has been adequately dehydrated can be safely stored for long periods of time. However, if the air is too dry, the sugar crystals in honey can reform and give liquid honey an unappealing appearance. Luckily, crystallization can be reversed through gentle heating, which restores the liquid nature of most honeys. When honey is judged at a county or state fair, judges look for color, flavor, sugar content, as well as density, freedom from crystals, cleanliness of the honey, and neatness in the packaging.

Question 2: How does nectar become honey?

ANSWER: The production of honey begins when foraging bees transport nectar back to the hive that they have collected from nearby flowers. The foraging bees accumulate the nectar in a special organ called a *honey stomach*, or *crop*, without digesting it. New research conducted by Susan Nicolson and Hannelle Human in South Africa demonstrated that the sugar concentration of the nectar collected by honey bees from a local aloe plant, *Aloe greatheadii* var. *davyana*, doubled between the time the bees collected it and when they delivered it to the hive, and its volume decreased as well. This result suggests that the bees begin processing the nectar into honey immediately, regurgitating it onto their tongue and evaporating it on the flight back to the colony.

Once back in the hive, a forager bee unloads the nectar by regurgitating it drop by drop, and a food storer bee sucks up the fluid with her proboscis from the forager's mouth. As the nectar is passed between bees, the complex sugars in the nectar are converted by enzymes produced by glands inside the bees' heads into simple sugars, primarily glucose, fructose, and sucrose, which become honey.

The food storer bees deposit the honey one drop at a time into storage cells in the honeycomb until the cells are filled. Once a cell is full, workers fan it with their wings until the water content of the honey has been reduced from the nectar's origi-

nal 80 percent to less than 20 percent, and then they cover the storage cell with a wax cap. The stored honey can be used to sustain the colony through the winter until foraging starts again in the spring. Honey does not spoil (but it can ferment), so if it is not used during the winter, it will provide a reserve for the colony in the early spring.

Question 3: Why are there so many different kinds of honey?

Answer: The flavor and color of honey depend on which flowers the bees have been using as a nectar source. Nectar sources vary with the blooming cycle, location, and weather, and some local beekeepers collect particular types of honey in coordination with the blooming of certain flowers that they prefer. Many beekeepers think that the best honey-making nectar comes from alfalfa, tupelo, buckwheat, clover, cotton, and orange. Beekeepers typically allow the bees to keep honey that they make from other flowers, and many hobby beekeepers don't try to label their honey based on the floral crop—they are simply happy to have a crop of naturally harvested honey. Honey of mixed floral origins is generally labeled “wildflower” honey. Natural food stores, growers, and farmers' markets typically sell honeys made from plants that grow locally, and stores in New York and elsewhere sell unusual honeys imported from Morocco, labeled carob seed, lavender, and jujube (a bitter, apple-like fruit.)

There are also different types of honey depending on how much it is processed. There is cut comb honey (cut straight from the honeycomb and bottled with the honeycomb wax), certified organic, chunk, strained or filtered, ultrafiltered, heat-treated, ultrasonicated, churned or whipped (also called honey fondant or spun honey), crystallized, and set honey. Raw honey is produced without heating, and some people consider this the tastiest type of honey available. Crystallized or whipped honey is the most preferred form of honey in many places in Europe, while Americans tend to prefer liquid honey.

Question 4: Is honey good for you?

Answer: Honey never spoils (if it is stored properly) and contains a surprisingly high level of antioxidants, non-nutritive agents that can slow destructive chemical reactions in food and animal tissues. A recent survey of a variety of monofloral honeys determined that, in general, the darker the honey, the higher the value of its antioxidant content. Buckwheat honey, one of the darkest types tested by May Berenbaum along with Steve Frankel and Gene Robinson, had the highest antioxidant content, greater than sunflower, tupelo, soybean, and clover varieties. Experiments conducted by other authors, including Nele Gheldof and colleagues, support the findings that honey should be valued because of its capacity to act as an antioxidant.

Honey is also a good source of carbohydrates to fuel aerobic exercise. According to Richard Kreider and colleagues, honey is easily digestible and its fuel is released very steadily after it is eaten, suggesting that it is an excellent way to promote sports performance and recovery. Skeptics, however, warn that honey is simply touted as a fad diet for athletes.

Bassan Zeina and colleagues state that honey is effective against a tropical, infectious parasite called *Leishmania*. In multiple studies, Mutya Subrahmanyam and colleagues indicate that mild burns healed faster when treated with honey and covered with gauze than similar burns that were treated with antibiotic creams and other dressings. Owen Moore and coauthors, however, published a meta-analysis of seven other published papers investigating honey as a burn treatment, concluding that there is a dearth of evidence about the efficacy of honey in this capacity and citing the lack of double-blind controls and poor validity testing. Many reports about medical uses of honey are anecdotal rather than being based on scientific or experimental studies; for example, in Sierra Leone, a drop of honey is put in each ear of a newborn baby to prevent infection. There is some evidence that honey may be a useful way to combat periodontal disease and gingivitis, but contrary evidence indicates that the highly acidic nature of honey makes

the sugar content potentially damaging to the human mouth and teeth.

A study published in the *Archives of Pediatrics and Adolescent Medicine* in 2007 by Ian Paul and colleagues suggests that honey may be beneficial to children suffering with persistent coughs. One hundred and five symptomatic children aged two to eighteen years of age participated in the study: thirty minutes before bedtime, they were given either a dose of buckwheat honey, honey-flavored cough medicine, or no treatment. Honey was rated by the parents of the children as having provided the most symptomatic relief of the nighttime coughing and sleep difficulty. Clearly, more research is needed to establish the degree of honey's health benefits.

Question 5: What is flea honey or honeydew?

Answer: Honeydew is a sweet substance excreted by aphids, also called plant lice, which are small, soft-bodied insects. They feed on the fluids in plants using a needle-like, biting mouthpart and are considered plant pests because they can damage trees, garden flowers, or agricultural crops if their population is large. Ladybugs, also known as ladybird beetles, are frequently released on aphid-infested plants because these beetles are predatory and eat aphids.

As the aphids suck liquids from the plants, they exude drops of liquid waste called honeydew. It is a clear, sticky liquid often seen on automobiles parked under trees and on car windshields during the summer. Bees, ants, and some caterpillars sip drops of excess honeydew that the aphids excrete. Bees in habitats that have lots of aphids but few flowering plants collect the honeydew and bring it back to the hive to be made into "flea honey."

Question 6: How much work does it take for bees to make a jar of honey?

Answer: Nectar that is turned into honey is gathered by bees drop by drop. It has been estimated that bees have to visit two

Honey Hunters in Rock Art

Evidence abounds that bees have had sacred and mystical significance in cultures and religions in prehistoric, ancient, and modern times. The queen lays eggs continuously without any evidence of mating, the tiny eggs undergo complete metamorphosis, and the bees somehow create elaborate and perfect hives containing a highly desirable, sweet, and healing substance. It is truly magical.

In some cultures, a foraging bee was marked with a drop of liquid or tagged with a piece of fluff or a strand of animal hair so that a human observer could more easily follow the bee and find its nest. It was a common belief that personal cleanliness and purity, including sexual abstinence, would protect a male honey hunter from being stung.

A Mesolithic rock painting was found on a wall of Arana Cave near Valencia in eastern Spain showing two naked men collecting honey and honeycombs from a wild nest. They are depicted using a long ladder and carrying baskets or bags. The painting has been dated variously from 6000 B.C.E. to 13,000 B.C.E. and may be the oldest evidence of human interest in bees and honey to date.

Eva Crane, the leading authority on honey hunter images, has collected images from rock paintings found around the world in which bees' nests and honey hunting are represented. The differences in the size, shape, and location of the nests in the paintings are quite striking, and there is often enough resemblance to contemporary wild beehives to suggest a tentative identification of the species, thus potentially establishing its existence in a specific locale. A great deal of this rock art was found in southern Africa, but examples have also been collected from Asia, Europe, northern Africa, and Australia.

Extraordinarily clear ancient engravings and paintings on stone detailing honey being harvested from human-made hives have been found in Egypt and dated around 2400 B.C.E., and physical evidence of artificial hives made from hollow logs as well as pottery vessels, woven straw baskets, and sealed

Honey Hunters in Rock Art

honey pots were found in the graves of Tutankhamen and other pharaohs.

In 2007, archaeologists digging in the ruins of the city of Rehov in northern Israel discovered evidence of a three-thousand-year-old beekeeping industry, including what they believe are the oldest intact beehives—thirty of them, dating back to 900 B.C.E. The beehives are made of straw and unbaked clay, and they were found in orderly rows, three high, in a room that was big enough to hold one hundred hives. An altar decorated with fertility figures was found alongside the hives, suggesting that they might have served some ritual or religious function.

million flowers to obtain enough nectar to make one eight-ounce jar of honey. They have to fly approximately fifty-five thousand miles back and forth from flowers to hive to gather enough nectar for that one jar, and to make one gallon of honey they have to fly the distance to the moon and back. How much honey a hive produces varies greatly, depending on the climate, location, weather, and general health of the bees, but the amount ranges from about fifty pounds to as much as two hundred pounds in a year.

Question 7: How much honey is gathered in the United States every year?

Answer: About 150 million pounds of honey are obtained each year in the United States from commercial sources. About five hundred thousand people keep hives, and there are approximately 2.5 million colonies of bees according to the U.S. National Agricultural Statistics Service. The amount of honey that is harvested from smaller beekeeping operations and hobbyist beekeepers is impossible to estimate.

Prior to the 1980s, beekeeping was a very common hobby. Many hobbyist beekeepers lived in rural areas, and the beehives provided pollination for small gardens and local fruit orchards and supplied the household with honey and beeswax. In the 1980s, parasitic tracheal mites arrived in the United States and infested many colonies, and in the 1990s, *Varroa* mites and small hive beetles joined the party, resulting in the demise of most rural colonies (see chapter 10, question 3: What parasites and insects prey on bees?). Most beekeeping is presently being done commercially; although, with the recent interest in honey bees due to the publicity about colony collapse disorder, there is a resurgence of interest in keeping bees (see chapter 10, question 10: What is colony collapse disorder?).

In 2007, the state with the most honey-producing honey bee colonies was North Dakota, with California and South Dakota in second and third place, respectively. Kentucky had the fewest number of registered bee colonies. The greatest yield per colony was from Mississippi, but total production was highest from North Dakota, California, and South Dakota, with Florida coming in very close to the top three producers. According to the Agricultural Statistics Board of the U.S. Department of Agriculture, the total value of honey production across the United States in 2007 was \$153,233,000.

Question 8: Can honey be toxic to humans?

Answer: Honey from certain flowers is called “mad” honey. It is produced when bees collect nectar from rhododendrons, azaleas (both members of the genus *Rhododendron*) or mountain laurel (*Kalmia latifolia*), flowers whose nectars all contain chemicals, called grayanotoxins, that are psychoactive and toxic to humans but not to bees. Their effects are short lived, and symptoms include nausea, vomiting, sweating, and dizziness. Abdulkadir Gunduz and colleagues in Turkey report that “mad” honey is used locally in folk medicines as an alternative treatment for a variety of medical disorders such as gastrointestinal

pain or hypertension; these claims have not been substantiated through appropriate medical testing, however.

In New Zealand, toxic honey can be found from a different source. Bees gather honeydew, a sweet secretion, from vine hopper insects, *Scolytopa australis*, that have fed on the toxic tutu bushes, *Coriaria arborea*. Symptoms of *tutin* poisoning in humans are vomiting, delirium, giddiness, stupor, and violent convulsions. Since December 2001, New Zealand beekeepers have been required to closely monitor the area within three kilometers of their hives where their bees might forage in order to prevent exposure to the toxin.

There is a Brazilian plant, *Serjania lethalis*, which produces a honey so poisonous that it has been reported to be used by native hunters for tipping their arrows and killing fish. Flowers in the Sumac genus *Rhus* make nectar that produces dark red honey (this includes *Rhus vernix*, poison sumac; and *Rhus toxicodendron*, poison ivy), but this honey is not harmful to people.

Green or unripe honey from a few plants can cause an allergic reaction in some people, and in rare cases, honey results in an allergic reaction due to contamination with pollen allergens. Honey should be considered in any patient with a food allergy that cannot be identified, because if honey is an ingredient, the patient may be having a reaction to pollen allergens in the honey. Max Deinzer and colleagues investigated alkaloids that affect the liver (hepatotoxic) that are found in the plant tansy ragwort, *Senecio jacobaea L.*, and in honey produced from its nectar. This plant is native to Europe but has widely invaded pasture lands in both North America and Australia. These alkaloids have the potential to cause cancer, mutations, and birth defects in bees, and the researchers caution that they may pose health hazards to the human consumer. Most people can consume honey without incident, and all of these ill effects are quite rare. However, honey should not be given to children under the age of one because infants may be susceptible to botulism, an illness caused by *Clostridium botulinum*, a toxin-producing bacteria that is rarely found in honey.

Mayan Beekeeping

Archeological and historical evidence indicates that the tradition of keeping bees and consuming honey and products derived from the fermentation of honey predates the arrival of *Apis mellifera* in the New World. According to Helen Ransome, when the conquering Spaniards reached Mexico and other areas in Central and South America, stingless beekeeping, or melipoculture, was already an established industry in many communities.

Prior to the European invasion of Central America, the Mayan people had a deep connection to many animals in their environment, including insects, and they often immortalized important animals into gods. They honored a “bee god” known as Ah Mucan (also written as Mucen or Muzen) Cab. The Mayans dedicated festivals to this deity to celebrate honey and mead production and used these occasions for trade and various religious ceremonies. The god is represented in carvings and art with wings expanded, as if preparing for landing or taking off. The favored species was called Xunan-Cab, which translates roughly to “royal lady.” Like the modern use of the stingless Mayan bee, *Melipona beechii*, for honey production, the Mayans raised bees in special hives made out of tree branches or other containers such as logs, gourds, or clay pots. There is also evidence that they used ceremonial pottery vases to carry honey and mead, and these containers were often inscribed with hieroglyphic stories that explained how the bee god helped the local community.



Fig. 22. A pendant, carved from mother-of-pearl, that embodies the relationship between man and bees within the ancient Mayan culture. Note the bee-like abdomen connected to parts of the human body. (Photograph K6169 © Justin Kerr, 1992.)

Question 9: What is mead?

Answer: Mead is a fermented alcoholic beverage made from honey and water. Eva Crane writes that this alcoholic beverage was probably produced thousands of years before the creation of beers and ales, and many drinks produced from fermented honey and other ingredients have been important in multiple cultures. Mead is sometimes called honey wine; although, because it is not made from grapes, it can't properly be called wine. When mead is made with the addition of flavorings such as ginger, cloves, cinnamon, or mace, the drink is called metheglin. Bracket, also called bragget or braggot, is a type of beer brewed with more than 30 percent honey as a source of sugar, equivalent to mead brewed with malt. It was first produced as a byproduct of beekeeping in areas where grapes could not be grown, and, not unsurprisingly, it is rather sweet. Mead was mentioned in sacred texts as early as 2000 to 1100 B.C.E., and in ancient Greece mead was said to have been the preferred drink. Aristotle (384 to 322 B.C.E.) discussed mead in his *Meteorologica*, and around 400 B.C.E. Plato recorded the behavior of a friend drinking nectar in the Garden of Zeus, when wine was not yet known. Hilda Ransome describes the role of mead and other bee products in multiple cultures, including Germanic myths, Welsh and Irish poems, and Mayan rituals.