



**“I’M HERE TO
TELL YOU THE
BEAR FACTS
ABOUT HONEY.”**

**A Reference Guide from
the National Honey Board**



Antimicrobial Properties

The factors that may contribute to the antimicrobial properties of honey are:

- High osmotic pressure, low water activity (A_w)
- Low pH - acidic environment
- Glucose oxidase system - forms hydrogen peroxide
- Low protein content
- High carbon to nitrogen ratio
- Low redox potential (E_h), due to high content of reducing sugars
- Viscosity opposes convection currents and limits dissolved oxygen
- Chemical agents
- Pinocembrin
- Lysozyme
- Acids (phenolic)
- Terpenes
- Benzyl alcohol
- Volatile substances (possibly phytochemicals influenced by bee enzymes)

Antioxidants

Generally, darker honeys and those with higher water content have stronger antioxidant potential. The antioxidants identified thus far in honey are pinocembrin, pinobanksin, chrysin and galagin. Pinocembrin is unique to honey and found in the highest amount relative to the others. Ascorbic acid (vitamin C), catalase and selenium are also present.

Chemical Characteristics

pH and Acids

| | | |
|-------|-------|--|
| pH | 3.9 | Range: 3.4-6.1 |
| Acids | 0.57% | Range: 0.17-1.17% (primarily gluconic acid) |

Proteins, Amino Acids, Isoelectric Point

| | |
|-------------------|-----------|
| Protein | 0.266% |
| Nitrogen | 0.043% |
| Amino acids | 0.05-0.1% |
| Isoelectric point | 4.3 |

Analysis: Honey is chemically compatible with a wide variety of products. Its pH and isoelectric point are in a range common to many food systems.

Color

The colors of honey form a continuous range from water white to dark amber. The color of honey is related to its mineral content and is characteristic of its floral source. Light colored honey typically has a mild flavor, while dark colored honey is usually stronger in flavor.

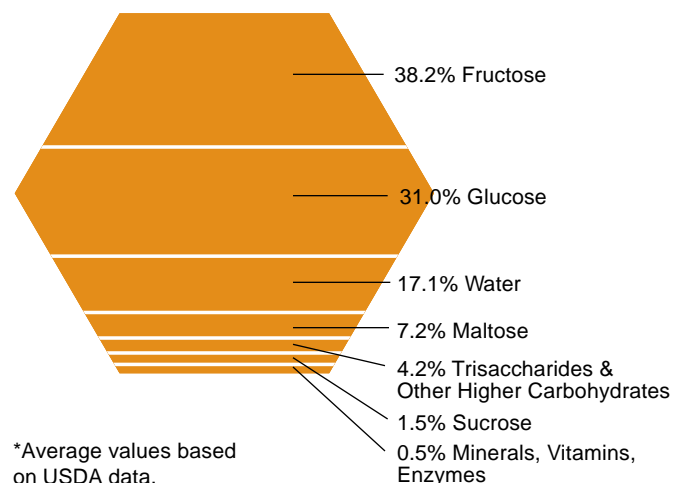
The Pfund color grader is a device used by the honey industry to measure the color of honey. The respective color designations, applicable range of each color, color range on the Pfund scale and optical density of freshly prepared caramel-glycerin solutions (USDA method) are presented on the following table.

Color Designations

| Color Name | Pfund Scale (mm) | Optical Density ¹ |
|-------------------|------------------|------------------------------|
| Water White | < 8 | 0.0945 |
| Extra White | 9-17 | 0.189 |
| White | 18-34 | 0.378 |
| Extra Light Amber | 35-50 | 0.595 |
| Light Amber | 51-85 | 1.389 |
| Amber | 86-114 | 3.008 |
| Dark Amber | > 114 | — |

¹Optical density (absorbance = 100/percent transmittance), at 560 nm for 3.15 cm thickness for caramel-glycerin solutions measured versus equal cell containing glycerin.

Composition*





Cremed Honey

Cremed honey is liquid honey processed by controlled crystallization to yield a product with a smooth, spreadable consistency. Also called “Cremed Honey,” “Whipped Honey,” “Churned Honey,” “Candied Honey” or “Honey Fondant.”

Crystallization/Granulation

Crystallization or granulation is a natural process that occurs in honey. Honey is a supersaturated sugar solution out of which the glucose tends to crystallize. The glucose/water content ratio and presence of nuclei for crystal growth help to determine the rate of crystallization. Crystallization is most rapid at 57 °F (14 °C) and can be reversed by heating. Honey appears lighter in color after crystallization.

Diabetes

Diabetics must control their total intake of carbohydrates, not the type. Therefore, honey may be included in a diabetic diet. They must, however, comply with the medical regime and diet instructions prescribed by their individual healthcare providers to keep blood sugar levels under control.

Energy

Honey contains 64 calories per tablespoon.

Enzymes

The Major Enzymes Present In Honey

| Enzyme | Function |
|-------------------------------------|--|
| Invertase | Converts sucrose to glucose and fructose |
| Amylase (also known as diastase) | Hydrolyzes starch to dextrins and/or sugars |
| Glucose oxidase | Converts glucose to gluconolactone, which in turn yields gluconic acid and hydrogen peroxide |
| Catalase | Converts peroxide to water and oxygen |

| | |
|------------------|---|
| Acid phosphatase | Removes inorganic phosphate from organic phosphates |
|------------------|---|

Extracted Honey

Extracted honey is liquid honey that has been separated from the comb by centrifugal force, gravity, straining or by other means.

Fermentation

Fermentation in honey is caused by osmophilic yeasts. It will not occur in honey that has a carbohydrate content > 83%, a moisture content < 17.1%, a storage temperature < 52 °F (11 °C) or that has been heat-treated. Properly extracted, treated and stored honey should not ferment.

Filtered Honey

Filtered honey is processed by filtration to remove air bubbles, extraneous solids and pollen grains.

Floral Sources

There are more than 300 floral sources for honey in the United States, including clover, alfalfa, buckwheat and orange blossom. Honey’s color and flavor vary with its nectar source.

Freezing Point Depression

15% honey solution:

29.44 to 29.25 °F (-1.42 to -1.53 °C)

A 68% honey solution freezes at 21.6 °F (-5.78 °C)

Functional Characteristics of Honey

(See chart on following page.)

Grading

Honey is graded, on a voluntary basis, using USDA standards. These standards are a point system based upon water content, flavor and aroma, clarity and absence of defects.

| | Minimum Total Solids (%) | Maximum Water Content (%) |
|----------------|-----------------------------|------------------------------|
| Grade A | 81.4 | 18.6 |
| Grade B | 81.4 | 18.6 |
| Grade C | 80.0 | 20.0 |



Functional Characteristics of Honey

| Applications | Bakery | Beverages | Cereals/Cereal Bars | Confections | Dairy | Meats | Sauces | Snacks | Spreads | Characteristics |
|-----------------------------------|--------|-----------|---------------------|-------------|-------|-------|--------|--------|---------|-----------------------------------|
| Adds/Retains Moisture | ● | | | | | ● | | | | Hygroscopic |
| Antioxidative Properties | | | | | | ● | | | | Theories: Maillard Precursors, Aw |
| Binding | | | ● | | | | | ● | | Colloidal Properties |
| Clarification | | ● | | | | | | | | Proteins |
| Color | ● | ● | ● | | | ● | ● | ● | ● | Color |
| Decreases Burn Perception | | | | | | | ● | ● | | Composition |
| Enhances Growth of Bifidobacteria | | | | | ● | | | | | Theory: Fermentable Carbohydrates |
| Enhances Browning | ● | | ● | | | ● | | ● | | Reducing Sugars |
| Enhances Shelf-life/Slows Staling | ● | | ● | | | | | ● | | Contributes Moisture |
| Extrudable | | | ● | ● | | | | ● | | Viscosity |
| Flavoring | ● | ● | ● | ● | ● | ● | ● | ● | ● | Distinctive Taste |
| Healthy Appeal | ● | ● | ● | ● | ● | ● | ● | ● | ● | Natural Image |
| Improves Reduced-fat Products | ● | | | | | ● | | | ● | Mouthfeel |
| Lowers Freezing Point | | | | | ● | | | | | Sugar Content |
| Texture | ● | | | ● | | | | | | Viscosity/Crystallization |
| Flavor Enhancer | | | | | | ● | ● | ● | ● | Organic Acids |

Heat Treatment / Pasteurization

Honey is heat-treated to prevent unwanted fermentation by osmophilic yeasts and to delay crystallization. One common heat treatment is 170 °F (77 °C) for two minutes followed by rapid cooling to 130 °F (54 °C). Other effective treatments include heating honey to 140 °F (60 °C) for 30 minutes or 160 °F (71 °C) for one minute or some straight line gradient between those two temperatures. Honey may be damaged by too much heat.

Hydroxymethylfurfural (HMF)

Hydroxymethylfurfural (5-hydroxymethyl-2-furaldehyde), also called HMF, is a compound that results from the breakdown of simple sugars (such as glucose or fructose) at pH 5 or lower. HMF occurs naturally in honey, especially in warm climates.

Infant Botulism

Infant botulism is a rare but serious paralytic disease caused by the microorganism *Clostridium botulinum*. After ingestion, *C. botulinum* spores can germinate, grow and produce toxin in the lower bowel of some infants under one year of age. *C. botulinum* spores are widely distributed in nature. They can be found in soil, dust, the air and raw agricultural products. Honey is also a potential source of *C. botulinum* spores. Infants are susceptible to infant botulism until their intestinal microflora develop. Children and adults with normal intestinal microflora are able to ingest *C. botulinum* spores without harm. The National Honey Board, along with other health organizations, recommends that honey not be fed to infants under one year of age.



Microbiology

Honey has inherent antimicrobial properties that discourage the growth or persistence of many microorganisms. The microbes that may be found in honey are primarily yeasts and spore-forming bacteria. No vegetative forms of disease-causing bacterial spores have been found in honey. Because bacteria do not replicate in honey, if high numbers of vegetative bacteria were to be detected, it may indicate contamination from a secondary source.

Nutrient Values

| Nutrient | Average amount per 1 Tbsp. serving (21 g) | Average amount per 100 g |
|---------------------|---|--------------------------|
| Water | 3.6 g | 17.1 g |
| Total Carbohydrates | 17.3 g | 82.4 g |
| Fructose | 8.1 g | 38.5 g |
| Glucose | 6.5 g | 31.0 g |
| Maltose | 1.5 g | 7.2 g |
| Sucrose | 0.3 g | 1.5 g |

Information for nutritional labeling*

| | | |
|--|---------|---------|
| Total Calories (kilocalories) | 64 | 304 |
| Total Calories (kilocalories) (from Fat) | 0 | 0 |
| Total Fat | 0 | 0 |
| Saturated Fat | 0 | 0 |
| Cholesterol | 0 | 0 |
| Sodium | 0.6 mg | 2.85 mg |
| Total Carbohydrates | 17 g | 81 g |
| Sugars | 16 g | 76 g |
| Dietary Fiber | 0 | 0 |
| Protein | 0.15 mg | 0.7 mg |

Vitamins

| | | |
|------------------|---------------|---------------|
| Thiamin | < 0.002 mg | < 0.01 mg |
| Riboflavin | < 0.06 mg | < 0.3 mg |
| Niacin | < 0.06 mg | < 0.3 mg |
| Biotin | Not available | Not available |
| Pantothenic Acid | < 0.05 mg | < 0.25 mg |
| Vitamin B-6 | < 0.005 mg | < 0.002 mg |
| Folate | < 0.002 mg | < 0.01 mg |
| Vitamin B-12 | Not available | Not available |
| Vitamin C | 0.1 mg | 0.5 mg |
| Vitamin A | 0 | 0 |
| Vitamin D | 0 | 0 |
| Vitamin E | 0 | 0 |

Minerals

| | | |
|-------------|----------|---------|
| Calcium | 1.0 mg | 4.8 mg |
| Iron | 0.05 mg | 0.25 mg |
| Zinc | 0.03 mg | 0.15 mg |
| Potassium | 11.0 mg | 50.0 mg |
| Phosphorous | 1.0 mg | 5.0 mg |
| Magnesium | 0.4 mg | 2.0 mg |
| Selenium | 0.002 mg | 0.01 mg |
| Copper | 0.01 mg | 0.05 mg |
| Chromium | 0.005 mg | 0.02 mg |
| Manganese | 0.03 mg | 0.15 mg |

Ash 0.04 g 0.2 g

*Contains less than 2% of the Daily Value for vitamin A, vitamin C, iron and calcium

Processing

(See chart on following page.)

Refractive Index

The moisture, or conversely the soluble solids in honey, is determined by measuring the refractive index of honey using a refractometer. Because the refractive index of honey is different from that of a sucrose solution at the same concentration, a special moisture chart must be used. This chart is found in AOAC Method 969.38 (see Analytical Methods). Using the "Brix" or "Sucrose" scale will provide inaccurate values for honey.

Rheological Properties

Most honeys have Newtonian properties. However, a few honeys have thixotropic properties (e.g., heather and manuka honeys) attributable to their relatively high content of certain proteins. Dilatancy is noted with very few honeys and is related to the presence of polysaccharides of high molecular weight.

Specific Gravity

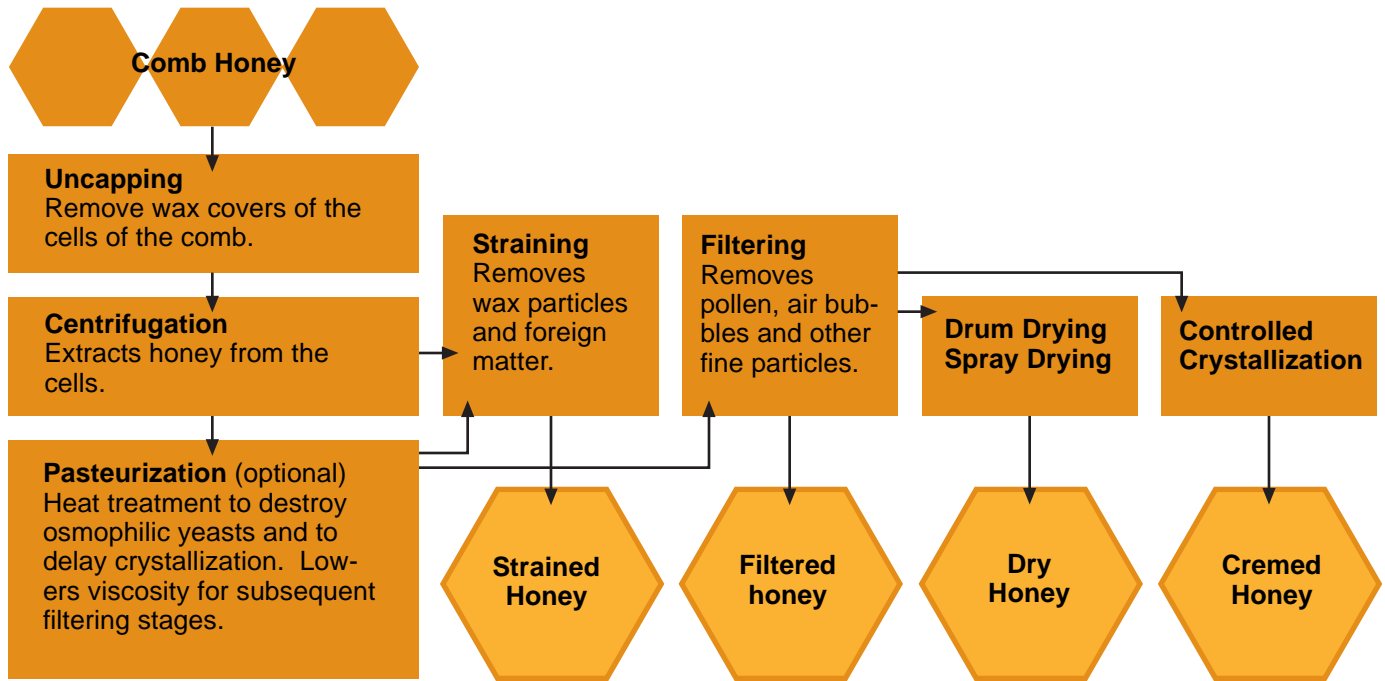
Dependent upon water content:

| Water Content (%) | Specific Gravity (20 °C) |
|-------------------|--------------------------|
| 15 | 1.4350 |
| 18 | 1.4171 |

Other factors such as floral source slightly affect the specific gravity of honey. Honeys from different origins or batches should be thoroughly mixed to avoid layering.



Processing



Specific Heat, Thermal Conductivity

The specific heat of honey is in the 0.54-0.60 cal/g/°C range for liquid honey, and is equal to 0.73 cal/g/°C for finely granulated honey.

The thermal conductivity of honey increases with temperature and total solids, ranging from 118×10^{-5} to 143×10^{-5} cal/cm sec °C.

Storage

The optimum storage temperature for honey is below 52 °F (11 °C) or in the 70-80 °F range (21-27 °C), in air-tight containers.

Strained Honey

Strained honey has been passed through a mesh material to remove particulate matter normally found in unprocessed honey. The mesh, however, does not remove any pollen that may be in the honey.

Sweetness Value

The sweetness value of honey is approximately equal to that of invert sugar.

Viscosity

Honey's viscosity is dependent upon its water content, temperature and floral source:

| Water Content (%) | Viscosity (poise) at 25 °C |
|-------------------|-------------------------------|
| 15.5 | 138.0 |
| 17.1 | 69.0 |
| 18.2 | 48.1 |
| 19.1 | 34.9 |
| 20.2 | 20.4 |

| Temperature (°C) | Viscosity (poise) at 16.1% H ₂ O |
|------------------|--|
| 13.7 | 600.0 |
| 29.0 | 68.4 |
| 39.4 | 21.4 |
| 48.1 | 10.7 |
| 71.1 | 2.6 |

| Floral Source (examples) | Viscosity (poise) at 25 °C, 16.5% H ₂ O |
|-----------------------------|---|
| Sage | 115.0 |
| Sweet Clover | 87.5 |
| White Clover | 94.0 |



The viscosity of honey decreases rapidly as its temperature rises. 1% moisture is equivalent to about 3.5 °C in its effect on viscosity. The viscosity can be adjusted to fit any manufacturing delivery system.

Water Activity

Dependent on its water content, temperature, floral source and other factors, honey's water activity varies between 0.5 (16% H₂O) and 0.6 (18.3% H₂O) in the 40-100 °F (4-37 °C) temperature range.

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Among its varied activities, the National Honey Board serves as a liaison between the honey industry and manufacturers. The program is committed to providing up-to-date technical information to current and potential honey users. For more information, contact:

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