

Carbohydrates and the Sweetness of Honey

General Information

Honey is composed primarily of the sugars glucose and fructose; its third greatest component is water. Honey also contains numerous other types of sugars, as well as acids, proteins and minerals.^{1,2} Sugars are also called sweet carbohydrates. Carbohydrates are described by the number of sub-units they contain. Fructose and glucose are monosaccharides, that is, simple sugars. Sucrose, which is composed of fructose and glucose linked together, is a disaccharide; it comprises a little over 1% of the composition of honey. Honey contains

other disaccharides which make up over 7% of its composition. Some of the disaccharides in honey are maltose, sucrose, kojibiose, turanose, isomaltose, and maltulose.

In addition, honey also contains carbohydrates known as oligosaccharides. These are medium-sized carbohydrates, containing more than three simple sugar sub-units, often made of mono- and disaccharides. Oligosaccharides are sometimes referred to as “higher sugars.”

Is honey sweeter than sugar?

Fructose is slightly sweeter

than sucrose, glucose is less sweet, and maltose even less sweet. In most honeys, fructose predominates and tends to make honey taste slightly sweeter than sugar. Some honeys which are very rich in fructose tend to taste very sweet, but there are a few types of honeys which contain more glucose than fructose.

On the average honey is 1 to 1.5 times sweeter (on a dry weight basis) than sugar. Liquid honey is approximately as sweet as sugar, yet it contains only 82.4 g carbohydrates/100 g (vs. 100 g for sucrose) and provides only 304

Table 1. Carbohydrate Composition of Honey

Carbohydrates In Honey	Average	Range	Standard Deviation
Fructose (%)	38.38	30.91-44.26	1.770
Glucose (%)	30.31	22.89-40.75	3.040
Reducing Sugars (%)	76.65	61.39-83.72	2.760
Sucrose (%)	1.31	0.25-7.57	0.870
Fructose/Glucose Ratio	1.23	0.76-1.86	0.126

Kcal/100 g (vs. 400 Kcal for sucrose).

What is the importance of the carbohydrate composition of honey?

Because honey contains such a variety of carbohydrates and other nutrients, it is much more than just a sweetener. The carbohydrates, major monosaccharides and minor oligosaccharides of honey, are responsible for some of its key functional properties. The ability of honey to hold moisture and extend shelf-life, its microwave reactivity and its ability to promote color and flavors development are all related to its carbohydrate composition.

Another important aspect of honey carbohydrate composition is crystallization. The fructose/glucose and glucose/water ratios are parameters which are used to help predict the tendency of honey to crystallize. honeys with a low glucose/water ratio generally do not crystallize easily.

What are the oligosaccharides of honey?

About 3 to 4% of the composition of honey is made up of oligosaccharides. Examples of oligosaccharides found in honey include erlose, theanderose, and panose. These sugars are formed when nectar and

honeydew are converted to honey.

How much "sugar" does a tablespoon of honey contain?

One tablespoon of honey weighs 21 grams, approximately 17 grams of that are carbohydrates. The total sugar content is the sum of all mono-, di- and oligosaccharides.

What is the caloric value of honey?

Using the usual value of 4 calories per gram, one tablespoon of honey contains 17 grams of carbohydrates and 64 calories (kcal). FDA guidelines suggest that, alternately, one may use the Atwater factor of 3.68 calories per gram of carbohydrate for calorie calculations.

What is the method used to measure carbohydrates in honey?

Various methods exist to measure total sugars, individual sugars (glucose, fructose, sucrose, and maltose), and higher sugars. The Association of Official Analytical Chemists International publishes official testing methods (AOAC 1995, 16th edition, section 44.4). Most laboratories can do these tests or have developed alternate techniques. The technique of choice will depend upon the particular situation. A list of laboratories is available

from the National Honey Board.

Are honey's carbohydrates fermentable?

Approximately 95% of the carbohydrates found in honey are fermentable. This characteristic is important for the manufacture of honey beers³ and wines, and in bakery applications. However, pure honey with a carbohydrate content $\geq 83\%$ or a moisture content $\leq 17.1\%$ will not ferment when stored properly.

Does honey contain "complex" carbohydrates?

Honey does contain small amounts of oligosaccharides but no "complex" carbohydrates such as fiber.

Does the sweetness of honey vary?

Although monofloral (from a single type of flower) honeys may have very different flavors and aromas, their sweetening "power" is similar (see table below). However, a few floral types of honeys which are very rich in fructose may taste somewhat sweeter. Manufacturers commonly use blends of honey which have been mixed to provide a consistent sweetness and flavor.

How does honey interact with sweet flavors?

Honey is a potent sweetness enhancer,

especially when added to products with low levels of sweetness. The sweetness intensity of honey increases with increased honey concentration, to a point. Research has shown that the addition of 25% honey to a 5% sucrose solution doubles the intensity of sweetness.⁴ The sweetness enhancement effect is somewhat less pronounced when honey is added to sweeter products. The addition of 25% honey to a 10% sucrose solution increases the sweetness intensity by 16%.

Is honey hygroscopic?

Because it is a highly concentrated “sugar” solution rich in fructose, honey can absorb water readily under certain conditions. In some

bakery products, honey is added to extend shelf-life and “lock” moisture in the product.⁵ Bakers often substitute 10-15% or more of a bakery product’s total sugar with a corresponding amount of honey. Research has also shown that honey can be successfully incorporated at levels as high as 12-15% in dry products such as breakfast cereals,⁶ potato chips⁷ and extruded snacks.⁸ It has been suggested that direct incorporation of liquid honey by extrusion processing may impart a protective effect against moisture absorption by the hygroscopic honey components.

Does honey depress the freezing point?

A 68% honey solution freezes at 21.6 °F (-12.01

°C), and a 15% solution at 29.44 °F to 29.25 °F (-1.42 °C to -1.53 °C). However, the freezing point depression effect is not very pronounced in product applications.

Research on honey ice cream and frozen desserts and honey has shown the following:

- The initial freezing point was 27.1 °F for control (cane or beet sugar) ice cream, and 25.8 °F for honey-sweetened ice cream (only 1.3 °F difference).
- After 60 days of storage at 10 °F there were no differences between products.
- The honey ice cream was similar to a product containing 5% fructose as a carbohydrate, among other sweeteners present⁹

Are the carbohydrates in honey present in microwaveable products?

Research has shown that honey is more microwave reactive than high fructose corn syrup.¹⁰ Honey can be used as a browning agent or surface coating in a wide range of microwaveable products. These include snacks such as

Table 2. Sensory Profile of Honey in Aqueous Solutions (sweetness intensity perception)

Honey Concentration	Clover Honey	Orange Blossom Honey	Wildflower Honey
25% Concentration	98.6	99.4	95.4
50% Concentration	129.6 ^a	124.6 ^{a b}	120.5 ^b
75% Concentration	137.0	137.2	131.9
100% Honey	130.1	134.3	130.1

^{a, b} The values within a row which are not followed by the same letter are significantly different at p ≤ 0.05.

**Table 3. Using Honey Instead of Other Sweeteners
(Substitutions Based on Carbohydrate Equivalencies)**

Sweetener (Average Values)	% Solids	% Water	Replacement of 1 kg (1000 g) Sweetener with Honey
Honey	82.4	17.6	
Sugar/Sucrose	100.0	0.0	Add 1.214 kg of honey and subtract 0.214 kg liquid from total formula
High Fructose Corn Syrup	71.0	29.0	Add 0.862 kg honey and 138 g liquid
Corn Syrup	80.3	19.7	Add 0.974 kg honey and 26 g liquid
Molasses	72.0	28.0	Add 0.874 kg honey and 126 g liquid

⁸ NHB. 1995. Honey in Extruded Snacks. National Honey Board, Longmont, Colorado.

⁹ Bachmann, L. 1995. Research Shows Consumer Acceptability of Frozen Desserts with Honey. The National Dipper 11(4):30.

¹⁰ Kevin, K. 1994. Making Microwave Ingredients User-friendly. Food Processing 12:74

¹¹ NHB and AIB. 1990. Honey: Its Utilization in Bakery Products. National Honey Board, Longmont, Colorado, American Institute of Baking, Manhattan, Kansas.

potato, corn or cereal-based chips as well as muffins, cookies, brownies and other baked goods.

How can honey be substituted for sucrose in food products?

Manufacturers need to consider that honey contains an average of 17.1% water. A simplified practical substitution formula on a sweetness/moisture basis is: subtract 1.8 lbs of water from the original formula for every 10 lbs of honey added. Other substitutions are found in the Table 3.¹¹

References

¹ USDA. 1962. White, J.W. Jr. et al. Composition of American Honeys. Tech. Bull. 1261. Agricultural Research Service, USDA, Washington, DC.

² White, J.W. Jr. 1980. Detection of Honey Adulteration by Carbohydrate Analysis. JAOAC. 63(1):11-18.

³ Lagrange, V. 1994. A Honey of a Beer. Brewers Digest 12:13.

⁴ Resurreccion, A. 1995. Effect of Enhancement of the Basic Tastes and Desirable Flavors by Honey. Unpublished manuscript. Dept. of Food Science, University of Georgia, Athens, Georgia.

⁵ NHB and AIB. 1990. Honey. Its Utilization in Bakery Products. National Honey Board, Longmont, Colorado, American Institute of Baking, Manhattan, Kansas.

⁶ Neumann, P.E., and Chambers, E. 1993. Effects of Honey Type and Level on the Sensory and Physical Properties of an Extruded Honey-Graham Formula Breakfast Cereal. Cereal Foods World 38(6):418.

⁷ Demetriades, K., et al. 1995. Evaluating the Role of Honey in Fat-free Potato Chips. Food Technology 49(10):66.