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The Not So Sweet Story Of SWEETENERS

Start A Counter-Revolution. Know The Enemy.

James Fischer

The Honey Counter-Revolution

A counter-revolution? Don't worry; no one needs to worry about buying camouflage fatigues or target practice at the rifle range. It's a kitchen-counter revolution. The goal is to liberate the slaves to sugar and artificial sweeteners, by replacing sugar bowls with honey jars. Ambitious? Yes. Difficult? Yes. But without a strategy that promotes your honey as a healthy and natural alternative to the sugar bowl itself, national trends appear to indicate that honey sales will shrink.

Let me explain

My father was a salesman until he retired and started keeping bees. He sold lighting fixtures, and developed an encyclopedic knowledge of not just the products he sold, but more importantly, the competition's products. He was able to discuss the advantages of one light versus another in great detail, so his way of "selling" was more "applications consulting" to builders and architects than a "sales pitch." It worked.

What does this have to do with honey? Well, if you want to sell honey, it helps to know "the competition." Consumption data indicate that honey is one of the more rarely-used sweeteners available, so even a small change in consumer habits for a tiny percentage of consumers would have a significant impact on the demand for honey.

The good news for us is that the competition makes claims that are most charitably described as "blatantly misleading." Consumers do not like to be misled, especially about food. You need not make extravagant claims about honey, you only need to debunk the misleading propaganda about the alternatives.

Honey was the original sweetener. Every other sweetener was created in an attempt to replace honey with something cheaper. Most people will agree that life is too short to tolerate cheap peanut butter, so honey should be an "easy sell" to anyone who cares at all about what they eat. (To quote my father, "Sure, you could use the cheaper stuff, but people will notice and remember.")

The Decline Of Cooking

The NPD Group, a market research firm, found that in 1993, 99% of U.S. households had a skillet. In 2002, the number dropped to 93%. That's a net decrease of over one million skillets per year. (If one does not even own a skillet, one can be assumed to have abandoned cooking for mere "reheating" of packaged food.) In 1993, 21% of U.S. dinners eaten at home had ready-to-eat main entrees, in 2002, it was up to 36%. Over the same time period, meals served with homemade desserts decreased from 7% to 3.5%.

Your grocery store may have already expanded their "deli" and "bakery" into a "ready-to-eat meals" department, complete with a salad bar. These "meal solution centers" are cropping up everywhere. Convenience stores, gas stations, airports, and shopping malls all offer "take out." Now the reason for all those cup holders in newer vehicles should be clear – will the minivan replace the dining room? No one is saying, but the 2000 Ford Excursion SUV came with seating for nine and 10 cup holders. The current Volvo V70 seats five, but has nine cup holders. You do the math.

While we can all understand that life can get hectic for people who have not discovered "life in the slow lane" as a beekeeper, it seems clear that cooking (with or without honey) is slowly becoming as obscure and arcane a skill as beekeeping.

To make matters seem even worse, the same surveys found that 77 cents of every dollar spent on "dining out" in 2002 was spent at a fast-food chain restaurant.

What Happens After What Comes Next

The combined impact of these trends means that we can't expect to increase our honey sales to consumers or expect demand to keep the prices up unless we can get them to think about replacing the sugar bowls on their kitchen tables with honey pots, and consider abandoning artificial sweeteners for honey. Taking on the competition head-on means that you need to know more about the competition than the customer does.

Price alone can't be the problem, given what people will pay for Ghirardelli chocolates. The Starbucks and Dunkin' Donuts coffee shop chains have clearly shown that marketing alone will convince people to pay them more than triple

the going price for a cup of coffee. Honey has a fine "premium product" reputation, proven by the large number of packaged food products that feature the word "Honey" in large letters on the label. Honey even has a very valuable cachet of "natural" that sugar and artificial sweeteners can never gain. "Natural" sells, if for no other reason than it makes Mom feel less guilty about owning a stainless-steel Sub-Zero fridge filled with heat-and-serve packaged foods and using the microwave more often than her $4,500 Aga range.

The only hurdle appears to be that beekeepers are unwilling to ask people what else they currently keep on the kitchen table, and discuss the merits of that sweetener as compared to honey. So read on, and think about how easy it would be to convince people to try using honey instead of sugar or chemical sweeteners.

A Brief History Of Sweeteners

It is likely that humans sought out honey even before they were recognizable as human. Food was likely in sporadic supply for early man, energy requirements were high, and honey would have been a rare treat. Man was predisposed by instinct to favor sweet things, since most everything that tasted sweet was not poisonous.

Most present-day humans have easy access to abundant food, and are not required to physically exert themselves very much, but we are still influenced by the same drives as our primitive ancestors. We still crave sweet stuff.

Despite the near total lack of situations where modern humans might need a high blood sugar level to help them escape from large toothy predators, sugar or sweeteners are added to nearly every packaged food product sold. These hidden added sweeteners are the dreaded "empty calories" that your mother warned you about, devoid of any food value other than the sugars themselves. Sweeteners are added for two reasons. First, they are cheap.

Second, there is a direct connection between sweetness and sales. Food conglomerates are well aware that all they need do to increase flagging sales of a packaged food product is to increase the amount of sweeteners they add.

Fat-Free and Fact-Free

For at least a decade, "reduced fat" and "fat-free" food has been promoted as "more healthy." Makers of packaged foods have responded to demand, and in some cases, helped to create concern about fat. This meant more demand for "fat-free" food. The problem was that in removing fat, the packaged food products were left bland and tasteless. The "answer" was to add sweeteners, most often corn syrup. But when you add sweeteners, the calories go up. As a result, many people buying "low-fat" foods are actually consuming more calories than before due to added sweeteners. "Low-fat food" did not result in people becoming less fat. It made many of them even fatter.

Added Sweeteners And Health

The expanding waistlines of the population of the industrialized world has resulted in a new and unique health problem. The rich and middle classes are thin and healthy, while the poorer among us suffer from obesity. Traditionally in human history, the poor have been thin, while the rich have been fat. Ongoing obesity in most cases leads directly to diabetes, and not surprisingly, medications to help diabetes patients are suddenly one of the largest growth markets for drug makers.

The USDA says that Americans' consumption of sweeteners has risen significantly over the last 40 years. Somehow, we went from 113 pounds per person in 1966 to 147 pounds in 2001. Added sugars, as opposed to naturally occurring sugars in fruit and other foods, are a little more than 15 percent of Americans' daily caloric intake.

While doctors, health experts and regulatory officials now realize that their emphasis on "fat free" has resulted in a problem worse than the one they hoped to solve, their attempts to educate consumers about "added sugars" have been frustrated by sophisticated marketing of high-profit products like soft drinks and packaged foods.

Big Profits Versus World Health

This Spring, the World Health Organization published a report suggesting that all forms of "added sugars" (over and above the natural sugars found in foods) should make up no more than 10% of the daily diet. While 10% is a very high number, the sugar lobby in the United States reacted by demanding that Congress cut off the World Health Organization's funding. Since the U.S. funds roughly a quarter of the WHO's operations, this would could put the WHO out of business.

The sugar industry was not at all happy with anyone suggesting that added sugars should be restricted to a mere 10% of our total diet. They want us all to buy more of the packaged food products that contain added sugars. The sugar industry is a significant special-interest group in U.S. lobbying and politics, handing out over $3 million in donations in last year's federal elections, according to the Center for Responsive Politics. It represents both sugar cane and corn farmers who grow corn for corn syrup.

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All Sweeteners Are Not Created Equal®

While artificial sweeteners like Equal® are clearly artificial manufactured products, most all so-called "natural" sweeteners also come from factories. Most natural sweeteners are no sweeter in their natural state than nectar. They must be refined to concentrate them, and make them taste sweet. In the process of refining, any part that is not a sugar is removed, including any nutrients.

Honey also comes from a "factory refinery" of a sort – a beehive. Nectar is evaporated, and in the process, becomes more concentrated. Unlike other sweeteners, all that is removed in the process is water, so honey has a small amount of protein and some nutrients. If not heated or filtered to extreme, honey has the clear advantage of being "exactly as nature intended."

But what exactly did nature intend? Nature uses multiple forms of sugar in nearly every creature and plant, so we have to get into some basic biochemistry before we talk about specific products.

There are three simple sugars, or "monosaccharides." These are Glucose, Fructose, and Galactose.

Glucose, also called "dextrose," is found in vegetables, fruit, and honey. When it is in the human body, it is called "blood sugar." In plants, glucose is synthesized from water and carbon dioxide by photosynthesis. In animals, glucose can be synthesized from fats, carboxylic acids, and amino acids. Glucose is made of six carbon atoms (carbo...) and hydrogen and oxygen equal to six water molecules (...hydrate), so glucose is the simplest form of a carbohydrate.

Fructose, also called "levulose" or "fruit sugar," is found in many fruits. Honey contains about 40% fructose.

Galactose exists almost exclusively in the bodies of mammals. Mammals can change glucose to galactose, and female mammal mammary glands convert galactose to lactose, which is "milk sugar."

Although these three simple sugars share the same molecular formula ($C_6H_{12}O_6$), the arrangement of their atoms are different. Chemicals with identical molecular formulas but different structural arrangements are called "structural isomers" by chemists.

Glucose can be converted into the other two simple sugars (and other sugar molecules) via minor chemical changes like reorienting the location of hydroxyl groups, such as when it is converted into galactose, or by oxidizing one carbon and reducing another by shifting the locations of the hydrogen atoms, such as when it is converted into fructose.

All more complex sugars are made by bonding these three simple sugars together in various ways.

I'm Dying For Some Disaccharides

Disaccharides are nothing more than pairs of simple sugars. Their names are sucrose, lactose, and maltose. Sucrose is common table sugar. It is made from glucose and fructose, which form a crystal when combined. Lactose is the major sugar in milk. It is made of glucose and galactose. Maltose is a product of starch digestion, such as when beer is brewed. It is made of pairs of glucose molecules.

Is Honey a Disaccharide?

Honey contains glucose and fructose, but it is not a disaccharide. The bulk of the glucose and fructose exist as separate simple sugars. A tiny amount of the glucose and fructose in honey is bound together to form sucrose, but this varies with different nectar sources, explaining why some types of honey, such as orange blossom honey, crystallize more easily than others. The crystals of sucrose act as "seeds" to encourage crystallization in the honey.

Starches Are Sugar Too!

When you link more than two simple sugars together, the result is called a "polysaccharide," or, in plain English, a "starch." There are two major types of starch – Amylose and Amylopectin.

An amylose is a linear, unbranched chain of several hundred glucose molecules. Amylopectin does not have a "linear" structure, but is "branched" like a tree.

Plants convert excess glucose into starch for storage in the form of roots (tubers) and seeds. Potatoes, rice, wheat, and corn are major sources of starch in the modern human diet.

Before starches can be used by animals, they must be digested. This is accomplished by chemicals called "amylases." With the aid of an amylase (such as pancreatic amylase from your pancreas), water molecules break the bonds between glucose molecules and eventually produce a mixture of glucose and maltose. Your body can't tell the difference between glucose from starches, from sugar, or from honey. Glucose is glucose, no matter how your body gets it.

Cellulose – How Plants Store Sugars

Cellulose is likely the single most abundant organic molecule on the planet. It is the major structural material in plants. Wood is mostly cellulose, while cotton and paper are almost pure cellulose. Like starch, cellulose is a polysaccharide made from glucose.

However, cellulose is very different from starch. Because of the orientation of the bonds between the glucose molecules, the end result is a long, rigid molecule. These linear molecules can lie close together, and form hydrogen bonds between adjacent molecules. The result is a series of stiff, long fibers that make up the cell walls of plants.

Glycogen – How Animals Store Sugars

Animals store excess glucose by polymerizing it to form glycogen. The

structure of glycogen is similar to that of the starch amylopectin, although the branches in glycogen are shorter and more frequent. (A "bush" as compared to the "tree" of amylopectin.)

Glycogen is broken back down into glucose when energy is needed, in a process called glycogenolysis. In glycogenolysis, phosphate groups – not water – break the linkages so that glucose can leave or enter a cell. Your liver and skeletal muscles are major storage depots of glycogen.

Sugars In Food

Now that you have digested the chemistry refresher course, we can look at specific sweeteners, compare them, and consider how they compete with honey for a place on the kitchen counter.

Raising Cane

Cane sugar comes in many different forms, but it is all nothing but sucrose. It is all processed in factories that produce significant air and water pollution, but are slowly being forced by environmental laws to clean up. The sugar that one can buy is not "natural" in the least, but the sugar makers use the word "natural" so often, one might get the impression that their products were some sort of health food.

All forms of cane sugar start with a sugar cane field in a subtropical location. The canes have leaves, and the universal practice is to burn the field to eliminate the leaves and any undergrowth from the roughly 10-foot tall canes to be harvested. The smoke from the fall burning is enough of a hazard that the state police in both Florida and Hawaii are forced to close roads when the wind shifts in an attempt to reduce traffic accidents caused by the smoke. (That's right, sugar is "white death" even before it is even white. Ask anyone who lives in Palm Beach County or Hendry County, Florida about the "fall smoke.")

The harvesting of sugar is slowly being mechanized, but about half of U.S. production is still harvested by hand with machetes. This is a labor-intensive process, so much so that sugar plantations in the Caribbean were among the first customers of the slave trade. The infamous "slave triangle" described in our history books was based on sugar. American-made rum was sold for African slaves, who then were sold in the Caribbean for molasses and sugar that were, in turn sold to rum distillers in the U.S., with large profits made at every step. (Wow, sugar was responsible for slavery!)

Whatever harvested cane does not fall off the trucks to punch holes through unsuspecting drivers' oil pans and radiators (yes, this really happens) goes through a mill.

The milling process starts by shredding and crushing the canes between rollers to extract the juice. The juice is clarified with lime, and allowed to settle. Then it is boiled in vacuum chambers, until it thickens into a brownish syrup. As the water evaporates, the sugars become concentrated enough to form crystals. The wet crystals are then spun in perforated drums to spin off the liquid, leaving the semi-refined sugar. This is the actual "raw sugar."

It contains all sorts of molds, yeasts, dirt, plant fiber, bacteria, and a not insignificant quantity of insect parts and their debris. The FDA won't allow this sugar to be sold as food – true raw sugar is "unfit for human consumption" under U.S. law.

The liquid that was thrown off by the spinning drums is what becomes molasses. It also needs quite a bit of "cleaning up" before it can be sold for human consumption.

The cleaning up is done at a refinery. The refinery washes, then dissolves the crystals, boils it again, then recrystallizes and spins it at least twice more, removing more molasses and "solids" at each step. Molasses is where the non-sucrose components of sugar cane go, including any vitamins and minerals.

Brown Sugar

Sugar pulled out before one of the final washing and recrystallization cycles is "brown sugar." It has been refined enough to remove all but a tiny fraction of the molasses, which gives it a brown appearance and stronger flavor.

But most brown sugar is nothing more than fully-refined white sugar that has been sprayed with some molasses after the complete refining process. Domino and C&H are among the few brands that sell

legitimate brown sugar, most all other brands are nothing but fully-refined table sugar "spray-painted" with some molasses.

Raw Sugar – A Raw Deal

The brownish packets of "Sugar In The Raw®" one can find in many coffee shops are not "raw sugar." They are nothing but "Turbinado Sugar," which will be described later. The folks that make "Sugar In The Raw" claim that their sugar is from the "*initial pressing of the cane, allowing the natural molasses to remain in the crystals*," a phrase that is apparently intended to conjure up images of winemaking, where "initial pressing" implies "best quality." With sugar, the reverse is true. Sugar from the actual "initial pressing" is an inedible substance that could not be sold as food for humans. Even more amazing is the total disdain shown in the assumption that their customers are uneducated enough to think that molasses (a collection of various impurities) can somehow be "in" crystals of sucrose. The impurities are "on" the crystals, not "in" them. This much more expensive sugar needs to be exposed as "100% plain old sugar with lots of added hype."

Brown Versus White

There are a large number of people who think that brown (or brownish) sugar is more "healthy" than white sugar. This mistaken belief is openly encouraged by the promotional efforts of sugar compa-

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A Summary Of "The Competition"

Name	What It Is
White Sugar	Sucrose
Evaporated Cane Juice	Sucrose
Sucanat	Sucrose
Beet Sugar	Sucrose
Brown Sugar	Sucrose & Molasses
Turbinado Sugar	Sucrose & Molasses
(Real) Maple Syrup	Boiled Tree Sap
Date Sugar	Dried Dates
Stevia	Dried Leaves

ARTIFICIAL TABLE SWEETENERS

Sweet 'N Low®	Saccharin
Equal®	Aspartame
NutraSweet®	Aspartame
Sunett®	Acesulfame Potassium
Sweet & Safe®	Acesulfame Potassium
Sweet One®	Acesulfame Potassium
Splenda®	Sucralose

SWEETENERS FOUND MOSTLY IN HEALTH-FOOD STORES

Invert Sugar
Brown Rice Syrup
Barley Malt
Fruit Sugar

INDUSTRIAL SWEETENERS HIDING IN PACKAGED FOODS

High Frutose Corn Syrup
D-tagatose
Sugar Alcohols
Polydextrose
Saccharin/Sweet 'N Low(R)
Aspartame/Equal(R)/NutraSweet(R)
Neotame
Sucralose/Splenda(R)
Acesulfame Potassium

nies about the "vitamins and minerals" in brown sugar that white sugar lacks. While it is true that white sugar contains nothing but sucrose crystals, the amount of "vitamins and minerals" in brown sugar are best described as "trace levels." You'd have to eat a massive and unhealthy amount of brown sugar to get any actual benefit from any of those vitamins and minerals. In comparison, the National Honey Board says that you'd have to eat only about 100 tablespoons of honey to get your Recommended Daily Allowance of a number of important minerals from that source. While some might consider this excessive consumption of honey, it is not only possible, but a certainty when we extract honey here at Farmageddon. (We have strict, ummm, "quality control standards." Yep, that's my story, and I'm sticking to it. "Very extensive quality control testing.")

Size Does Matter

A bewildering array of different types of granulated white cane sugar are available, and all are sold for much higher prices than the usual 5-lb bag of "table sugar." The only difference between them is crystal size.

"**Bakers Special Sugar**," or "**Castor Sugar**" in the UK, is the smallest crystal size. This is the sugar you most often find on doughnuts.

"**Superfine**," "**Ultrafine**," or "**Bar Sugar**" has only slightly larger crystals than Baker's Sugar. It is used in meringues, as well as for sweetening fruits and iced drinks since the smaller crystals dissolve more easily than larger crystals. (There are some bartenders that will call this "Fruit Sugar" but actual "Fruit Sugar" is fructose which comes, not surprisingly, from fruit.) "**Confectioners**," or "Powdered Sugar" is granulated sugar that has been ground to a smooth powder and then sifted. It contains about 3% cornstarch to prevent caking. Confectioner's sugar comes in three grades ground to different degrees of fineness.

"**Table Sugar**" is the common sugar that one most often sees. Note the subtle use of the term "table," implying that it belongs on the dinner table, rather than locked up with the guns, cigarettes, booze, explosives, and other dangerous items. Does anyone label their honey "table honey"? I thought not. No wonder the sugar bowl never leaves the kitchen table, while the honey is hidden in a cabinet, behind several other bottles. You have to admire sophisticated marketing. You can learn something from it.

"**Coarse Sugar**" has larger crystals than "Table Sugar." Coarse sugar is made from the most highly-refined sugar. This makes it more resistant to color changes or breakdown to fructose and glucose at high temperatures. This matters in cooking when making fondants, confections, and liquors.

"**Sanding Sugar**" is another large crystal sugar, used to sprinkle on top of baked goods. The larger crystals reflect light and look pretty.

Brown Stuff

With all the different types of white sugar, you did not think that the sugar-marketing geniuses would pass up the opportunity to sell multiple types of sugar/molasses mixes at ever-higher prices, would you?

"**Turbinado Sugar**" is sugar with a slightly larger crystal size than table sugar, and has not been washed to remove all the molasses, making it appear brownish. As with brown sugar, most all products called "Turbinado Sugar" are produced by simply spraying crystallized fully-refined white sugar with molasses.

"**Muscovado**" or "**Barbados Sugar**" is a British product. It is very dark brown and has a very strong molasses flavor that can only be an "acquired taste." The crystals are coarser and stickier than "normal" brown sugar.

"**Free-Flowing Brown Sugar**" is a technical innovation that avoids the "clumping" of brown sugar into hard lumps. A "cocrystallization" process is used to make brown sugar that is more of a powder than a crystal, and is less moist than brown sugar. Since it is less moist to begin with, it does not clump and is free-flowing like granulated white sugar. (Save your money, and put a small chunk of terra-cotta tile that you have soaked in water into your canister of brown sugar. This will "humidify" the canister, and keep the brown sugar from clumping.)

"**Demerara Sugar**" is another British product, essentially a very sticky large-crystal brown sugar. It is put in tea, coffee and on hot cereals.

"**Evaporated Cane Juice**" and/or "**Sucanat**" is one of the most cynical of the sugar industry's marketing forays, which like Turbinado Sugar, chatters on about being "*a 'first crystallization', minimally-processed sweetener made from fresh evaporated cane juice... harvested, extracted, clarified, evaporated and crystallized all within twenty-four hours...*" in hopes of making people think that it is something, anything other than pure sucrose with trace amounts of junk of an unspecified nature. Note that the word "sugar" will never appear on a package of "evaporated cane juice," since this form of sugar is sold to people who associate "sugar" with "bad nutri-

tion." You have to admit that the sugar people know how to package and market a product.

A Brief Word From The Salt Mines

Sugar promotional efforts have apparently taught the people who sell salt something about marketing. You may have noticed the sudden appearance of "Sea Salt" on grocery shelves, with crystals larger than usual. This one really makes me laugh, since it is strictly true that the package contains "sea salt." ALL salt came from seas, but all except a tiny fraction of what is sold happen to come from seas that dried up millions of years ago, and have been covered up by layers of rock since then. Real "sea salt" is evaporated from seawater, is very expensive, and is a snobbish affectation for social-climbing cooks who never took any chemistry, and want to impress people with the fact that they use salt from places where most people would like to vacation. As usual, vague hints that anything "more natural" or "less processed" is somehow different, better, and more healthy surround these "sea salt" products. The lesson should be clear to someone with a product that truly is natural.

Light Brown Versus Dark Brown

By now, you likely have figured out that "Light Brown Sugar" contains less molasses than "Dark Brown Sugar," and likewise, "Blackstrap Molasses" is simply darker than regular molasses.

You can dismiss all forms of sugar as "exactly the same" from not only a chemical, but also a health and nutrition standpoint with no fear of being even slightly wrong, but you should also stop and marvel and the sophisticated marketing used to make even experienced cooks think that they must buy more than sugar and molasses for their pantry. There has to be something that we can all learn from this about application-specific packaging and pricing for honey.

Even skilled bakers, who should know better, buy brown sugar rather than simply add molasses and white sugar to a recipe that calls for "brown sugar."

The Cane Mutiny

There are nearly as many non-cane sugars as there are types of cane sugar. While these products are nothing more than one or more of the same three simple sugars described at the start of this article, these products exist simply because they are not made from sugar cane, a point that is either stressed in an attempt to seem more healthy, or hidden completely if the product is cheaper than cane sugar.

"**Beet Sugar**" is what you get if you buy a bag of sugar at the store than does not say "Pure Cane Sugar" on the label. I'll bet your local store brand and generic brand sugar bags don't say "Pure Cane Sugar." In 1744, a German chemist realized that the sucrose he could extract from sugar beets was the same sucrose as sugar from sugar cane. (He broke the starches down into sugars with nothing more than hot water.) Napoleon supported the sugar beet growers when war with England resulted in blockades, halting sugar shipments from the Caribbean.

While crystals of sucrose from sugar beets should be no different than crystals of sugar from cane, experienced cooks avoid beet sugar when making frostings, jellies, and many cakes. I've yet to hear anyone explain the exact difference, but scanning electron micrographs reveal that cane sugar crystals are "cleaner-looking" than beet sugar crystals. Since pure sucrose would form similar "clean" crystal shapes regardless of source, it seems clear that refined beet contains a larger percentage of impurities than refined cane sugar.

"**Invert Sugar**" starts as refined sugar. Acid and heat break down sucrose molecules to a mixture of glucose and fructose. Candy manufacturers use invert sugar to control "graining." This is not a "consumer sweetener," but is used by advanced home confectioners.

"**Brown Rice Syrup**" is extracted from rice with enzymes that partly break down the starches into

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their component sugars, and is then strained and cooked. The final product is 50% "soluble complex carbohydrates," which means molecules of starch that were not completely broken down into sugars, 45% maltose, and 3% glucose. You won't find this much outside of health-food stores.

"**Barley Malt**," like brown rice syrup, comes from grain, specifically barley. It consists of about 40% "complex carbohydrates," 42% maltose, 6% glucose, and about 1% fructose. This is another health-food store product.

"**Fruit Sugar**" is pure fructose. Fruit sugar is claimed to have a more uniform crystal size than Bartender's Sugar from cane, but I keep forgetting to bring a microscope when I go to a bar, so I have not verified this. True fruit sugar will be clearly labeled as being made from fruit. If it does not say so, it should be assumed to have been made from corn syrup.

"**Corn Syrup**" and "**High Fructose Corn Syrup**" should be familiar to beekeepers as a food source for colonies in danger of early Spring starvation. This stuff is cheap to make, so it is ubiquitous in processed foods and beverages, even food found in "natural food stores." Despite the name, the fructose is not from fruit but comes from breaking down cornstarch with enzymes, acids, and heat. Corn syrup is the primary source of the "added sugars" in the diets of most of the industrialized world at present, so people who even go so far as to stop using sugar still get more sugars from corn syrup alone in their diet than nutrition guidelines suggest. "Dark Corn Syrup" is nothing more than Light Corn Syrup to which coloring and flavoring have been added.

High Fructose Corn Syrup In Both Food And Beekeeping

To make HFCS, processors first extract dextrose from corn. Enzymes are then used to convert the dextrose to fructose. The result is 42% fructose corn syrup, or "42-HFCS," which consists of: 42% fructose, 52% dextrose, 6% disaccharides – often supplied in a "70% solids" mixture, which means 30% water.

By filtering this mixture, most of the molecules larger than fructose can be removed, yielding 90% fructose corn syrup. This can then be mixed with 42-HFCS to make "55-HFCS," which contains: 55% fructose, 41% dextrose, 4% disaccharides – often supplied in a "77% solids" mixture.

These syrups are considered equal to cane sugar as bee feed, and, when purchased in quantity, are considerably cheaper than sugar purchased in bulk.

Bill Bernacchi of B&B Honey Farm, near La Crosse, WI supplies significant quantities of HFCS to commercial beekeepers, and says that while both 42-HFCS and 55-HFCS are adequate bee feeds,

"*Type 42 tends to crystallize easily, and when it does it is very hard and difficult to liquefy. It is used by very few commercial beekeepers. Those that use it are feeding when the weather is warm both day and night.*

Type 55 is the choice of commercial beekeepers. It crystallizes very slowly, and can be liquefied readily if it does set up. It is easier to liquefy than honey."

HFCS is most often diluted by beekeepers with an additional 10% water by volume to form a final HFCS concentration of between 60% and 70%.

While adding water slows the crystallization process, untreated water can contain bacteria that can cause the syrup to ferment or become rancid. The good news is that chlorine or chloramine in municipal water will kill the bacteria, but the bad news is that fluoride in municipal water is said to be toxic to bees over time. Water filters can block most of the fluoride and the chlorine or chloramine. (Yes, even water requires considerable thought in beekeeping.)

HFCS is available to the hobbyist beekeeper in five-gallon pails and 55-gallon drums from B&B Honey, Mid-Con, and Betterbee. Some local beekeeping associations also get together and split a large order.

Higher Than "High"

If "High Fructose" is not enough for your sweet tooth, you can buy 100% fructose made from corn syrup. A company named Estee in Garden City, NY sells crystallized fructose that they admit is "made from corn." Their marketing is much more primitive than their chemistry, as their product is named "Fructose Natural Sweetener," and their "pitch" is limited to "sweeter than sugar," "a sodium free food" and "no bitter aftertaste" in big letters on the side of the box. Perhaps they are simply being honest about their product.

Much Less "Manufactured" Sweeteners

There are a small number of sweeteners that cannot be dismissed as products of smoke belching factories owned by massive corporations. In a fair evaluation, these should be given nearly equal respect with honey.

Pure Maple Syrup and Maple Sugar come from the sap of hard maple, rock maple, and black maple trees. Anything that does not say "Pure Maple Syrup" likely has no actual maple syrup in it at all. I'm going to go easy on maple syrup, since there are a number of maple syrup producers who also keep bees, maple syrup is not a general-purpose sweetener that "competes" with honey, and I like maple syrup. (I'm still working on my long-term research project to officially settle the long-standing dispute over whether New Hampshire maple syrup is better than Vermont maple syrup or visa-versa, so producers from each state are encouraged to send samples for, ummm, "extensive testing" to me in care of this magazine. Please use plain, unmarked boxes, or the editor will grab it all.)

In late Winter, trees are tapped by boring a small hole to obtain the dilute juice or sap. This sap is strained and excess water is evaporated off, resulting in syrup. This used to be done in open kettles over a fire. Modern operations use multiple evaporators, and syrup producers love stainless steel as much as beekeepers. It takes approximately 34 gallons of sap to make one gallon of syrup. If this maple syrup is heated to about 230°F and cooled quickly without stirring, it will crystallize and form maple sugar.

"**Date Sugar**" is another sweetener that deserves respect. It is made from dehydrated dates that are ground into a powder. It has roughly the same nutrient value as dried dates, which makes it the only sweetener that can be truthfully said to contain significant food value beyond the sugars.

An obscure product, "**Stevia**," is nothing but the leaves of a South American shrub. Though it is sweet, the FDA has not yet approved it as a food additive, so it is sold as an "herb" or "dietary supplement" with a wink and a nod. If studies are done that prove that it is safe, it could become the first bonda-fide natural "diet sweetener." The leaves contain several chemicals called glycosides, which taste sweet, but have no calories. Stevia has taken over 40% of the Japanese sweetener market, so it may become a major sweetener worldwide.

"**Sorghum Molasses**" is still available, and it was the first form of molasses made in the U.S. Sorghum stalks are ground up or pressed, and the juices drained. The exact final product depends upon the degree of evaporation.

What's Really In Honey

(Lifted from http://www.nhb.org/download/factsht/techbroch.pdf)

The National Honey Board says that overall, honey contains the following items, in the following amounts:

	Average		Average
Fructose/Glucose Ratio	1.23	Moisture, %	17.2
Fructose,%	38.38	Reducing Sugars, %	76.75
Glucose,%	30.31	Sucrose, %	1.31
Minerals (Ash),%	00.169	Total Acidity, meq/kg.	29.12
		True Protein, mg/100g.	168.6

The Major Enzymes Present In Honey

Enzyme	Function
Invertase	Converts sucrose to glucose and fructose
Amylase	Hydrolyzes starch to dextrins and/or sugars (diastase)
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

Nutrient Values

Nutrient Average amount Average per 1 Tbsp. serving amount (21g) per 100g

Water 3.6g
Total Carbohydrates 17.3g
Fructose 8.1g
Glucose 6.5g
Maltose 1.5g
Sucrose 0.3g

VITAMINS

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

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

Information For Nutritional Labeling*

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

MINERALS

Calcium 1.0 mg
Iron 0.05 mg
Zinc 0.03 mg
Potassium 11.0 mg
Phosphorous 1.0 mg
Magnesium 0.4 mg
Selenium 0.002 mg
Copper 0.01 mg
Manganese 0.03 mg
Ash 0.04 g

Semi-Artificial Sweeteners

There are three sweeteners that can be made from "natural" sources, but require quite a bit of fancy chemistry to create. None of these are consumer products; all are special-purpose chemicals for highly-processed food.

"**D-tagatose**" is about 92% as sweet as sucrose, but it is poorly metabolized, has a net impact of only 1.5 calories per gram instead of the four calories per gram one gets from all forms of carbohydrates. Structurally, it is close to fructose. Tagatose can be made from whey, a byproduct of cheese making.

"**Sugar Alcohols**," such as

Continued on Next Page

Sorbitol, Xylitol, Lactitol, Mannitol, and Maltitol are used mainly to sweeten sugar-free candies, cookies, and chewing gums. These forms of sugar are so poorly metabolized by the human body that the term "sugar free" is fairly accurate for products that include these chemicals.

"**Polydextrose**" is synthesized from glucose, plus roughly 10 percent sorbitol and 1 percent citric acid. It is used as a replacement for sugar, starch, and fat in low-priced, low-quality commercial cakes, candies, dessert mixes, gelatins, frozen desserts, puddings, and salad dressings.

Sweeteners Not Found In Nature

All artificial sweeteners face a serious and basic problem. No one knows one from another, and most of them have caused cancer and other severe health problems in white lab mice. Never mind that mice are a lousy stand-in for humans in many ways, and don't even bother to mention that most "white lab mice" are actually rats of a breed called "Norwegian Gray." Bottom line, artificial sweeteners scare people. They have every right to be scared.

Cyclamate was marketed in the 60s as a "miracle product," but FDA banned it in 1970 after evidence emerged linking it to bladder cancer. Subsequent studies have failed to verify that link, so the FDA is considering a petition to re-approve cyclamate. This product will likely undergo a significant name change if the FDA re-approves it, as the story of cyclamate is too well known.

Saccharin (Sweet 'N Low®) is a synthetic compound derived from coal tar. (Yum! Pass the COAL TAR!) It is claimed to be 300 times sweeter than sugar. Saccharin is forced to carry a warning label, since U.S. studies in 1972 and 1973 of rats fed saccharin resulted in bladder cancer, and a 1977 Canadian study confirmed the U.S. studies. The FDA proposed to ban saccharin for all uses except as an over-the-counter drug, but since it was the only sugar substitute available at the time, it was not banned. More recently, the FDA considered removing it from the list of known carcinogens. Expect another name-change for this chemical, since it has nearly as bad a reputation as Cyclamate.

Aspartame is sold under the brand names Equal® and NutraSweet®. The beverage industry, the biggest user of artificial sweeteners, likes aspartame because it has no aftertaste and requires no warning label. Independent studies have suggested that it contributes to the "formation of formaldehyde adducts," and the approval of this chemical was the subject of a great deal of controversy even within the FDA. In essence, formaldehyde is a scary thing as it damages to the neurological system even at very low levels. The only warning label on products containing Aspartame says "Phenylketonuric" or "Contains phenylalanine." Phenylketonuria is a rare genetic disease in which the body cannot use the chemical phenylalanine.

Neotame is a new chemical approved by the FDA in 2002. It is very similar to Aspartame and is claimed to be 30 times more powerful a sweetener than aspartame. There is also a great deal of controversy surrounding this chemical, as it is hard for anyone to ignore reputable scientists doing independent studies and using terms like "neurotoxin" in their reports. Since the same company makes both aspartame and neotame, expect to see neotame in packaged food products, but not as a sweetener packaged for sale to consumers.

Sucralose is sold under the brand name Splenda®. It is a chlorinated form of sucrose, so it is derived from sugar, but is non-caloric, and contains less than one gram of carbohydrates. Pre-approval testing showed that side effects included shrunken thymus glands, enlarged livers, and enlarged kidneys, but the maker argued that this was only at very high doses, convincing the FDA to approve it.

Splenda has been the subject of a recent and massive advertising blitz claiming that "Splenda is made from sugar, so it is as safe as sugar." But is it? There have not been any long-term studies on the effect of this chemical on humans, not even a 12-month or 24-month study, and in the tiny number of studies done on this chemical, the lab rats did not fare well at all.

The "chlorinating" process used prompts concern on the part of some health experts. The process chemically changes the structure of the sugar molecules by substituting three chlorine atoms for three hydroxyl groups. But are the resulting chlorine atoms "safe" like in salt, or a potential health problem, like in "Chlorinated Pesticides" such as DDT? Only time will tell, but the actual chemical name for what comes out of the "chlorinating" process is "1,6-dichloro-1,6-dideoxy-BETA-D-fructofuranosyl-4-chloro-4-deoxy-alpha-D-galact opyranoside," so it should be clear that this stuff bears no resemblance to sugar at all, and is a much more complicated structure than the simple bonding of sodium and chlorine to form salt.

The manufacturer claims that sucralose passes through the body rather than being metabolized, but the FDA disagreed, finding that 11% to 27% of sucralose is absorbed in humans. The bottom line here is that we have a very complex chlorinated molecule, one metabolized by the human body, and one where no one has even bothered to looked at health effects on humans for a single year.

Another problem with sucralose is purity. The FDA says that sucralose "is produced at an approximate purity of 98%." The other 2% varies, but includes contaminants like heavy metals (such as Lead), Arsenic, Triphenilphosphine Oxide, Methanol, Chlorinated Disaccharides, and Chlorinated Monosaccharides.

In contrast, if such contaminants were found in honey at even parts-per-billion levels, entire shipments of honey would be seized,

product recalls would be issued, and a great deal of negative publicity would result. Somehow, chemical sweeteners can be sold even though they are contaminated at rates as high as 2%.

Acesulfame Potassium is sold under the names Sunett®, Sweet & Safe®, and Sweet One®. It is FDA-approved for baked goods, frozen desserts, candies, and beverages. The Center for Science In The Public Interest urged the FDA to ban this chemical based upon both inadequate testing, and cancer in test animals resulting from what little testing was done.

In summary, artificial sweeteners are easy to sell against, by simply learning what they really are, and cutting through the marketing hype to expose the chemistry set of substances found in every package.

But What Goes On The Table?

Don't make the mistake of thinking that plastic squeeze bears are the only packaging required to get honey a place on the dining room table. Take a look at sugar bowls – they match the china. While every beekeeper meeting silent auction includes decorative honey pots and dippers, using dippers can be a messy experience for those unfamiliar with them.

A better alternative is a "syrup dispenser" of the type found at diners. These have a sliding metal tab that opens when a trigger is pulled or a lever is pushed, and closes when released. This metal tab cuts off the flow of honey cleanly without drips, and does a good job of keeping the honey sealed away from air, dust, and moisture.

Restaurant supply houses sell these for as little as $2 each. Fancy versions exist, but you need to have these available for sale, or at least to show the customer a dispenser that works without looking tacky.

How Do You Use Honey Where A Recipe Calls For Something Else?

This is another common question, and is easy to answer. Honey can easily replace sugar in most any recipe. 3/4 cup of honey replaces one cup of sugar. Reduce liquids by one-half cup for each cup of honey you add to the recipe.

To substitute honey for molasses, use exactly the same amount. The resulting flavor and color will be "lighter."

To substitute honey for corn syrup, use exactly the same amount, but consider reducing other sweet ingredients, as a honey is sweeter than consumer-packaged corn syrup.

Dealing With The "Honey Is Messy" Objection

Clearly, people who cook and care about what they eat are the prime targets for the suggestion that honey can replace other sweeteners, but cooks must measure their ingredients, and honey can be a problem, as more seems to stick to the measuring cup than go into the mixing bowl. The answer is a "Wonder Cup," a measuring cup in the form of a cylinder with a bottom that can be pushed up to the top edge, so that not a drop of honey is wasted. These sell at retail for about $5.00, and they really do work as claimed. Other techniques work as well including using a measuring cup for the oil component first.

Is Honey Sweeter Than Sugar?

Beekeepers get asked this question all the time, and it makes a great "science experiment" that requires no special equipment. School teacher's lounges are sure to have a microwave and/or a water cooler with a (red) hot water spigot, so you can even add this to a school beekeeper presentation.

Fill two cups with the same amount of boiling or hot water. In one cup, immediately add two tablespoons of sugar, measured with care. Once both cups have cooled, add two tablespoons of sugar to the unsweetened cup.

Once the sugar has dissolved, taste each. The cup you sweetened while it was hot will be noticeably sweeter.

The initial conclusion might be that more sugar dissolves in hot water than in cold water. But you added the same exact amount of sugar to each cup, and you can see that all the sugar is completely dissolved in both cups.

Then why is one sweeter than the other? The hot water inverts the sugar (sucrose) to become glucose and fructose, and fructose is sweeter tasting than the more complex sucrose. Since honey contains more fructose than sucrose, there are very similar odds that your taste buds will encounter the sweeter fructose, and consistently experience a "sweeter" sensation with honey as opposed to sugar.

Sweetener Sweetness Relative To Sucrose

Sucrose	1.0
Glucose	0.6
Fructose	1.73
Lactose	0.16
Mannitol	0.6
Sorbitol	0.5
Xylitol	1.0
Maltose	1.0

Gee, that's neat Mr. Science, but what about people over 10?

Easy – offer a taste test. If you are like most beekeepers who sell to the public, you lay out disposable spoons or straws and a "taster" jar front and center. Keep a handful of packets of each of the competition's products in your pocket, and do the obvious. Even honey of marginal quality will "win," since all the other stuff tastes like "nothing."

Invasion of the Space Sugars!

Scientists found extraterrestrial sugar compounds in the "Murchison" and "Murray" meteorites. This discovery gives solid support to the view that meteorites could have delivered compounds that contributed to the development of life on Earth.

The meteorites have a higher concentration of simple sugars than of the large, complex sugars that are abundant on Earth. Also, the ratio of carbon-13 to carbon-12 in the meteorites' sugar compounds matches that expected from extraterrestrial sources.

Some of these compounds might even predate the solar system, originating in the interstellar cloud of gas and dust that gave birth to the sun. Last year, scientists reported that they had found a simple sugar in a star-forming cloud 26,000 light-years from Earth using spectroscopy. **BC**

James Fischer keeps bees and spends his Winters working on the Unsolved Problems of Science, such as why a pint of "Heavy Cream" actually weighs less than a pint of "Light Cream."