"Have some bread and dip it in the wine vinegar; honey from the comb is sweet to your taste" (Proverbs 24:13, Ruth 2:14): Sweet and sour flavors

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Sweet and sour are two of the basic tastes our taste buds can sense, along with bitter, salty, and umami (savory/meaty from partially broken-down proteins). As such, agents used for sweetening and souring food can tremendously influence the character of a dish and give it a unique and complex flavor profile that can leave a good impression with the people eating it. Therefore, it is worth becoming familiar with the broad range of flavors available under the generic headings of "sugar" or "vinegar" or other unspecified ingredients in recipes.

Sweetening Agents

Almost all nonartificial sweetening agents are sugars of one sort or another. Sugars are a class of carbohydrate (molecules consisting mostly of carbon and hydrogen), and can be divided into monosaccharides, disaccharides, and more complex carbohydrates known as oligo- and polysaccharides. Monosaccharides are the simplest sugars and can be absorbed by the body directly. The monosaccharides are fructose, galactose, and glucose. Disaccharides are composed of 2 simple sugars bonded together and must be broken down during digestion into the simple monosaccharides before being absorbed by the body. These include lactose (glucose + galactose), lactulose (fructose + galactose), maltose (glucose + glucose), sucrose (glucose + fructose), trehalose (glucose + glucose), cellobiose (glucose + glucose).

When we talk about and compare sweeteners, two useful measures are the glycemic index and relative sweetness. The glycemic index is a measure of how 50 g of a given carbohydrate raises blood glucose levels. It is an index relative to glucose, which is assigned the standard glycemic index value of 100. Relative sweetness is another index, this one relative to sucrose, which is assigned the value of 100. These values can vary greatly depending on the chemical composition of a given sweetening agent, which in turn reflects growing conditions and processing methods. The same is true of flavor that also reflects the source species and harvesting conditions.

Solid/crystalline sweet agents

Modern white sugar is usually derived from sugar beets (*Beta vulgaris*), but historically came from sugar cane (*Saccharum* spp), which is still available, along with sugar derived from coconuts, dates, and other sources. Sugar extraction from beets, which grow in temperate climates, was documented as early as the 1500s, but large-scale commercial sugar production from beets began only in the 1800s. Sugar cane grows in tropical climates and may have been domesticated in southeast Asia as early as 6000 BCE (before common era), with granulated sugar being produced in India long before the medieval era. Sugar cane cultivation spread throughout the Mediterranean region as a result of Muslim expansion, settlement, and trade. Sugar from sugar cane, particularly in loaf form is a very medieval sweetener.

Granulated sugar
Glycemic index: 60
Relative sweetness: 100
Composition: 100% disaccharide sucrose

White granulated sugar is highly refined and very pure and unadulterated, thus lacking any minerals or other nutritional components. The flavors of cane-derived versus beet-derived sugars can be noticeably different to some people.

Brown sugar
Glycemic index: 65
Relative sweetness: 97

Composition: sucrose + molasses

Sucrose disaccharide with molasses derived from either sugar beets or sugar cane. Most often, modern brown sugar is created by adding the molasses back into completely refined white sugar, but sometimes the refinement process is stopped so that molasses is not completely extracted.

Jaggery/piloncillo
Glycemic index: 35
Relative sweetness: 90?
Composition: 50% sucrose + 20% invert sugars + 20% water + trace minerals/nutrients/insolubles

Known formally as noncentrifugal cane sugar, this traditionally produced and minimally processed sugar retains some of the molasses with the sugar crystals as well as moisture, since the cane juice is boiled only enough to form a paste that can be shaped into loafs. Most often derived from cane juice, it can also be made from dates or the sap of one of several palm species or a combination of these. This traditional sweetener is still widely produced and used across Asia and Latin America and can be found in import grocery stores.

Coconut sugar
Glycemic index: 35
Relative sweetness: 90-100
Composition: 70%-80% sucrose + glucose + fructose + trace minerals/nutrients/insolubles

It is derived from the sap of coconut palm flowers (*Cocos nucifera*). Originating in Asia, it has become popular in recent years. I have not yet found evidence that coconuts were used as a food source or sweetener during the medieval era in Europe or the Mediterranean in general. It can be found in health food/organic food sections and import grocery stores.

Palm sugar
Glycemic index: 35
Relative sweetness: 90-100
Composition: 70%-80% sucrose + glucose + fructose + trace minerals/nutrients/insolubles

Derived originally from the Palmyra palm *(Borassus* spp), it can also come from date palm (*Phoenix* spp), nipa palm (*Nypa fruticans*), or sugar palm (*Arenga pinnata*). It is very similar to coconut sugar, differing in terms of species of origin and whether the palm tree is tapped in the trunk (palm sugar) or in the flowering stalk (coconut sugar). It is processed the same way and also originates in Asia. Again, look at import grocers.

(Semi)fluid sweet agents

These sweeteners can range from liquids that pour easily to very viscous to semicrystallized, depending on production method, age and storage conditions. These physical properties can be changed by heating, adding water, etc. The focus here is on agents that are cooked down from naturally sweet liquids, usually saps or fruit juices, to form a syrup or molasses (with the exception of honey). Note that these are distinct from flavored syrups of various sorts that are created by adding flavoring agents to sugar solutions to create rose syrups and other perennial favorites. Some people use the terms molasses and syrup interchangeably, while others consider only the byproduct of refined sugar production to be true molasses.

Honey
Glycemic index: 50 (range, 31-78)
Relative sweetness: 97-110
Composition: ~70% fructose/glucose + maltose + sucrose + water + complex sugars

Produced by bees and some other insects from flower nectar though primarily harvested from

domesticated honeybees (*Apis* spp). It is possibly the oldest sweetener known, with a long history of both nutritional and medical uses. It has a wide range of textures and flavors influenced largely by the flower sources.

Agave syrup
Glycemic index: 15
Relative sweetness: 133-150
Composition: 56-92% fructose + glucose
Syrup derived from the agave plant (*Agave* spp) from the Americas and South Africa. This seems to be a modern sweetener.

Barley malt syrup
Glycemic index: 42
Relative sweetness: 50
Composition: ~65% maltose + complex sugars
Derived from sprouted barley (*Hordeum vulgare*).

Brown rice syrup
Glycemic index: 25-98
Relative sweetness: 50
Composition: ~52% maltotriose + 45% maltose + 3% glucose
Syrup derived from brown rice flour cooked with enzymes to break down starches into sugars. As far as I know, this is an entirely a modern product.

Corn syrup
Glycemic index: 100
Relative sweetness: 30-40
Composition: 20-98% glucose
Syrup derived from corn starch cooked with enzymes to break down starches into sugars. This is an entirely a modern product.

Maple syrup
Glycemic index: 54
Relative sweetness: 60-100
Composition: 66% sucrose + 33% water + other sugars/trace minerals/nutrients
Derived from boiling the sap of the sugar maple (*Acer saccharum*) and harvested when it first starts moving up from the roots in spring. The sugar maple is native to North America, so this is a modern sweetener.

Molasses
Glycemic index: 55-60
Relative sweetness: 70-105
Composition: ~50% sucrose + glucose + fructose + trace minerals/nutrients
This syrup is derived from boiling juice to extract sugar crystals—it's what's left when the crystals are removed at first (light), second (dark), or third (blackstrap) boiling. Molasses is most commonly derived from sugar cane, but can also come from beets, dates, grapes, pomegranates, or other plants.

Sorghum syrup
Glycemic index: 50

Relative sweetness: 100
Composition: 46% sucrose + 23% water + 16% glucose + 13% fructose + trace minerals/nutrients/insolubles

This syrup is derived from sweet sorghum (*Sorghum* spp, especially *S. bicolor*), a relative of sugarcane, which grows in temperate climates and originated in Africa.

Fruit syrups

Made by boiling down fruit juice until it thickens. Commercially produced fruit syrups often add sugar, and both period and modern home recipes often call for added sugar as well, presumably to aid with thickening. Common examples are pomegranate, cherry, rhubarb.

Souring Agents

Sour flavors come from the acid content of food items. Unripe fruits contain high amounts of acids that are converted to the fruit sugar fructose as they ripen, though some fruits remain sour even when ripe because the acid content remains high. Another source of acid is bacterial fermentation, which converts alcohol (itself the product of yeast fermentation of sugar) to acetic acid.

Verjus (or verjuice)

Literally “green juice”, it is made from pressing unripe grapes. It is rarely used in modern cooking, outside of Syrian and Iranian cuisines, but can appear in many medieval recipes. It is considered a good complement to wine as its flavor does not “compete” with the wine the way that vinegar and citrus fruits do. In other words, it doesn't affect the flavor of wine that is either another ingredient of the recipe or paired with the food dish. This term verjus is sometimes applied to juice made from crabapples or unripe apples.

Citrus fruits

Citric acid and ascorbic acid are found in such sour juices as citron, grapefruit, lemon, lime, and Seville or bitter orange (in other words, citrus fruits). These juices are commonly used in modern cuisines, though only lemon and Seville orange are found regularly in medieval recipes, I believe.

Other sour fruits

Crabapples are perhaps best known, but there are also pineapple, sour apple, cherry, plum, and grape varieties, as well as various unripe fruits that can be pressed for sour juices.

Vinegar

Vinegar is sour due to the acetic acid content. The flavor profile of a given vinegar reflects the residual sugar leftover from incomplete yeast fermentation to alcohol and the alcohol leftover from partial fermentation to acetic acid, as well as the amount of acid.

The type of vinegar is a reflection of the source material, most commonly apple cider, white wine, and red wine. Note that the modern white distilled vinegar is much closer to an industrial solvent than a cooking ingredient. Wine vinegars can also be subdivided according to grape varietal, such as moscatel, sherry, champagne, cabernet sauvignon, etc. Vinegar can be made from anything that can be fermented. Other examples are coconut vinegar, malt vinegar, quince vinegar, ume plum vinegar, and so on.

Balsamic vinegar

This vinegar type is worth a special mention. It is made from white Trebbiano grapes cooked down (reduced) to ~30% of the original volume, and then aged a minimum of 12 years in casks of various wood types according to the highly regulated solera system (also used in some sherry production). This production process gives it a rich, complex, intensified flavor different from most other vinegars, as well as a thicker texture. The production of balsamic vinegar is documented back to the eleventh century. Note that there are many cheap imitations, but true balsamic vinegars come only from Modena and Reggia Emilia, Italy.