Sugars For Fermentation

Many sugars can be used for fermentation. They all have specific characteristics that will have an effect on the taste and mouthfeel of your brew. Here is an outline of the most common sugars used in brewing.

1. Glucose, dextrose or corn sugar.

Glucose is a monosaccharide. This simple sugar is derivable from converted starches such as what happens when mashing malted grain. Sugar processors can make this sugar from a variety of sources—corn (maize), wheat, rice, potatoes, in short, anything with cheap starch can be an input into the process. However if not completely refined down to simple sugars, some of the origin can be discerned.

The right-handed variation of glucose is called dextrose.

2. Maltose

A disaccharide made up of two glucose molecules. Completely fermentable. Contributes 45 points of specific gravity per pound.

3. Fructose (fruit sugar)

Another monosaccharide. In all-malt beers, this normally appears as only a few percent of the wort. Yeasts will rapidly ferment this but there might be some off-flavor problems if used in brewing beer.

Fructose tastes much sweeter than glucose or even the combination of fructose + glucose (= sucrose). That's why big food processing companies use "high fructose" sugars because they get more bang for the buck by using less of a sweeter tasting sugar.

4. Sucrose (table sugar or cane sugar)

Sucrose is a disaccharide composed of one molecule of glucose and one of fructose. More precisely, it is dextrose plus dextrorotary fructose. It must be broken apart before the yeasts can use it. When heated in an acidic solution (such as wort) the sugar is inverted to make glucose and fructose. Yeasts will invert the sucrose if it is not already in that form before using by using invertase. It is derived from sugar beets or sugar cane that are crushed and dissolved in water. The raw syrup is boiled down to concentrate it to a point where some fraction crystallizes. The remaining heavy syrup (see "molasses") is separated from the 95+% pure sugar. The crystals are further processed several times to increase its purity yielding, eventually, the pure white crystals we commonly use. Some other commonly used sugars are also produced during the processing.

A complaint in the early days of modern home brewing was that using table sugar in beer-making resulted in a "cidery" beer. The symptoms were that a beer made with table sugar that was added to the boil produced a cidery flavor that faded after several weeks in the bottle. Therefore the rule of thumb became 'avoid all table sugar'. While this is still a good idea when using malt extract, this old-(ale)wives tale is misleading. That defect most likely came from poor yeast due to a too low pitch, insufficient free-available-nitrogen, or a lack of other necessary yeast building materials in the wort. Table sugar can be used in small amounts with no harm and it is certainly cheaper to use for priming.

This simple colorless sugar will lighten the body of a beer since it can be completely fermented. It also lightens the beer color.

5. Invert sugar

This is simply sucrose (aka, table sugar) that has been subjected to "hydrolysis" which breaks the disaccharide sucrose into its constituent sugars. The fructose is inverted (made into its optical isomer). The inversion process involves adding acid and is usually done at high temperatures to speed up the process. Alternately, the invertase enzyme can be used.

6. Raw sugar

The only unrefined sugar available to the average consumer seems to be Sucanat, an evaporated sugar cane syrup. Raw beet sugar is reputed to be unsavory. It may be possible in some markets to get other raw sugars (e.g., in Hawaii, pineapple sugar may be sometimes found).

7. Demerara or turbinado

This is crystallizable sugar from the first step of refinement. It has a tan to brown color from the residual impurities. Some food faddists attribute beneficial results from using this but unless a lot is consumed, the potential benefits are very low. Demerara is the UK term; turbinado the US (and Spanish language?) term. Demerara is usually a dark brown shade while turbinado is lighter, more of a tan or taupe color. It is 98% sugar with some residual proteins and unfermentable carbohydrates present.

8. Molasses or treacle

This is the residue of the sugar after the crystalized portion has been removed. The choice of names for this sugar syrup seem to reflect regional language preferences rather than any major differences. In the US, "molasses" is the preferred term while in the UK and ex-colonies, "treacle" is used. Regular treacle is an inverted sugar produced from the residue of refinement. The acid treatment darkens it. Molasses is filtered and may have a sulfur compound added to sterilize and stabilize it.

"Black treacle" is roughly the same flavor as "blackstrap molasses" however treacle may be produced differently. While there are differences between the differently named syrups, there is

also a wide variability within syrups of the same name! Find one company's product you like since that may be the only level of consistency obtainable.

Light molasses is roughly 90% sugar. Blackstrap is about 50% sugar and has a wide variety of crud remaining.

9. Golden syrup

Like molasses, this is a syrup that remains after the crystallizable sugars have been removed. However, since the syrup is removed later in the refinement process, it does not have as heavy a taste or color as molasses. Lyle & Tate's product is derived from cane sugar. The syrup has been inverted using a strong acid (hydrochloric acid, I think) and then counter-acted by the addition of base (NaOH) after a short time. Some of the golden color is from the acid treatment. A salty taste comes from the acid + base combining to form NaCl.

10. Brown sugar

In the US, this is just refined sugar with some molasses added back in. The US food law says that only refined sugar (no raw components) can be sold with this name. This law may actually have more to do with enforcing a similar taste for both sugar beets and sugar cane since the beets, when un-refined, have a poorer taste than cane. [Sidenote: with the possible elimination of sugar support prices in the US, this category may change...] Compare this to Piloncillo (Mexican brown sugar) which is a semi-refined granulated sugar.

11. Belgian candi sugar

This sugar is commonly used in Belgium beers. It comes in several colors - light to dark. When added to beer, it thins out the high gravity beers and contributes color and, for the dark version, some residual caramel flavors. Candy sugar is sucrose. Its production is the same as for rock candy (i.e., slow crystallization of a concentrated sugar solution) made from straight sucrose so a brewer should be able to substitute regular sugar for it. Dark candy sugar has been caramelized before it is crystalized.

12. Corn syrup

Basically glucose with water. May have maltose. Beware about buying the typical grocery store version because it _might_ have some vanillin/vanilla as a flavoring. Additionally, some brands have a preservative that could affect fermentation. Dark corn syrup is just the regular syrup with some coloring. Use wherever you would use straight glucose/dextrose such as priming.

13. Honey

Honey is a complex mix of sugars but it is mainly glucose (roughly 30%, by weight) and fructose (40%) in invert form; the bees supply the invertase, which is the enzyme that inverts the fructose.

Honey's make-up is not consistent - it varies by source, season, region, and producer. It is about 75% fermentable sugar; the remainder is water, proteins, some minerals, etc.

14. Jaggery

Un- or semi-refined date sugar.

15. Lactose or milk sugar

An unfermentable sugar (at least by ordinary beer yeasts) often used to boost the residual sweetness as in "milk stouts".

16. Maltose syrup

Some UK recipes call for this. To make it, you mix glucose and a dextrin powder in a 4:1 ratio. The 20% dextrin will remain unfermented and therefore lends body and mouthfeel that a pure sugar syrup would not.

Priming:

You can choose either of two paths when deciding on a priming sugar — do you want to keep the priming sugar hiding in the wings or do you want to bring it onstage? The monosaccharides and plain sucrose allow you to carbonate the beer without changing the existing flavor profile. The other sucrose-based sugars: Belgian candi sugar, invert sugar syrups, honey and maple syrup, will add some degree of flavor accent to the beer. The next big question is, “How much to use?”

The most commonly quoted answer to this question is 3/4 cup (~4 oz./113 g by weight) of corn sugar for a 5 gallon (19 L) batch. This will produce about 2.5 volumes of carbon dioxide in the beer, which is pretty typical of most American and European pale ales. Three ounces (by weight) will produce a little lower carbonation level of about 2.0 volumes, and five ounces will produce about 3.0 volumes. For more information on carbonation volumes, see Chapter 11 of my book, “How To Brew,” available online at www.howtobrew.com. The point is that 4 oz. (133 g) of glucose is typically used to carbonate five gallons, and this is the basis for calculating amounts of other priming sugars. For example, let’s calculate how much honey to use to equal 4 oz. (113 g) of corn sugar. Honey is about 18% water and is quoted as being 95% fermentable.

Priming equation

To find this out, first set up the equation:

(Weight of A)(Percent Solids of A)(Fermentability of A) = (Weight of B)(Percent Solids of B) (Fermentability of B)

In the equation, the variable A represents a sugar for which the weight, percent solids and fermentability is known. In our equation, we’ll use corn sugar as we know these details. The variable

B represents a sugar for which the percent solids and fermentability are known. Substituting in the numbers gives us:

(4 oz)(90%)(100%) = (X)(82%)(95%)

If we solve for X we find that it equals 4.62 oz. (131 g) So, priming with 4.62 oz. (131 g) of honey should give carbonation equal to priming with 4 oz. (113 g) of corn sugar.

Another way to approach this problem is by looking at sugars according to their extract yield — what the specific gravity of a solution will be if a pound of the sugar is added to water to make a gallon (3.8 L) of solution. The table on the facing page (p. 38) lists the extract yields of several common brewing sugars. The extract yield allows you to calculate the amount your original gravity will be boosted by adding this sugar. The fermentability — also given in the table — describes what percentage of the sugar can be utilized by your brewers yeast.

Using the extract yield numbers from the chart on page 38, our example becomes:

(4 oz)(42)(100%) = (X)(38)(95%)

Solving for X, we get 4.65 oz. (291 g) of honey. The calculation for other sucrose products are very straightforward because the sugars are usually 100% fermentable, except in the case of partially refined sugars like molasses where there is a lot of other material present other than sugar. Malt extract typically has a significant proportion of unfermentable sugars, varying from 60–85%, depending on brand and yeast strain. A typical fermentability for extract is probably about 75%.

Summary:

Brewing is all about utilizing sugars and those sugars always end up as monosaccharides when they are fermented. However, the yeast process each type of brewing sugar differently as it is being broken down into glucose and fructose, and these differences will effect our fermentation performance. Usually a high percentage of glucose and fructose in the wort will inhibit the fermentation of maltose and maltotriose, and this can lead to a stuck fermentation.

Therefore, brewing adjuncts high in monosaccharides should be added after primary fermentation has finished. These sugars can be used for priming though, with allowances made for the percent moisture and degree of fermentability. Hopefully this article has provided a better understanding of how to use sugars in your brewing.