CHAPTER XX

מסכת ברכות · פרק ששי · משנה א'

כֵּיצַד מְבָרְכִין עַל הַפֵּרוֹת?

עַל פֵּרוֹת הָאִילָן - אוֹמֵר בּוֹרֵא פְּרִי הָעֵץ. חוּץ מִן הַיַּיִן, שֶׁעַל הַיַּיִן - אוֹמֵר בּוֹרֵא פְּרִי הַגָּפֶן.

How does one recite the blessings on produce? On the fruit of the tree, one says, "[Blessed are You, Hashem, our G-d, King of the universe] Who creates the fruit of the tree," except for wine. On wine, one says, "[Blessed are You, Hashem, our G-d, King of the universe] Who creates the fruit of the vine."

Why is wine special and how is it made?

Wine enjoys a special status in Judaism because it both satisfies one's hunger and gladdens the heart[1]. For these reasons, it gets its own unique *beracha*. Because of these special qualities, wine plays an important role in many of our most important events. For instance, we drink wine at *kiddush* on Shabbos and Yom Tov, under the *chuppah*, at a *bris*, and at the *Pesach Seder*. In the *Beis Hamikdash*, many *korbanos* were accompanied by wine that was poured into the *mizbe'ach*.

The alcohol contained in wine affects how we feel and how we behave in a number of ways. When consumed in moderate quantities, alcohol can make us feel happy, reduce anxiety, and make us more sociable. When we drink wine in moderation as part of our *avodas* Hashem, these effects can increase our love for Hashem and of His Torah and Mitzvos.

Drinking wine, however, is a tricky business. Just as wine can bring joy, it can also bring great tragedy, as we learn from the story of Noah after the Flood[2] and from the deaths of Nadav and Avihu[3]. When we drink too much alcohol, we are unable to think clearly, we are released from our proper inhibitions, and we become clumsy, foolish, and ugly. The Rambam warns that one who drinks to the point of drunkenness has sinned and has behaved in a disgusting manner. Frequently drinking too much alcohol can also cause permanent damage your body, causing many life-long illnesses, and can even lead to premature death. It is estimated that alcohol is responsible for 3 million deaths every year—more than 5% of all deaths worldwide[4]!

So we understand a bit of what alcohol does, but how does it get into the grape juice in the first place?

It all starts with sugar

The process of creating alcohol starts with the **sugar** in the juice. There are many different types of sugar, but they are all made of quite similar **molecules**. The three most common types of sugar are **glucose**, **fructose** and **sucrose**.

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[1] Berachos 35a

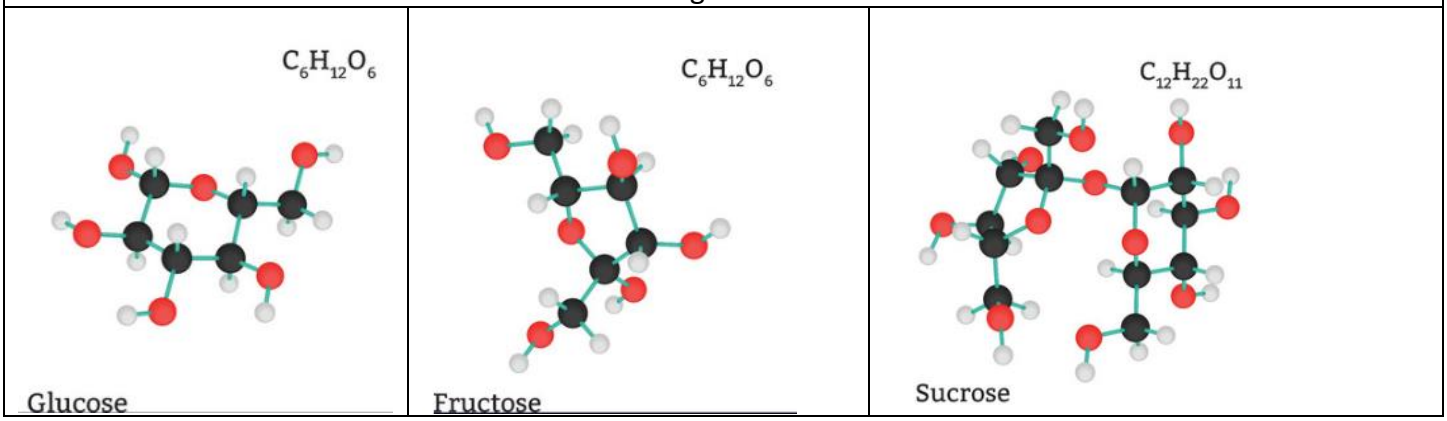
[2] See Bereshis 9:20-22

[3] See Rashi to Vayikra 10:2

[4] https://www.who.int/news-room/fact-sheets/detail/alcohol

Here's what their molecules look like:

Figure XX.1: Sugar molecules. These are "ball and spoke" models of molecules. Each ball represents an **atom**. The black balls represent **carbon** atoms. The red balls represent **oxygen** atoms. The white balls represent **hydrogen** atoms. The lines connecting the atoms represent the **chemical bonds** that hold them together.



If you count the balls in each of the models, you will find that glucose and fructose molecules each have 6 carbon atoms, 6 oxygen atoms, and 12 hydrogen atoms. The chemical formula for these two molecules is $C_6H_{12}O_6$.The "C" in the formula stands for a carbon, and the 6 after it tells you that there are six carbon atoms in the molecule; the "H" stands for hydrogen, and the "O" stands for oxygen.

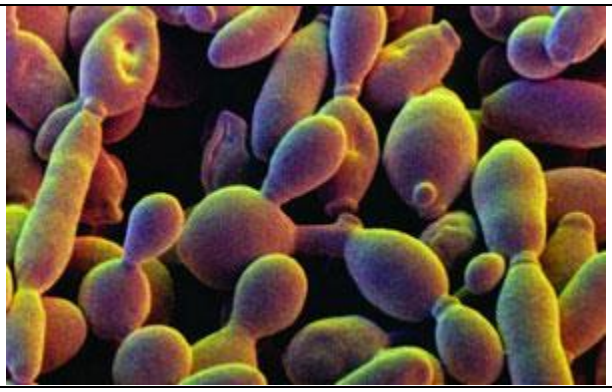
Every glucose and fructose molecule is made of this precise "recipe" of 24 atoms. Nevertheless, the shape of glucose and fructose molecules (i.e., the way these 24 atoms are connected) is not exactly the same, and that is what gives them slightly different properties. Can you see the difference in the models in Fig. XX.1?

The sucrose molecule is larger and more complicated. It is made of one glucose and one fructose molecule that have bonded together. When the two molecules are combined, a few atoms are left out. Look carefully at the illustration of the sucrose molecule. Can you see which atoms have been lost? (Hint: the chemical formula for sucrose is $C_{12}H_{22}O_{11}$.)

All fruits contain different amounts of these three sugars. The sugar that you buy in the supermarket is almost all sucrose, because the sugar molecules in sugar cane and sugar beets (which is where industry gets its sugar) are almost all sucrose. On the other hand, grapes contain mostly glucose and fructose with very little sucrose. As a grape ripens, the quantity of sugar within it increases. At the same time, ripening reduces some other chemicals in the grape that give it its distinctive flavor. So, picking grapes when they are "just right" is very important if you want a quality wine.

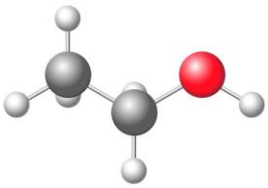
<u>The fungus among us</u>

Sugar by itself doesn't turn into alcohol. For that, you need **yeast**. Yeast is a special type of **organism** called a **fungus** that is neither an animal nor a plant. Fungi (more than one fungus are called "fungi") get their nutrients by **secreting acids** and **enzymes** to dissolve the food with which the yeast comes in contact. Some fungi, such as molds and mushrooms, have tiny hair-like growths called **hyphae** that secrete the acid. (You can read a lot more about them in Chapter XX משנה ג', פרק ו' on mushrooms and truffles). Yeasts, however, are just single **cells**, and do not have hyphae, so the acids and enzymes emerge directly on the surface of the yeast cells. Sugars that come into direct contact with the yeast cells are dissolved, and the mixture of dissolved sugar and acids is later absorbed back into the yeast cell for **digestion**.

Figure XX.2: Yeast cells as seen under a microscope. Each yeast cell is about 3 **microns** long (there are 1000 microns in one millimeter—a human hair is about 50 microns thick.) You can see that many of the yeast cells are **budding**. That means new yeast cells are growing out of their parent cells. They will eventually separate from the parent cell to form new yeast cells.	

Simple sugars are food for yeasts. When yeast digests sugar, a byproduct is alcohol (more accurately, a type of alcohol called ethanol) as well as carbon dioxide gas.

This is what the alcohol and carbon dioxide molecules look like:

	
Alcohol (Ethanol)	Carbon dioxide
Figure XX.3: Ethanol and carbon dioxide molecules	

Ethanol has 2 carbon atoms, 6 hydrogen atoms, and 1 oxygen atom. **Carbon dioxide** has 1 carbon atom and 2 oxygen atoms. If you look carefully at the pictures (or if you get out a pen and add up all the pieces), you may be able to discover what the yeast does when it digests fructose or glucose. The yeast breaks the sugar molecules into smaller parts. If you count the different types of atoms in glucose, fructose, ethanol and carbon dioxide you will find that yeast breaks one glucose or fructose molecule into two ethanol and two carbon dioxide molecules.

But why? What does yeast gain by breaking down a sugar molecule into pieces? The answer is **energy**. Energy is released when the bonds holding a molecule together are broken. The yeast harnesses this energy to power the processes that keep it alive! By the way, we humans do pretty much the same thing, digesting sugars to get energy—though we do it in a different way that makes carbon dioxide and water only, without creating alcohol.

	Where are yeasts found? Yeasts are common fungi that are found just about everywhere in our **environment**. Some types of yeast grow slowly on the outside of grape skins. The "dusting" you see on the outside of the grapes in the picture is yeast growing naturally on the grapes.
	When the grapes are squashed to make grape juice, the yeasts that had been on the grape skins, suddenly find themselves in a pool of grape juice, rich in sugars. The yeasts start to eat the sugars and to multiply rapidly, producing alcohol and carbon dioxide gas. This process is called **fermentation**. The picture shows red wine in the process of fermentation. Can you see all the carbon dioxide bubbles?
	Relying on natural yeasts produces variable quality wines. modern wineries add chemicals called **sulfites** to wine to kill the natural yeasts, and then they add specialized yeasts to the grape juice to produce the exact flavors the winemaker seeks. This picture shows what industrial yeast looks like.
	Eventually, the yeast in the wine will have consumed all the sugar in the grape juice. When the yeast runs out of food, it will die and sink to the bottom of the wine container, forming a sludge called **lees**. In the picture you can see lees in a bottle of white wine, before it has been filtered out. After the winery filters the lees out of the wine, it is ready for bottling.
Figure XX.4: From Grapes and Yeast to Wine	

Most wines contain about 11-14% alcohol. Most grapes contain enough sugar to naturally make this amount of alcohol during fermentation. Once all the sugar has been converted to alcohol, the wine is no longer sweet to the taste and is called "dry" wine. When alcohol levels rise above 14%, the alcohol typically kills the yeast, so 14% is, more or less, the natural limit for alcohol content in wine. If a winery wants wine with a higher percentage alcohol, it must add alcohol directly to the wine. (Such alcohol-supplemented wines are called "fortified" wines.)

To make a wine which is sweet and only contains, say, 5% alcohol, as in the case with ever-popular Muscato wines, the yeasts are killed (by adding sulfites) when they have only converted about half of the sugar in the

grape juice. To make a sweet wine with 11-14% alcohol, the winery has some options. It can add alcohol to a Muscato-type wine, add sugar to a dry wine, or start with a grape that has an especially high sugar content, so there is sugar left over from the fermentation process after the yeast dies from the high alcohol content.

Aside from sugar and alcohol, there are many different substances in grapes, each with its own aroma and taste. The type of grape, the weather, and the soil all affect the contents of a grape and thus the taste of its wine. As you can tell, there are many variables that go into making wine, which is why it involves not just tradition, but also skill, science, and good fortune.

Pictures

Molecules: https://www.vectorstock.com/royalty-free-vector/carbohydrate-sugar-set-vector-10494913