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ARTICLE

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Making Malt Extract

Connecting with your food and its ingredients is one of the most rewarding parts of being a brewmaster or chef. Learning where ingredients come from and how they are made gives an understanding of how the variance in breeding, growing conditions, harvesting, storage and processing creates the ingredients' different flavors and colors. For homebrewers, there are many articles on the "life and times"of different malts and hops, yet little information on the origin of one of their most widely-used ingredients — malt extract.

The Main Use of Malt Extract

On a worldwide basis, much more malt extract is used in the production of food and other products than in brewing. Malt extract has been manufactured for hundreds of years, and was the first grain-based sweetener manufactured naturally using simple technology — long before modern corn syrup.

Food applications include baked products, especially those that require browning or color development such as bagels, pretzels and pizza crusts. Malt extracts are the main source of flavor and color in many breakfast cereals. Malt extract and malted milk powder are also used in confectionery, frozen desserts and non-alcoholic beverages. Malted milk balls, candy bars such as Milky Way®, malt cups, malted milk shakes and Ovaltine® all derive flavor and functionality from malted barley products. In many Caribbean, African and Middle Eastern countries, carbonated malt-based beverages are very popular. It's a common ingredient used to improve the palatability of pet and human medicines. It's used in nutrient broths and agar for growing or culturing microorganisms. Historically, diastatic malt extract was even used in non-food industries as a source of amylase enzymes for applications such as paper sizing. Of course, malt extracts are also used in the brewing industry for finished product and wort stream adjustment, for boosting gravity in craft or regional breweries and also as the main source of wort for homebrewers, microbreweries and pubs, especially those with systems below seven barrels (~220 gallons/820 L).

Depending on the intended use, the manufacturing and quality of malt extracts can vary widely. The main differences in manufacture and quality are between those extracts intended for food and brewing use. This article will cover each of the stages in the process of making malt extract, highlighting the important steps and differences.

Brewing vs. Food-Grade Extracts

Brewing-grade malt extracts are made with only the highest quality brewing malts and get additional colors and flavors from using specialty malts. This gives them a flavor suitable for beer or other products where they are the main flavor component. Food-grade malt extracts are often made with non-brewing grade food or distilling malt, and are usually used as a minor ingredient. In many cases, malted barley products for the food industry are blended with corn syrup, caramel color or other ingredients. This might not be apparent from the trade name or brand name of the product, but it will appear on the ingredient statement. Darker versions of food grade extracts are often made by heating them until they darken to the desired color. This lowers the pH of the extract and generates darker, molasses-like flavors.

Nonetheless, the manufacture of brewing-grade and food-grade malt extracts both involve variants of the brewing process in which malted grains are crushed and mashed. The wort is separated from the spent grains and is then concentrated and dried.

Here are the highlights of the malt extract making process:

Step 1: Milling

Malt extracts are produced in large brewhouses or plants with modern equipment. The milling equipment used to grind the malt is usually dictated by the method of wort separation employed in each plant. For plants using lauter tuns, milling is accomplished with four or six-roller mills. For plants using mash filters or other methods, hammer mills are used.

Step 2: Mashing

Brewing-grade malt extracts are typically mashed under controlled conditions to produce various degrees of starch breakdown and resultant fermentability. This involves carefully controlling the pH and using multiple temperature steps during mashing.

Food-grade extracts may be mashed in a variety of methods, but are usually concerned more with maximum extraction speed and less with producing a particular degree of fermentability. Typically a simple single step mashing process is employed.

Step 3: Separation

In the modern brewing-grade plants, the wort is separated from the spent grains in lauter tuns or mash filters. Both these methods produce high-quality worts and can be set up for high throughput, with as many as 10–14 brews per day.

Centrifuges, vibratory sieves and other solid/liquid separation equipment are sometimes used to separate malt extracts in food-grade plants. These means work well, but typically are producing malt extract with less regards for flavor purity, turbidity, color, oil content, tannin extraction, hot side aeration and other factors that are important for brewing worts. Some of these systems are batchwise and some are continuous.

Unlike in brewing, in which the brewer strives to make a wort of a defined strength by manipulating the liquor-to-grist ratio and amount of sparge water added, malt extract production plants are set up to make worts with as little water as possible. Because of the high cost of water removal later in the process, the economics of extract efficiency change somewhat and sparging is limited to the minimum amount needed to rinse the grain. Thus, some yield is often sacrificed to limit the dilution of the wort. Oftentimes the final rinsings (or weak wort) are collected and used as mash-in or sparge water to help increase extract efficiency. Typically the concentration of worts produced in an extract plant are 16–24% solids (S.G. of 1.064–1.098).

Step 4: Boiling/Whirlpool

Boiling and hot break separation are used in brewing-grade products to achieve sterilization, coagulation of proteins, volatilization of DMS precursors, isomerization of hops, etc. Hopped extracts may be boiled for longer periods in order to achieve better hop utilization, though many are made with hop extracts to achieve better consistency. This also reduces the need for boiling. Unhopped extracts are typically boiled only long enough to achieve good protein coagulation. Because of the large scale of malt extract brewhouses, highly efficient boiling systems are used.

Food grade plants often do not use brew kettles or whirlpool tanks and frequently run wort straight from the lauter tun to buffer tanks to feed the evaporator.

Step 5: Whirlpool Tanks and Trub Removal

Brewing-grade plants remove proteins coagulated during the process using whirlpool tanks or centrifuges. This produces a clearer overall extract suitable for brewing. Some also go an extra step and remove additional "cold break" prior to evaporation.

Step 6: Vacuum Evaporation — Keeping Things Cool

Though malt extract could simply be concentrated in the brew kettle, the darkening and flavor development that would result would make a terrible tasting product as dark as caramel. This would also use an incredible amount of energy. For these reasons, malt extracts and most other food products are concentrated using vacuum evaporators.

Modern continuous evaporators evaporate the wort very quickly at low temperatures and with high efficiency. Most modern designs are either rising or falling film evaporators. These evaporators consist of multiple columns or "effects" that are a group of straight vertical pipes heated on the outside by direct steam or vapor.

In falling film evaporators, the wort is fed to the top of these columns and is distributed to the tubes where it falls, forming a thin film as it travels down the tubes. Water is evaporated from the thin film of liquid and escapes to the middle of the tube. At the bottom of the tubes the concentrated liquid simply falls into a reservoir and is pumped to the next effect. The vapor also escapes out the bottom of the tubes and passes into a separator where any droplets of wort are removed from the water vapor.

In rising film evaporators, liquid is fed to the bottom of the effect, filling the tubes. As steam heats the product, vapor bubbles form and rise up the tubes, carrying liquid with them and causing a continuous flow or fountaining of the liquid. The bubbles aggregate toward the middle of the tubes, forcing the liquid into a film on the sides of the tubes. The liquid escapes out the top of the effect, with the vapor again going to a separator. This is a very similar principle to the calandrias or percolators used in large brew kettles, though the liquid flow volumes are typically lower in evaporators.

Water vapor created from the product in one effect leaves the separator and is then used as steam in another effect. This can happen because each effect is under a different amount of vacuum and thus boils at a different temperature. Thus water vapor from wort boiling at 160 °F (71 °C) and half an atmosphere of vacuum can be used as steam to heat an effect boiling at 120 °F (49 °C) and three-fourths of an atmosphere of vacuum.

In this way, the latent heat of vaporization of this steam, as well as its temperature differential, can be reused. This leads to very high energy efficiencies, allowing these evaporators to evaporate wort with only 20–30% of the energy required for atmospheric boiling.

Depending on the evaporator setup, as much as 25–30% of the water in the product may be removed in a single pass through an effect. Thus an incredible amount of evaporation occurs in a very short time. Transit times though all the evaporators effects can occur in as little as 15 minutes. This means that the average bit of wort can go from 16% solids (SG 1.064) to 80% solids (SG 1.380) in only 15 minutes, boiling at average temperatures of 120 °F (49 °C). It's easy to understand how a high-quality wort can be produced by this gentle boiling process.

Evaporators are such efficient and gentle water removal devices that they are also used to concentrate the wort prior to drying. Typically 90% of the water in the wort is removed by vacuum evaporation and the remaining amount is removed by drying. Wort is thus concentrated to 50–70% solids prior to drying.

Step 7: Spray Drying

There are several types of dryers that can be used to produce malt extract. They can be divided into two types, atmospheric and vacuum.

Atmospheric Dryers

There are two types of atmospheric dryers: modified spray dryers, which are known as filtermats and traditional spray towers.

In both types of atmospheric dryers, concentrated worts are pumped to the top of large open chambers that are 30–50 feet (9–15 m) high. They are pumped under high pressure to specially-designed atomizing spray nozzles that create a fine mist of very small droplets.

Air is heated to very high temperatures of 250–400 °F (121–204 °C) and very low relative humidities and impinges on the fine droplets. With droplet sizes on the order of 200 microns, one gallon (3.8 L) of concentrate will create a quarter of a billion droplets with an equivalent surface area of 200 square meters (2,200 sq ft.). This is about half the size of an NFL end zone. With this amount of surface area, evaporation and drying can occur extremely rapidly. For example, in less than a second the product flashes off most of its moisture as it falls a few feet in the drying chamber.

During this time the product heats up, but due to evaporative cooling of the large amount of water that is flashed off the product, the product temperature only rises 20–30 °F (11–17 °C), minimizing thermal damage. The product falls out of the evaporative zone into the dry zone where it collects.

In traditional spray towers, exit temperatures are lower and the product remains free flowing. In filtermat dryers, the hotter product sticks together to form particles that accumulate on a moving bed. Because the product is thermoplastic (hot and sticky), as it lands on the mat screen it builds up into a layer, like snow.

Vacuum Dryers

Vacuum band dryers are large horizontal, sealed chambers that are maintained at a high level of vacuum. Inside the chambers are long horizontal belts or bands on which the concentrated product is distributed. These bands pass over plates that are heated by steam or hot water which, in turn, heats the product to drive off moisture. Much like evaporators, this type of drying takes advantage of the lower boiling point under vacuum to gently dry the product.

A second type of vacuum dryer is the vacuum drum dryer. It contains two stainless steel drums that are heated by steam. Concentrated liquid forms a puddle between these two drums which boils, aiding in concentration. As the drums turn toward each other, a thin film from this puddle coats each drum surface and passes between them.

Traveling around the outside of the rotating drum, the water in the thin film boils off, creating a dried film of product. Near the top of the drum, a doctor blade removes this thin film from the drum surface and it comes off complete, almost like a sheet of paper. The cleaned surface of the drum turns back into the puddle to receive more product which is fed continuously into the puddle.

Different Dryers for Different Extracts

Good grade extracts are often dried on spray towers. Drum drying and spray drying are the two most common types of dryers used for liquid food products. Because of the their physical characteristics and the ease of thermal damage, malt extract drying requires special modifications of these driers to be done successfully.

Spray towers produce powders that are very fine, due to small droplets required to get these materials to dry in a very short time. This fine particle size is great for dispersing evenly in dry mixes used by bakeries. They are very poor at going into solution by themselves, however, as they tend to ball up and form clumps in water that resisting dissolving. They are also very prone to dusting in the air, which can make a big mess while brewing or handling in a humid environment. If meant to be used in beverages or quickly dissolved, spray dried extracts must typically be agglomerated after drying.

Agglomeration

Agglomeration is a process of slightly rewetting a powder to allow the fine particles to stick together. This creates larger particles with porosity that allow for improved handling and dispersion.

Products dried on filtermats, vacuum band or vacuum drum dryers tend to be coarser and larger in particle size. Because they are broken pieces of a dried cake or agglomerate, they are full of pore spaces which facilitate the entry of water and natural dispersion of the product. Thus these products are naturally agglomerated during the drying process. Drum dried products can look flaky or crystalline, while band and filtermat dried products are more irregular.

After drying, the malt extract is conveyed and packaged in environments containing chilled dried air. If air of too high a relative humidity ever contacts malt extract, it will absorb water and can then either clump, or remelt and solidify to a rock-like consistency. Malt extract is always packaged in bags with complete moisture barriers to prevent this.

Applied Understanding

What is gained by a further understanding of the manufacture of malt extract? A brewmaster should, of course, understand that they should specifically use one manufactured for brewers. (Historically some articles critical of malt extract for brewing focused on malt extract products that were never intended for brewing beer.)

Understanding the process also helps homebrewers better appreciate the care that goes into creating malt extracts with the quality needed to produce beer. Maintaining quality requires constant control of temperatures and time to minimize any ill effects upon the finished product.

This attention to control needs to be continued even after the liquid is produced. One of the most frequent mistakes extract brewers make is using extract that is old or improperly stored. Storage temperature is the critical factor. Liquid extract stored cold will maintain its flavor almost indefinitely — stored warm, it will darken noticeably in a few months.

To Boil or Not to Boil

Given that malt extract has already gone through a brewing cycle, many brewers have questioned the amount of additional processing that must be done to successfully brew beer from extract. Specifically, the question of whether worts made from extract require boiling often arises. Understanding their manufacturing process and the main goals of boiling malt extract provides the answer.

There are 5 main "-ations" that brewers are concerned with when boiling their wort or concentrated worts. These are:

- Caramelization (of sugars)
- Volatilization (of DMS precursors)
- Sanitation
- Coagulation (of proteins) and
- Isomerization (of hops)

Caramelization and Volitization:

Brewing-grade extract has already undergone a kettle boil and extensive volatilization. Beneficial colors and flavors have been developed from caramelization and Maillard reactions in the kettle boil. Any volatile off aroma or flavors from the grain or DMS precursors have been removed. If the extract is diluted to wort and held at boiling temperatures without proper additional volatilization, additional precursors can be generated. In general, worts from malt extract do not need to be boiled to remove DMS precursors. However, if they are boiled, the boil must be vigorous enough to remove these precursors as more are created when wort is held hot.

Coagulation:

All brewing-grade manufacturers remove hot break from their malt extracts. Some manufacturers also remove the cold break.

Sanitation:

Though not a sterile product, brewing grade malt extract has gone through a boiling step and has a very low microbial count. It exists as a low water activity product, not permitting growth or spoilage. Contamination is normally so low that simple pasteurization of wort at 160 °F (71 °C) for 2–5 minutes is enough to provide reasonable assurance of an uncontaminated finished product. Thus, if using a hopped malt extract or hop extracts, brewers can get away with very short or nonexistent boils, depending upon hop aroma desired and confidence in yeast and sanitation.

Isomerization:

Boiling is necessary to isomerize the alpha acids in hops in order to make them soluble. If you are brewing with unhopped malt extract, you will need to boil your hops in wort. However, you can withhold a sizeable amount of your malt extract and add it late in the boil or at the end of the boil.

Now Brew Some Beer

With a better understanding of malt extract production, brewers can better understand when and how to use the extract properly and how to store it. When chosen and used properly, high quality malt extracts can produce world class beer.