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Advanced Mashing

- supplement to the **Basic and Deluxe All-grain System Instructions**

Step Infusion Mashing

The steps below describe the procedure for conducting a multiple-step infusion mash, used when brewing with low- to moderately-modified malts. These instructions assume familiarity with all-grain brewing using a single-infusion mash.

Principles and Advice

What makes a multiple-step infusion mash different from a single-step infusion mash is the inclusion of a *protein rest* of 20-30 minutes at or near 122°F. The purpose of a protein rest is to use *proteolytic enzymes* within the grain to break down large protein molecules in the mash, which achieves four important things:

- reduces protein haze when the beer is chilled
- aids body and head retention by creating small molecular-weight proteins which remain in the beer
- more thoroughly releases starch from grain's endosperm, giving higher mash yields
- creates a nutrient-rich wort for yeast

A protein rest is used when brewing with low- or moderately-modified malts, or high-protein grains like wheat or corn. *Modification* refers to the degree of protein breakdown that is carried out during malting. Low- or moderately-modified malts are often made from high-nitrogen barley; these kinds of malts are usually for lager brewing and are made from barley grown in continental Europe, especially Germany and the Czech Republic. Since English and American malts are as a rule fully modified, the proteolytic enzymes have already been used and destroyed during malting, so there is no benefit from including a protein rest when brewing with these malts.

As with a single-infusion mash, a multiple-step infusion begins when water is heated to a given *strike temperature*, then mixed with the grist to reach the protein rest. After a 20 to 30 minute protein rest, the temperature of the mash is raised to the saccharification range, where it rests for 60 minutes at 150° to 158°F. From this point onward, the procedure for a multiple-step infusion mash is the same as for a single-step infusion.

The keys to multiple-step infusion mashing are raising the temperature of the mash evenly and preventing heat loss during the rests.

Adding infusions of hot water to the mash to raise the temperature is the most common method; remember to stir thoroughly. This method allows you to mash in an insulated vessel like a picnic cooler, which minimizes heat loss.

If you mash in a kettle, you can apply direct heat to raise the temperature of the mash. *It is important to start with a more dilute mash and stir constantly* when direct-heating your mash. The drawbacks to this method are the risk of scorching the mash and the risk of destroying the enzymes with uneven heat.

Procedure

- Collect the strike water – you will need 1 quart of water for every pound of grain to be mashed (you may need more than 1 quart per pound if your mash vessel has a lot of *foundation space* – the empty space between the false bottom and the bottom of the mash vessel. In a kettle, heat the strike water to 134°F. Pour the heated water into the mash tun. Slowly add the *grist* (crushed grain) to the water in the mash tun, stirring well to prevent clumping. The temperature should stabilize at 122°F. Additional hot or cold water can be added to correct the temperature, but don't worry if the temperature is slightly off - proteolytic enzymes are active from 113° to 131°F. *Do not exceed 150°F during this step*, or you may destroy the enzymes needed for protein breakdown.
- Rest at this temperature for 20 to 30 minutes. During the *protein rest*, malt enzymes break up large protein molecules to improve head retention and body and reduce haze.
- While the mash is resting, collect the infusion water – you will need 0.5 to 0.75 quarts of water for every pound of grain used in the mash. In a kettle, heat the infusion water to 200°F.
- When the protein rest is finished, add the hot infusion water, 1 quart at a time, to the mash to raise the temperature to the saccharification range. Stir and measure the temperature after each addition. The temperature should stabilize between 149° and 158°F – refer to your recipe for the exact saccharification rest temperature to be used. Additional hot or cold water can be added to correct the temperature. *Do not exceed 168°F during this step*, or you may destroy the enzymes needed for starch conversion.
- Rest at this temperature for 60 minutes. During the *saccharification rest* malt enzymes convert the grain's starch into fermentable sugars.
- While the mash is resting, collect and heat sparge water. When the saccharification rest is finished, proceed with mash-out (brief rest at 168°-170°F) and sparging as with an infusion mash.

Decoction Mashing

The steps below describe the procedure for conducting a double decoction mash, a traditional European technique still used today by many Czech and German breweries. These instructions assume familiarity with all-grain brewing using a multiple-step infusion mash.

Principles and Advice

A decoction mash uses the same rests as a multiple-step infusion mash; the difference with decoction mashing is that a portion of the mash – the *decoction* - is removed from the mash tun, slowly heated to boiling, and then added back to the main mash to raise the temperature to the next rest. In addition to the results achieved with multiple-step infusion mashes, decoction mashing also has these effects:

- physically breaks down unconverted starches and proteins, making them more accessible to enzymes and increasing extraction
- enhances malt aroma and flavor in the finished beer

Boiling the mash degrades the most complex starch and protein molecules, speeding up conversion and increasing the creation and extraction of sugars from the grain. Because the portion of the mash that is boiled is very dense and low in pH, decoction mashing does not extract astringent compounds from the grain.

Boiling the starch-rich mash also triggers chemical reactions that form *melanoidins*. These same reactions occur when caramelizing onions or searing a steak. For brewing purposes, melanoidins deepen the color of the wort and provide a more intense malt aroma and flavor. An infusion mash schedule doesn't achieve the necessary

heat or duration of heat to trigger these reactions.

Some decoction mash schedules include an *acid rest* of 15 – 20 minutes at 95°F, prior to the protein rest. This practice originated in breweries that used very pale, low-modified malts and extremely soft, low-calcium water; the acid rest served to lower the pH of the mash to optimal levels through the creation of phytic acid by *phytase*, a malt enzyme. Since phytase is destroyed by heat, it's not possible to significantly reduce the pH when brewing with more fully-modified malts or highly-kilned malt varieties like Vienna or Munich. However, this optional step does help thoroughly *solubilize* the grist, washing enzymes out of the malt and into solution and hydrating the proteins and starches in the kernels; a well-solubilized mash makes for fast conversion and easy mixing.

Because the decoction is heated to boiling, any enzymes contained in it are destroyed before they can be added back to the main mash. To ensure complete breakdown of protein and conversion of starches, *it's important that* the first decoction of a double decoction mash (or the first and second decoctions in a triple decoction mash) *consist only of the grain portion* of the mash - the *thick mash*. The great majority of the enzymes will be contained in the liquid portion – the *thin mash* – once the grain is mixed with water. Most of the thin mash should remain in the mash vessel when the decoction is removed. The volume of a thick-mash decoction should be one quart of thick mash for every pound of grain in the recipe – about eight to ten quarts of thick mash for a standard-gravity beer.

For both double and triple decoction mash schedules, the final decoction raises the mash temperature from saccharification to mash-out. Because conversion is complete and the enzymes will not be needed after this point, the final decoction consists of thin mash – it's easier to collect and boil. The volume of the final decoction should be about half of the volume of mash water used – about five to six quarts for a standard-gravity beer.

To conduct a decoction mash, you will need (in addition to a mash/lauter tun and other standard all-grain equipment) a small kettle (at least 3 gallons) for boiling the decoctions. A 1 quart measuring cup with a handle or a small strainer is ideal for separating the thick mash. Because decoction mashes take longer than other mash schedules, it's very important to have a well-insulated mash tun to prevent heat loss.

While heating the decoction, stir to keep the malt from sticking and scorching. If necessary, a small amount of water can be added to reduce the risk of scorching and make stirring easier.

How long to boil a decoction depends on the beer being brewed. A decoction for a pilsner-style lager needs to be boiled only very briefly to preserve the pale color, while a doppelbock mash will become darker and richer by boiling the decoction for up to 30 minutes.

In a double decoction mash (procedure given below), the mash starts with the protein rest; alternatively, it may start with the acid rest and use an infusion of hot water to reach the protein rest. The first decoction (thick mash) raises the mash temperature to the saccharification rest. The final decoction (thin mash) raises the mash temperature to mash-out.

In a triple decoction mash, the mash begins at the acid rest. The first decoction (thick mash) raises the mash temperature to the protein rest, and the second decoction (thick mash) raises the temperature to the saccharification rest. The final decoction (thin mash) raises the temperature to mash-out.

Is decoction mashing worth the trouble? Its detractors argue that there isn't enough difference between a decoction-mashed beer and an infusion-mashed beer to justify the extra time and labor. Its proponents argue that the rich maltiness of many German and Czech beers can't be reached without it, and that breweries like Erdinger, Ayinger, Bitburger, Plzensky Prazdroj (the brewers of Pilsner Urquell), Paulaner, et al., wouldn't decoction mash if it wasn't important to the character of their beers.

Procedure

- Collect the strike water – you will need 1.5 quarts of water for every pound of grain to be mashed (you may need more than 1.5 quarts per pound if your mash vessel has a lot of *foundation space* – the empty space between the false bottom and the bottom of the mash vessel. In a kettle, heat the strike water to 134°F. Pour the heated water into the mash tun. Slowly add the grist to the water in the mash tun, stirring well to prevent clumping. The temperature should stabilize at 122°F. Additional hot or cold water can be added to correct the temperature, but don't worry if the temperature is slightly off - proteolytic enzymes are active from 113° to 131°F. *Do not exceed 150°F during this step*, or you may destroy the enzymes needed for protein breakdown.

Note: to add an optional acid rest, strike 1 quart of water per pound of grist at 100°F and rest for 15 minutes; add hot water to raise the mash temperature to the protein rest and proceed as below.

- Protein rest for 20 to 30 minutes.
- When the protein rest is complete, remove the first decoction. Using a measuring cup or strainer, collect in the decoction kettle 1 quart of thick mash for every pound of grain used in the mash. Leave behind as much liquid as possible – there should be just enough liquid in the thick mash to fill up the spaces between the kernels. Gently heat the decoction, stirring to prevent sticking and scorching – use very low heat. If necessary, a small amount of water can be added to reduce the risk of scorching and make stirring easier. Boil the decoction for up to 30 minutes.

Tip: Scorching will occur early in the decoction if at all! Heat *very* slowly to start, and increase the rate of heating later as needed.

- When the first decoction has been boiled, return about 75% of the decoction to the mash to raise the temperature to the saccharification range. Stir and measure the temperature, and add more decoction to further raise the temperature as needed. Stir and measure the temperature after each addition – you may not need to add the entire decoction back to the mash. The temperature should stabilize between 149° and 158°F – refer to your recipe for the exact saccharification rest temperature to be used. Additional hot or cold water can be added to correct the temperature. *Do not exceed 168°F during this step*, or you may destroy the enzymes needed for starch conversion.

Note: if you reach the correct saccharification rest temperature before the entire decoction is returned to the main mash, add cold water to the remaining portion of the decoction to cool it to saccharification temperature, then add it back to the main mash.

- Saccharification rest for 60 minutes.
- When the saccharification rest is complete, remove the second decoction. You will need to collect in the decoction kettle enough thin mash to equal about half of the volume of mash water that you started with – i.e., if you started with 12 quarts of strike water, collect about six quarts of thin mash. It will be easiest to remove this portion using a spigot on the mash vessel – don't worry if the thin mash is cloudy or contains particles of grain. Gently heat the decoction, stirring occasionally – scorching shouldn't be a problem with the thin mash. Boil the decoction for up to 30 minutes.
- While the decoction is heating, collect and heat sparge water.
- When the second decoction has been boiled, return about 75% of the decoction to the mash; repeat the procedure for the first decoction to raise the temperature to mash-out. Proceed with sparging as with an infusion mash.

Further reading

Brewing Lager Beer (2nd Edition) Gregory Noonan
How to Brew John Palmer
The Brewer's Companion Randy Mosher