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# ALTERNATIVES TO DRY MILLING

7 min read

Following kilning at the maltster, dry pale malts contain approximately 3–6% moisture. Malts with less moisture would be too brittle while malt that contains more moisture than this would suffer a decreased storage life and possibly lower yield. The increased moisture can result in lower enzymatic power for instance, and this, in turn, will impact mashing. Improperly stored malt — such as malt stored with unmalted grains — may pick up moisture. This is because unmalted grains have a higher moisture content (e.g. unmalted barley usually contains 12–14.5% moisture).

Malt with the correct moisture level should provide no problems when dry milling. The endosperm should be crushed into smaller particles whose size distribution depends on the number of rollers in the mill and their mill gaps. In a like manner, the husk of the malt — which is reasonably brittle in dry malt — will also be broken into multiple pieces. This is again a function of the mill type and settings.

When mashing, smaller endosperm particles result in a higher extract yield. However, for brewe employing a lauter tun, these smaller husk particles also increase the time it takes to lauter a ba / may also result in higher polyphenols and tannin levels in the wort and finished beer, which can lead to higher astringency in the beer.

Dry milling works well for many breweries. It is a relatively straightforward and a workable tradeoff between efficiency and “lauterability”, which can be found by adjusting the mill properly. Achieving this consistently, on the other hand, requires the brewer to regularly check the quality of the milling by measuring the size assortment of the milled grains, and making mill adjustments. This is because the consistency of the incoming malt varies and due to the normal wear of the rollers, for instance. Different malt types perform differently in the mill (e.g. very dark malts tend to be more brittle). The ideal grist assortment will depend on the type of mash separation technology one uses (lauter tun vs. mash filter).

However, two alternatives to dry milling — conditioned milling and wet milling — offer some improvements over dry milling. Most notably, in both cases it is possible to yield smaller endosperm pieces while leaving larger husk pieces or husks that are whole. This results in higher yield with improved lautering, lower polyphenol extraction, and lower dust (and thus, lower explosion risk). However, these options require additional equipment that needs to be carefully controlled and can give the brewer additional concerns.

**Conditioned Milling**

In conditioned milling, the malt is sprayed with steam or hot water as it is augered (or otherwise conveyed) to the mill. The malt receives a small amount of moisture that is sufficient to wet the husk making it less brittle, while the amount of moisture increase to the endosperm is much lower, thus keeping it brittle. The wetted husks become “leathery” and are more pliable than dry husk. When milled, the husk of each grain breaks into fewer pieces. This helps in lautering and also in limiting the amount of polyphenols that leach from the husks. Because the husks are broken into fewer and larger pieces, the mill gap can be tightened to produce smaller endosperm particles. Conditioned milling may be done on a 2-roller, 4-roller, or 6-roller mill.

On some mills, the husks may be separated from the endosperm pieces during milling. The husks may then be reunited with the wort immediately before lautering. This will reduce the polyphenol content in the beer. This can be done with dry milling, too.

Conditioned milling requires the equipment necessary to wet the malt, but not a new mill. The procedure needs to be performed correctly to be effective. If the malt receives too much moisture, dissolved starch from the endosperm can gum up the mill. If the moisture increase is inadequate, this merely results in an outcome similar to dry milling. When employing conditioned milling, the brewers must also pay increased attention to cleaning — and sanitizing, where applicable — any surface that becomes wetted.

**Wet Milling**

Wet milling is conceptually similar to conditioned milling, but much more water is used. In wet milling the malt is steeped in water for about 15 to 30 minutes in a hopper above a 2-row mill. When the malt reaches 15–30% moisture, the malt is milled. At the low end of this range, the water may not have penetrated the husks and this will be conceptually similar to conditioned milling. In wet milling, the husks generally remain in one piece and the endosperm is extruded from it. [i, ii, iii]

Wet milling has the benefits of conditioned milling — the ability to grind finer yet still yield larger husk pieces. Studies have shown that starch conversion occurs more quickly in wet milled grains [iv] a 10–20% moisture gives the highest levels of conversion [v]. And, as with conditioned milling, the grain dust explosion is greatly lowered. (It is not eliminated because grain dust can be produced in handling leading up to milling.) However, there are other benefits as well.

The brewer has many options when wet milling. The water from the milling operation may flow into the mash tun or it may be diverted away. Generally, if hot water is used for the initial step, the water is diverted. In this way, polyphenols from the malt husks do not enter the wort. If cold water is used, the water — and the aroma and flavor active compounds from the husk — becomes part of the wort.

Wet milling has potential disadvantages. In order to wet mill, the brewer needs to replace their existing mill with a mill designed for wet milling. In practice, these are 2-roller mills. Some of these systems can be hard to adjust, may result in higher maintenance costs, and a larger capacity mill may be needed to meet the desired brewing schedule (since wet milled malt cannot be stored). The traditional steeping system using a malt bin has mostly been replaced with an intensive steeping chamber to reduce these disadvantages. As with conditioned milling, wet milling requires that the brewer pay extra attention to sanitation in mill, which includes the steeping hopper and the rollers.

**Wet Milling Green Malt**

A special type of wet milling setup is being tested for milling green malt. The kilning stage in malting — the final stage where the grain is dried — requires the most energy. Eliminating this stage would make the overall brewing process more energy efficient. However, the brewery would need to brew with green (unkilned) malt. The wet mill set up that was tested first cut the green malt — while it is steeping in 83–85°F water (adjusted to a pH of 3.8–4.0 with lactic acid) — with a stainless steel blade. The cut green malt slurry was then transferred to a second mill where it is ground between two stones. [vi]

The resulting beer was deemed to have a high drinkability, with no dimethyl sulfide (DMS) being present. Levels of the precursor to DMS, however, were high. The biggest difference between the green malt beer and beer made from kilned malt under the same conditions was a higher degree of apparent attenuation (with a resultant higher alcohol by volume (ABV)). Brewing beer from green malt could lower the batch-to-batch cost. However, a much higher attention to malt inventory would be required as the shelf life of green malt is very small (a few weeks) compared the shelf life of dry malt (many months).

If a brewery is consistently both getting poor results with its current dry mill, and has access to sufficient capital, a switch to conditioned or wet milling may be a worthwhile investment. However, if the brewery has a 4-roller or 6-roller mill that is giving good results, it may take a long time for the upgrade in equipment to pay for itself. And, as noted earlier, wet types of milling require extra attention to cleaning and sanitation of the mill and hopper. Milling green malt may become a possibility for large breweries, resulting in a large reduction in the amount of energy required to malt, mill, and mash each batch.

By Dr. Chris Colby

[i] Lewis and Young. 2002. Brewing: Second Edition. Kluwer Academic/Plenum Publishers, New York, p. 208

[ii] Briggs, et. al. 1981. Malting and Brewing Science: Volume 1 Malt and Sweet Wort: Second Edition. Kluwer Academic/Plenum Publishers, New York, p. 314–316

[iii] Kunze. 2004. Technology Brewing and Malting: Third International Edition. VLB, Berlin. p. 209–212

[iv] Sczwajgier. 2011. Dry and Wet Milling of Malt. A Preliminary Study Comparing Fermentable S al Protein, Total Phenolics and the Ferulic Acid Content in Non-Hopped Worts. J. Inst. Brew. 117(4): 5

[v] de Moura and Mathias. 2018. A Comparative Study of Dry and Wet Milling of Barley Malt and Its and Influence on Granulometry and Wort Composition. Beverages 4: 51

[vi] Aerts and Chapelle. 2021. Innovative Milling Technology for “Green” Malt Brewing, Brauwelt International: V

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