TOPIC: AGRIBUSINESS, PRODUCT INNOVATION, DISTILLING

KEY MALT QUALITY CHARACTERISTICS FOR DIFFERENT BEER STYLES AND WHISKY

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If you are presented with a base malt that claims to be the “best brewing malt” or the “best distiller’s malt”, how would you know if it is indeed the “best” for you? The answer is the typical “It depends”, because whether a malt is a best fit for your needs is judged on a number of important factors such as the beer style, and the particular aspects of your own operation and product formulation. In this brief article we explore some key quality characteristics that make a malt “the best” for you. In particular, we will focus our attention on the protein, carbohydrate and enzymatic factors. We will also mention some future malt-related product innovations.

It starts with the barley that is available to the maltster

Barley breeding takes years to deliver varieties for commercial production. As the dynamics of product development and the market place evolve, so should the barley varieties grown. In order to provide timely feedback to barley breeders from these market changes, the Technical Committees of both AMBA (American Malting Barley Association) and BMBRI (Brewing and Malting Barley Research Institute) have published Breeding Guidelines for target quality attributes of barley and malt that meet the needs of different formulations. Specific ranges are set forth for parameters such as protein, free amino nitrogen (FAN), diastatic power (DP) and predicted spirit yield (PSY). These Guidelines have become critical references to help ensure supply-chain and quality needs are met. From these barley varieties the maltster can then produce a wide variety of malts depending on the malting process used.

The Protein Factors

Malt protein provides the molecular basis for enzymes, foam-enhancing peptides, FAN, and potentially beer haze. And it can also impact flavor stability as we will describe shortly.

The AMBA guideline for malt protein level in two-row malt is ≤ 11.8% for all-malt brewing and distilling, while for adjunct brewing and grain distillers they are ≤12.8% and 11.0-13.5%, respectively. For all-malt brewing, when the protein content is at low/moderate level, e.g., around 10% protein in some European malts, there is usually an adequate amount of assimilable nitrogen for yeast. Studies have found that the optimal FAN demand in brewer's wort increased from 13.3 to 15.5 ppm/°Plato when the wort gravity was increased from 12-to 18 °P (Casey and Ingledew, 1986).

Excessive residual amino acids in the beer is not desirable as it could then act as substrate for staling aldehydes through Strecker Degradation. This takes place over time at room temperature particularly when the beer pH is at the high end. A typical Strecker aldehyde is methional from the amino acid methionine. This aldehyde exhibits meaty, brothy and cooked potato notes even at low threshold, and increases substantially in packaged beer as beer ages (Yin, 2022). This is one of the major staling mechanisms in all-malt beer instead of the papery notes resulted from lipid degradation/oxidation. Hence the AMBA guideline for FAN level in two-row malt is 140-190 (mg/L) for all-malt brewing & distilling, while they are much higher at >210 and >250 (mg/L) for adjunct brewing and grain distillers, respectively.

A related or alternative metric to the FAN level is that of the so-called Kolbach Index also known as the Soluble-to-Total Protein ration (S/T). This ratio assesses the degree of protein degradation and modification during the malting process. Soluble proteins are those that have been extracted and some of them are available for yeast metabolism during fermentation, while total proteins include both soluble and insoluble proteins.

The optimal FAN or S/T level is influenced by the product style. Prior to the craft beer boom, the high enzyme and high FAN features of malt in North America were well sought after for lager brewing where a high percentage of adjuncts was used. Also, breweries in the southern hemisphere faced some local barley varieties that were not be able to provide sufficient nitrogen for adjunct brewing. Now however, when brewing with all-malt recipes such as for IPAs and for Pilsner style craft beers, the high FAN and enzymatic features become unnecessary since there is no additional starch to degrade from adjuncts and, therefore, the wort nitrogen concentration is not lowered by the use of these ingredients.

Therefore, the requirements for quality specifications of malt in North America have changed substantially since the craft IPA revolution. This might be one of the reasons why the barley variety Copeland which has a moderate protein and enzyme potential has endured since 1972.

The Carbohydrate factors

One of the important carbohydrate factors is the level of beta glucans and arabinoxylans. Their levels in the cell wall are ideally controlled at low levels to avoid process performance difficulties regardless of the beer styles to be brewed, with a possible exception for hazy beers. Wort viscosity is a more accessible surrogate metric for these carbohydrates. The AMBA guideline for viscosity is <1.50 (absolute cp).

Starch is the source for fermentable sugars and spirit yield. However, diastatic enzymes are required to degrade the large molecules to oligosaccharides. From a given barley variety, the maltster can impact the level of DP in the malt through the malting process, kilning in particular. Studies have demonstrated that malt with higher diastatic power (DP) enzymes produced more maltose and glucose which are readily fermentable (Yin, 2021). Moderate DP levels (110-150 °L, ASBC or 370-650 WK EBC) are required for all-malt brewing and distilling, while higher DP is naturally required for adjunct brewing and grain distillers (up to >200°L, ASBC or >680 WK).

For the production of no-alcohol beers, the starch is preferably degraded to dextrins and oligosaccharides. These are non-fermentable by the yeast. Further degradation is to be avoided as much as possible, as otherwise fermentable sugars such as maltose are generated. Even if a maltose-negative yeast is used, high levels of maltose in the wort and resulting beer are not desirable. Producing a very low fermentability wort requires, among other things, a malt to be low in DP, especially the beta-amylase component of the enzymes.

Unique features of distiller's malt

When it comes to distilled spirits, although the majority of them use a portion of un-germinated cereals like rye and corn in the formulation, all-malt distilling such as single-malt whisky in America has emerged to compete with popular imported products. The optimal malt for this application requires additional features that were not usually addressed for grain-distilling.

Other than the protein and carbohydrate aspects, there is increasing attention to certain specific malt qualities for distiller's malt. One focus is the ethyl carbamate (EC) formation in distilled spirits from epiheterodendrin (EPH) in barley, as EC is considered to be harmful to human health. EPH is a glycosidic nitrile (GN) and its level is variety-dependent. Odyssey, Full Pint and Genie, for example, appears to be non-EPH producers. Some breeders' lines show signs of non-GN already. Malting processes promoting the formation of GN include high steep-out moisture, long germination time and high temperature (MacLeod *et al.* 2018). The AMBA guideline for glycosidic nitrile is <0.5 (gm/MT) for all-malt distilling.

Predicted spirit yield, an economic indicator, is based on the amount of fermentable sugars available for the yeast to convert to alcohol. This parameter is a combined reflection of the starch content and the diastatic enzymes, particularly beta-amylase and limit dextrinase. The AMBA guideline for PSY is 400 (LPA/MT) minimum. Therefore, it is critical that the malt kilning conditions are carefully controlled so the enzymatic activities are well preserved.

Other quality factors like micro-load on malt is often specified as there might be no microorganism kill stage, such as wort boiling, in the spirit production process. Bacterial counts need to be managed in the optimal range depending on the processes and the target product flavor profile.

Forthcoming innovation for malt-forward beverages

The craft pale ale revolution was propelled by the biotransformation of hop components whether it was the terpenes for citrus notes or thiols for tropical fruit flavor. The move made American IPA more popular than those from the London and the Burton eras. Likewise, it has now been demonstrated that the carbon sulfur lyase activity from gene-edited yeast strains could release overwhelmingly high tropical fruit notes from malt. One of the thiols, for example, 4-mercapto-4-methyl-pentan-2-one (4-MMP) exhibits flavors like blackcurrant and *Sauvignon blanc* at about 1.5 ng/L. But when it is in its natural bound form with cysteine or glutamine, the threshold is thousands of times higher and not readily detected. The content of bound thiols, however, is found to vary widely by barley variety. How the malting process impacts the release is yet to be studied. The advances of new molecular approaches and analytical technologies will create tremendous opportunities for new product development where malt will have an important role to play.

References

Casey, G. P. and Ingledew, W.M. M. (1986) Ethanol Tolerance in Yeasts, CRC Critical Reviews in Microbiology 13(3):219-280.

MacLeod. A., Zuluaga, G., Turner, H., and Sherman, J. (2018) Levels of glycosidic nitrile in North American malting barley cultivars. Proc. Brewing Summit, San Diego, USA. Poster # 079.

Yin, X. S. (2021) Practical Brewing Sciences – MALT. Book by Am. Soc. Brew. Chem. St Paul, USA

Yin, X. S. (2022) A Look at Three Key Malt-Derived Mechanisms of Beer Staling and Practices of Mitigation. MBAA TQ. 59(2) 38–47.

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