QUALITY FACTORS IN MALTING BARLEY

Malting barley is barley that will produce high quality malt. It is a specialty crop for which a premium price is paid by domestic maltsters and exporters.

Quality requirements for malting barley are reasonably strict and are directly related to processing efficiency and product quality in the malting and brewing industries. Many of the characteristics required are under the control of the producer. Others are determined by weather conditions during the growing and harvesting season.

High quality malting barley should have the following characteristics:

- Pure lot of an acceptable variety
- Germination of 95% or higher (3 day test)
- Protein content of 11% to 12.5% (dry basis)
- Moisture content of 13.5% maximum
- Plump kernels of uniform size
- Fully mature
- No signs of pre-harvest germination
- Free of DON from *Fusarium* head blight
- Free from disease
- Free from frost damage
- Not weathered or deeply stained
- Less than 5% peeled and broken kernels
- Free from heat damage
- Free of insects, admixtures, ergot, treated seeds, smut and odour
- Free of chemical residues

The above list may seem formidable but each of these factors has an impact on malting and brewing processes and on the quality of the end product – beer. Good farming practices that increase yield should also improve barley quality. More care is required to produce high quality malting barley, but the premium over feed barley for selected malting barley provides compensation for the extra effort.

MALTING AND BREWING

Malting is a biological process that turns barley into malt. It is a three stage process, including steeping, germination and kilning. During steeping (soaking) the moisture content of the barley is increased to prepare the kernels for germination. Germination (growing) is carefully controlled with temperature, moisture and time to allow the kernels to progress to the point where the enzymes necessary for brewing are generated but the growth of roots and shoots is limited. Kilning (drying) reduces the moisture content of the kernels, stops the biochemical processes within the kernels, carefully preserves the enzymes generated during germination, and generates colour and flavour compounds.

Malt is one of the key ingredients in brewing – another biological process – providing starch and the enzymes necessary to produce the fermentable sugars, which yeast then turn into alcohol, as well as other yeast nutrients. Malt also provides colour and flavour compounds which contribute to the final character of a beer. "Extract" refers to all these compounds that are solubilized from malt during the first stage of brewing, with starch being the main component.

BARLEY VARIETY

Malting barley varieties possess high levels of several enzyme systems that are necessary to bring about the desired chemical changes within the kernel during malting. They also have other characteristics necessary for the efficient production of quality malt, and high quality beer. Most varieties of feed barley lack one or more of the necessary enzyme systems or have other features that make them unsuitable for malting purposes.

Different malting barley varieties behave differently during malting. This is why it's necessary to keep varieties separate as they're grown, harvested, stored, shipped, and processed. Each variety will produce malt with a particular quality profile. Brewers specify which variety or varieties they want in the malt they use in order to get the quality characteristics they need to make their particular types of beer.

To ensure that there is a demand for the malting barley variety you want to grow, it is best to check a range of sources, including your local malting company and elevator company, the CMBTC recommended list, as well as provincial guides with information on varietal performance in your growing area.

Certified Seed: The use of certified seed helps ensures varietal purity, as well as overall quality of the seed, and its use is strongly encouraged.

GERMINATION

Germination is absolutely critical to the malting process. If barley won't germinate, it can not be processed into malt. It's that simple. And beer can't be made out of raw barley. A minimum of 95% germination on a 3-day 4 ml germination test is an absolute requirement.

Any factor which interferes with the uniformity of germination or reduces the vigour of kernel growth during processing, will reduce the quality of malts produced. Several of the characteristics described below are a problem because of their impact on germination.

PROTEIN CONTENT

Malting barley with a high protein content results in lower extracts for the brewer. It also slows down water uptake during steeping, potentially affecting final malt quality. A very low protein level, on the other hand, results in a lack of enzymes necessary to modify the barley kernel and to break down the starch during brewing. Each brewer defines the malt protein level that's best for them based on their process, their yeast and the type of beer they're making. Generally, barley protein within the range of 11 – 12.5% can be used by maltsters to meet many brewers' needs. There are limited requirements for malting barleys with protein levels outside of this range – check with your maltster or elevator company to ensure you understand their requirements.

Just as blending varieties will cause problems during the malting process, blending barleys with different protein levels to achieve an acceptable average will also cause real problems during malting because of the effect on water uptake and therefore the uniformity of conversion into malt. Final malt quality will be compromised since the conditions will be set for a protein level that doesn't represent either batch of barley used to achieve an average reading.

Protein level is determined primarily by growing conditions. Early planting and high yields usually results in lower percentage protein. Excessive rates of nitrogen fertilizer will increase protein levels, but the application of nitrogen, on the basis of soil tests, to obtain optimum yields will normally have only a minor effect on the protein content of the grain. Good production practices that increase yield will generally tend to reduce protein levels.

MOISTURE CONTENT

Malting barley over 13.5% moisture does not store well. Moisture levels need to be low enough to inactivate the enzymes involved in seed germination (see "pre-harvest germination" below) as well as to prevent heat damage (below) and the growth of disease microorganisms. Quality and germinative capacity may significantly deteriorate. The grower should be sure that the harvested barley is below 13.5% moisture when stored.

Storage: Large amounts of selected barley and barley available for selection are typically stored on the farm. Because malting barley is a high quality product, storage should be in bins that are dry, clean, and high enough that ground water can not get in. Walls and floors should be thoroughly swept and measures should be taken to prevent infestation and to make it rodent proof. Ideal storage conditions can be maintained by means of natural aeration or frequent turning of the grain in the bin.

Drying: If the moisture content of harvested malting barley is above the safe level of 13.5%, it can be dried on-farm, but this must be done very carefully. Applying excessive heat can damage germination in the kernels, which will make the barley unacceptable for malting. Drying too quickly can cause kernel brittleness, increasing their vulnerability to breakage. Damaged kernels can also have germination problems. If heat is applied, the maximum air temperature should not exceed 30°C (86°F). Dry slowly with large volumes of air. When feasible, continuous drying is better than batch drying. The drying process should include a cooling period. This reduces the bin temperature, preventing heating within the bin's core. When aerating, the fan should be kept on until the drying process is complete. If the farmer chooses to shut off the fan, it should be for no longer than a few hours at a time. A crust can develop on the grain that prevents sufficient air flow when aeration begins again.

KERNEL PLUMPNESS AND UNIFORMITY

Maltsters are much more interested in plumpness than in test weight. A plump kernel contains more starch and gives a higher percent of extract which in turn produces a greater amount of beer from a given weight of malt. Extract yield is as important to a brewer as barley yield is to a producer. Uniformity of kernel size assists in obtaining uniform germination and, therefore, higher quality malt.

NEGATIVE QUALITY FACTORS

Pre-harvest germination: Malting barley may germinate under wet conditions during crop maturation through harvest. Although the barley is still alive, once pre-harvest germination has occurred, the barley will never perform optimally in the malt house, compromising malt quality. Barley showing signs of pre-harvest germination will therefore not normally be selected for malting.

FHB infected / DON positive: *Fusarium* head blight (FHB) and the presence of deoxynivalenol (DON) in barley directly impacts the quality of both the malt and the beer which can be made. Barley from areas with conditions conducive to FHB is routinely screened for DON and barley with DON levels over 0.5 ppm will normally be rejected for malting purposes.

Immature barley: Barley which has not fully matured before being harvested germinates slowly and erratically. This factor results in many otherwise suitable samples of barley being refused for malting. Fully ripe, uniformly matured barley is required for the production of top quality malt.

Diseased kernels: A number of fungi that attack the growing barley plant can result in damaged kernels. The most common, black point, is a black or brown colour at the germ end of the kernel. Covered smut is not present inside mature barley kernels but smut spores are often found on or beneath the hull surface and on smutted heads in threshed samples. The spores can be carried through the malting process and negatively affect beer quality. Malting conditions which encourage barley germination are also ideal for the further growth of diseases present in infected kernels. Samples with diseased kernels are therefore avoided.

Frost damage: Germination is seriously affected by frost damage. Early seeding and the use of adapted varieties will assist in escaping frost damage.

Weathering and staining: The weather during harvest determines the level of weathering and staining of barley kernels. Severely weathered barley is unsuitable for malting as germination is affected and moulds and other undesirable microorganisms are usually present. Bright or light straw coloured kernels are preferred and the degree of weathering or staining will affect the likelihood of the barley being selected for malting.

Peeled and broken: Barley samples are commonly rejected for malting if the level of "P & B" is too high. This is a quality factor that is under the control of the producer. Broken kernels will not germinate or will grow in an abnormal manner. Peeled kernels take up water faster than unpeeled kernels and this reduces the uniformity of germination during malting. The sprout of a normal barley kernel grows under the hull and is thus protected during the growing process. The sprout of a peeled kernel is not protected and, if broken off during processing, germination will be interrupted and the kernel will not be completely malted. Peeled kernels are also more susceptible to mould growth.

Improper combine adjustments are the major cause of peeled and broken kernels. Properly threshed malting barley will contain less than 5% peeled and broken kernels. Maltsters do not object to small amounts of beard remaining attached to the kernel.

The amount of kernel damage increases each time the barley is handled. However, properly threshed malting barley will not be seriously damaged during normal handling.

Heat damage: Barley which has been stored at high moisture levels will commonly show heat damage (see the section above on Moisture, Storage and Drying). Heated kernels are dead, and so won't germinate. Barley lots with heated kernels have high levels of bin mould and the bad smell of rotten grain, which impacts the flavour of malt and beer. Samples containing any heat damaged kernels are not purchased for malting.

Contaminants: Barley will not normally be selected for malting if there is any evidence of insects, ergot, treated seeds, smut, or bad odours. Barley should also be free of other grains, especially oilseeds.

USE OF AGRICHEMICALS

The treatment of malting barley with agrichemicals any time must be in accordance with manufacturers' labels and recommendations as approved by Canada's regulatory agencies. Particular attention should be paid to use rates, crop growth stages during application, and the pre-harvest interval recommendations on the label. Furthermore, BMBRI members require that the barley offered for selection for malting must not have been treated with glyphosate or any other chemical that acts as a desiccant on the barley.

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