

PROCESS CONTROL FOR MYCOTOXINS (e.g. DON) IN MALTING

Pre-Malting Practices

Store barley one year prior to malting.

Purchase low DON barley!!!

Improve procedures to clean chaff/straw.

Increase two-row in blend ...assuming these areas are mold free.

Setting a barley maximum spec of 1.0 ppm DON with existing specs for protein & kernel plumpness should yield malt with < 0.5 ppm DON and acceptable malt quality.

Avoid purchasing barley with late infection - may have low DON....high [mold] results in high [DON] during malting.

Use of starter cultures to inhibit DON/gushing producing strains of mold (e.g. IFBM Malting Yeast of SKW-Biosystem).

Lactic starter cultures (+)...*L. plantarum* better than *L. acidophilus* or *Pediococcus pentaceus*.

Cooler bed temperatures (65°F ideal).

Aggressive, vigorous aeration.

Moisture levels below 46%.

Starter culture of *Geotrichum candidum*.

Lower germination temps will lower DON, but undermodify!

More frequent bed turning.

Uniform bed temperatures.

Winter vs. summer malting.

Less water spraying than usual.

Kilning & Germination

Adding *Geotrichum candidum* to steep water.

Predicting malt DON for barley with < 1.0 ppm DON is unreliable.

Improve aspiration of dust.

Clean at slower speeds (2/3 setting).

Use of gravity separator to remove shriveled kernels.

Use of grade A barley to malt.

Increase Canadian six-row...assuming these areas are mold free.

Hot Water Washes.....short hot washes anywhere from 80-100°C....hotter the temp, shorter the time (+) e.g. 5 seconds at 100°C, 10 seconds at 86.6°C, 30 seconds at 70.8°C.

Increased air flow rates (higher fan speeds)

"Breakthrough" air not fully saturated.

Dry upper bed faster.

Increased drying rates

Two vs. three deck kilns.

Four vs. five day germination times.

DON is heat stable....survives kilning quite well!

Employment of hot air by-passes

"GRAS" spray treatments.

More rapid kilning.

Maximum limits for DON in wheat is 1ug/g in the USA and 0.75 ug/g in Austria. Cereals in general in Russia is 1 ug/g.

Process Surveys

Steeping

Longer overflow time periods.

Spray steeping.

Anaerobic steeping.

Reduce dry couch times.

Active skimming of floaters.

Late anaerobic steep (-)?

DON is water soluble.

[DON & ZEN] drop in steeping.

Adding lactic acid to steep water inhibits growth of *Fusarium* during malting.

[DON] highest in green malt...more in early kilning, then when > 85°C see less & after sprout removal. [ZEN] higher in kilned vs. green malt

Korean survey found DON levels of 0.44 ug/g for two-row malting barley.

@ 55-90% of the DON in the grist ends up in the beer.

Moderate correlation of barley/malt DON with wort color and xylanase activity.

Penicillium verrucosum a good indicator mold for the presence of specifically **ochratoxin A** in barley.

Rapid first lime steep...few hours.

Achieve a 93% reduction in [DON] with a 60 minute soak in 10g/L of sodium bisulfite, with no adverse impact on germination.

Two lime steep treatments.

Four vs. three steep water changes.

Uniform water penetration.

Cooler steep temperatures (50°F).

Increase lime steep-in water.

Use of variable height overflows.

Adding "IBFM Malting Yeast", at steep start to inhibit mold growth is EU approved.

PRACTICES CLAIMED TO REDUCE MALT DON LEVELS

Correlation between barley and malt DON "moderately strong" at r = 0.70.

Need over 50 ppm DON to start inhibiting yeast growth and fermentation profile.

In worst case scenario (i.e. highest level ever measured), beer consumption could contribute @ 6% of the recommended TDI maximum.

Wort spiked with 250-500 ng/g of DON and T-2 resulted in fermentations with significant differences in profile of higher alcohols and total ethanol.....these levels are below regulatory!

Ochratoxin A.....malt grist with 470 ug/kg.....**process survey** shows 21% lost by degradation during mashing....25% goes in spent grains....15% lost during fermentation by yeast uptake....15% lost in DE filtration.....remaining 21% ends up in beer.

ASBC XXVIII
(Casey;
June/06)