

# PROCESS CONTROL FOR BEER FOAM: BILL OF MATERIALS - MALT PROTEINS

## LTP: "Can't Take the Heat!"

[LTP] (+)...@ 25 ppm in unboiled wort...drops to 5-15 ppm after boil. GGS says LPT important in foam stability, but Z (40kD) is not.

Native LTP protein in barley relative poor foam enhancer...once denatured though during boiling, exposure of hydrophobic portions (internal in the hydrophilic state in barley) greatly increases foaming ability!

SAB reports more LTP survives at higher altitude breweries due to the lower boil temps!!!!...see NIEBEM values of 260 vs. 220 seconds at high vs. sea level breweries, respectively...still must manage ratio of other foam positives and negatives... "Beer Dilution" and "Foam Robustness" considerations.

LTP only foam active once it is denatured by boiling and hydrophobic regions exposed....beers produced at high altitudes (1800 m vs. sea-level), with lower boiling temps (96 vs. 102°C), have much higher levels of the undenatured protein (17-35 ug/ml vs. 2-3 ug/ml)...former actually an advantage if worts high in free fatty acids....a disadvantage if worts low in free fatty acids....remember multivariate/interactions!

LTP protein is quantitatively small in beer, but enriched in foam....denaturation during boiling actually enhances its foam positive properties....excellent role in foam generation, relatively little as a foam stabilizer though.

More LPT1 expression in barley from dry summers vs. wet (+)

**10-kd Barley lipid transfer protein = LTP....gene encoding is LPT1.**

LTP1 enriched in aleurone layer.

Barley (12-27 kD) or wheat (13-20 kD) Lipid Binding Protein.

5-15 kD proteins (e.g. LTP1 hordein & glutelin fragments) (+)

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35-50 kD HMW proteins (e.g. 11C7 protein 27 and proteins Low LTP beer can have good foam if the [FFA] is low ....if LTP low, see at 0.70 (good foam) vs. 2.84 (bad foam)...i.e. still possible, depending on dynamics!!!, (+) as stabilizer). Kit to detect Z7 is Biacore's "Surface Plasmon Resonance (SPR) BIOSENSOR".

GGS: structure of foam is as a network of hexagonal bubbles....LTP protein, a 17 kDa polypeptide and protein Z most important for formation and stability of foam.

LTP is not synonymous with LBP...these are independent proteins!!!!

## Effect on Beer Foam

"Lipid Binding Proteins" (+) e.g. PIN (puroindolines from wheat) and HIN (hordondolins from barley)...are foam positive, but because of heat sensitivity of little practical significance.

Barley Lipid Binding Proteins act to bind fatty acids, preventing them from damaging foam.

Use of LP-malt with outer layers removed....foam stability greatly improved.

Carlsberg's patent on "Cereal LTP" proteins to enhance foam formation i.e. cereal derived lipid transfer proteins.

Low LTP beer can have good foam if the [FFA] is low ....if LTP low, see at 0.70 (good foam) vs. 2.84 (bad foam)...i.e. still possible, depending on dynamics!!!

40 kD polypeptide, not protein, is foam active.

Specific malt proteins enhance foam (e.g. Z and LTP), however hydrophobic fractions in general are also foam positive.

Protein Z (40 kD) (+)...equals 10-25% of all beer protein...i/3 glycosylated by Maillard reaction in boiling...has two isomers, Z4 and Z7.

Malt derived proteins enhancing foam through interaction with hop IAAs are: a) protein Z4, b) LTP, c) Hordeins (MW 17 & 23kD) and d) Hordondoline & puroindoline...are lipid scavengers lost during kettle boil.

## Malt Proteins: LBPs & Z

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