

BEER FOAM: FOAM-POSITIVE & FOAM-NEGATIVE COMPOUNDS

Foam Positive

- Beer melanoidins (+)
- Beer polyphenols (+)
- Beta glucan, arabinoxylans (+)
- Fe, cobalt salts (+)
- Foam proteins [low proline]
- Higher pH's increase foam stability, especially of albumin fraction.
- Foam positive: divalent cations like zinc; IAAs at higher levels, ethanol if < 5%; nitrogen gas as slows disproportionation.
- Foam (+): IAAs, metals, gums, proteins > 5 kD, [real extract, viscosity, CHO, K, Mg, Tin, proteins over 50 kD, total protein].
- PGA a foam protector (by adsorbing lipids, not a foam stabilizer)...beware a *Ja* Schlitz learnings though!!!

Zinc over 0-2 ppm progressively increases foam stability of albumins, especially as degree of hydrolysis increases. Only increases foam stability of hordeins if intact, thus little importance in brewing due to process hydrolysis.

Metal Cations (Mn, Al, Ni) are (+) as they strengthen bubble film through cross-linking of hop IAAs.

Foam stabilizers (e.g. PGA, gums, cellulose acetate, Quest's yeast derived glycoprotein derived foam protector, hop pectin extract, (Heineken's collagen/gelatin or milk protein hydrolysate, Manucol Ester B (PGA), heteropolysaccharides S-10 etc...).

Added Zinc (+)....serves as divalent cation binding together i.e. bridging, protein/IAA complexes joined together by hydrophobic bonds, with the acidic (i.e negatively charged) parts of the IAAs being external and available to bind with cations. **Divalent cations** in general....avoid lethal cobalt aka Canada in 1960s!!!!

Miller: claim beta-glucan is foam neutral.

For German lagers, require 1.5 - 2.5 mg/100 mL of coaguable nitrogen (KOAGUL) in finished worts for acceptable packaged beer foam quality.

Foam Positive

- Nucleation sites of any kind (+)
- Oxygen (+)
- KMS (+)

NHL Method: Following correlation of beer constituents with foam observed in survey of 30 US beers:

- Beer polypeptides:**.....positive correlation with NHL & Life, not Head...specific to low MW (< 10kDa) and high MW fractions (> 50 kDa)
- IAAs & Polyphenols:**....positive correlates with NHL, less so for Life
- Real Extract:**....high positive correlation with NHL & Life...none with Head.
- Metals: Potassium, tin, chromium:** ...positive correlates with NHL, less so for Life...no correlation seen with **zinc, Al, Ni, Cu** and **molybdenum**....**iron** weak positive correlates with NHL.
- CO₂:**....positive correlates with Head value.
- Ethanol:****weak positive correlates with NHL**
- Color/pH:**no correlation seen.

Polysaccharides (+ as stabilizer).

Beer RE (+) or [MTT] (+)

Metals (+)

Effect on Beer Foam

Foam (-): Lipids, basic amino acids, high [ethanol], intermediate size proteins (0-50 kD).

Foam negative: lipids; ethanol > 5% as lowers surface tension.

Albumin foam impaired by ethanol (especially if > 5%).... hordein increased by ethanol.

BRI: Fatty acids fall in two groups:

- Short Chain Group**....C₆₋₁₀ derived from **yeast** and
- Long Chain Group**....C₁₆ and longer derived from **malt**, some unsaturated.

In terms of impact on foam:

- Fatty acids < C₁₂ are not surface active enough in the []'s found in beer to compete with foam proteins and destabilize foam;**
- C₁₂-C₁₄ fatty acids and the unsaturated C_{18:1} and C_{18:2} fatty acids destabilize foam by disrupting and weakening the adsorbed protein film, leading to bubble rupture;**
- saturated fatty acids C_{16:0} - C_{18:0} are foam negative, but act via the formation of hydrophobic aggregates, destroying foam through a film-bridging mechanism.**
- LBPs can prevent or even reverse negative effects of fatty acids on foam.**

Di- and trihydroxyoctadecanoic acids derived from linoleic acids (...degrade first to hydroperoxides, then these acids, thus oxidation crucial in their formation) determine the preponderance of FDE values for fatty acids in beer.....regulate and control negative effect on beer foam through mashing conditions.

C₁₂-C₁₈ long chain fatty acids damaging to head retention. Free fatty acids interfere with hydrophobic interactions of amphipathic proteins, destabilizing the foam bubbles.

Ethanol (-) for foam stability, (+) for foam formation....latter by lowering surface tension (which is why NAs and wort have such poor foaming ability), former by accelerating coalescence. Foam sucks in HG beers.

- Basic amino acids (e.g. arginine) (-)
- Residual cleaning solutions (-)
- NaCl (-)
- High RDF (-)

Linoleic acid destroys foam through increased rate of coalescence.

Beer pH (-)

Foam negative compounds: low MW nitrogen compounds (especially if hydrophilic), glyceroids, sterols, polymers, polyphenols, polymers, fatty acids, ethanol, higher alcohols, esters, sulphites, non-ionic detergents and cationic detergents (-)

Brewhouse enzymes contaminated with proteases (-)

Beer pH (-) between 3.8 to 4.6...better at lower pH's.

Malt derived (once again its the malt, not yeast) hydroxy fatty acids dihydroxyoctadecenoic and trihydroxyoctadecenoic (**DHOD & THOD**) are foam negative. Are produced during mashing by interaction of LOX enzyme and an enzyme with "**POX-like activity**". Formation inhibited by anaerobic mashing and temperature over 70°C, meaning barley breeding only practical solution. At 1 ppm spiking, diminish foam. One practical method of control is to lower mash pH from 5.5 to 5.0enzymes repressed at lower pH's.

Linoleic acid (-)

[Wort particles] (-)

Ratio of < 5000 kDa/> 5000 kDa peptides (-)

Foam Negative

Foam Negative

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