

# WORLD BREWING CONGRESS

Bitterness assessment in dry hopped beers  
based on sensory tests and analyses

Willi Mitter

# Subjects

- Dry hopping examples
  - Influence on analyses
  - Influence on bitterness
- Theoretical calculation of bitterness
- Dry hopping with pellets and hop oils
- Storage trials
  - Influence on analyses
  - Influence on taste

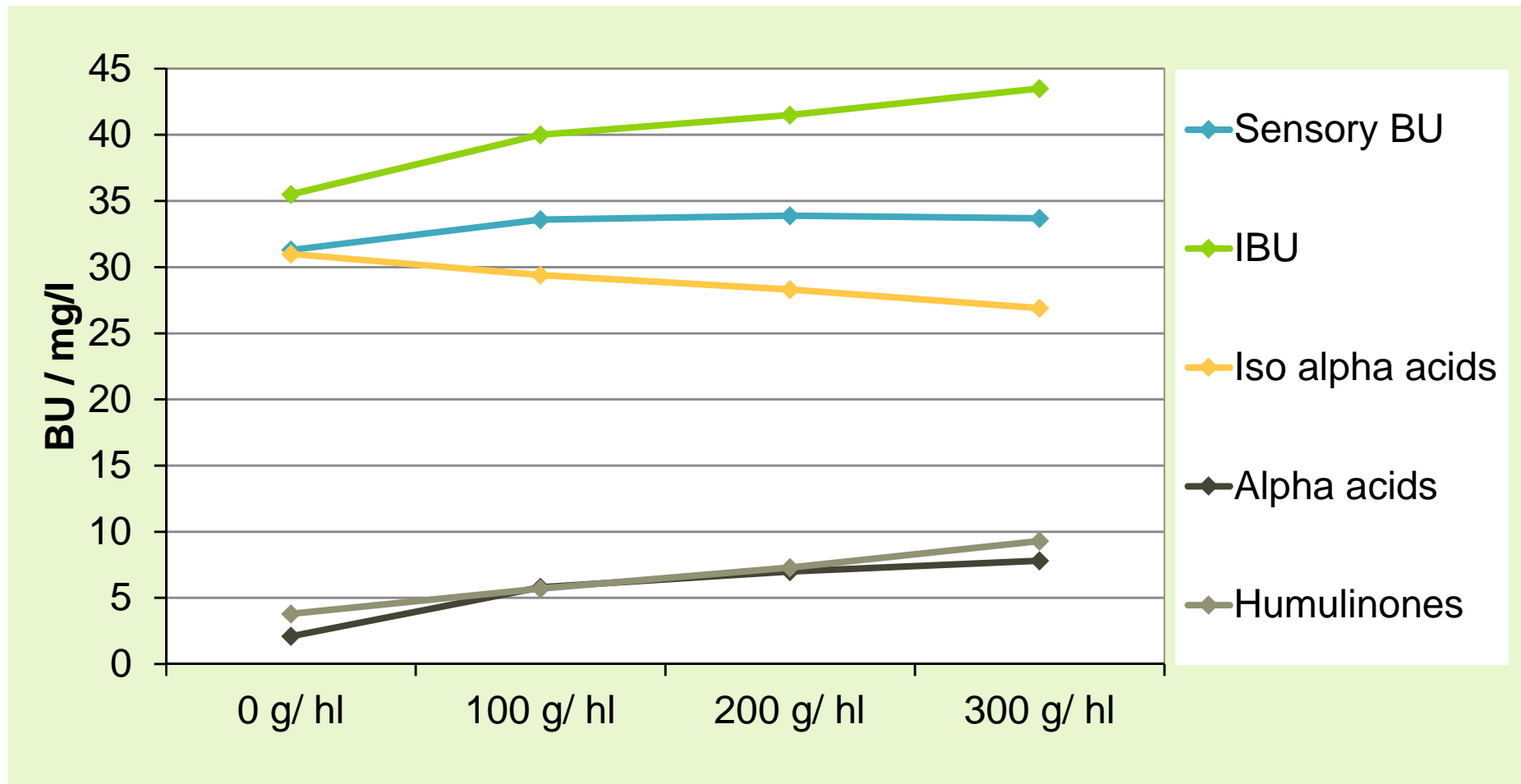
# Description Pale Ale

Identical base beer for dry hopping

- 2 x 10hl brews, fermented together
- After main fermentation split into 4 x 5 hl tanks
- Differently dry hopped Analyses of base beer
  - Gravity ~ 14.0 %
  - Alcohol ~ 6.0 Vol.-%
  - Iso-alpha acids HPLC: 20-25 mg/l

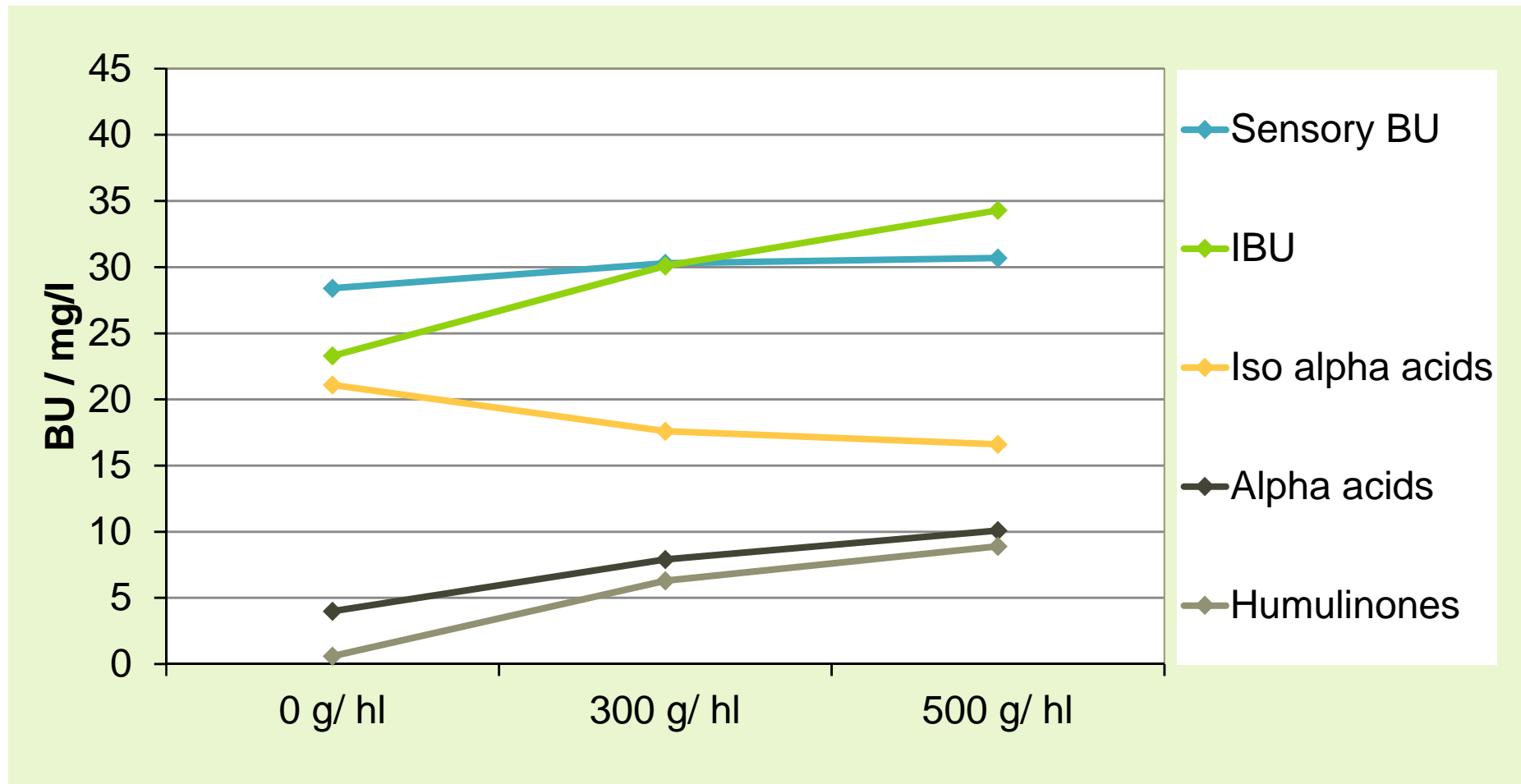
# Behaviour / IBUs & bitter substances

Example 1: Hüll Melon



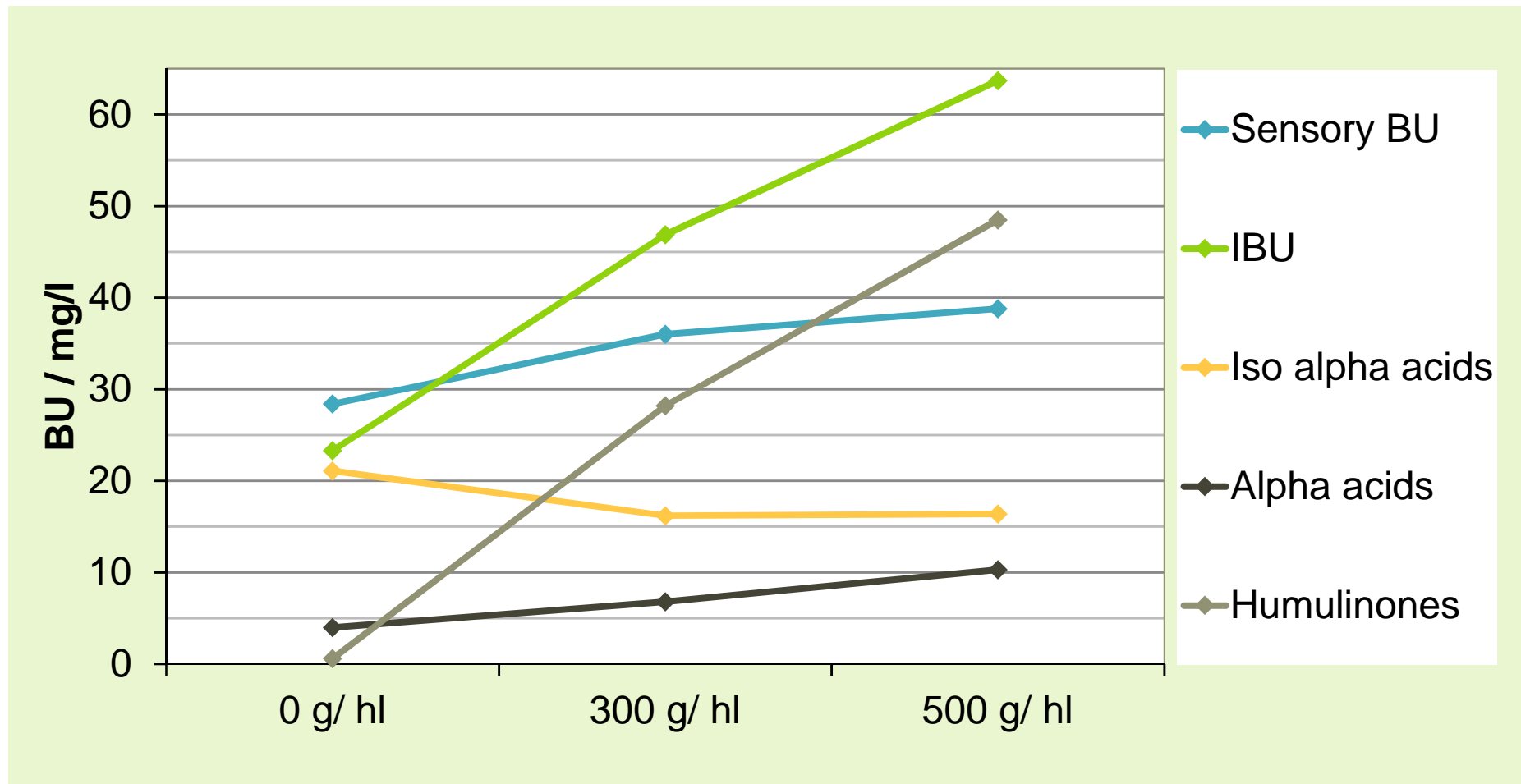
# Behaviour / IBUs & bitter substances

Example 2: Hopsteiner breeding line 09410



# Behaviour / IBUs & bitter substances

Example 3: Hopsteiner breeding line 10416



# Application of formula

$$CB = IAA + AA \times 10\% + H \times 66\%^*$$

CB = Calculated bitterness

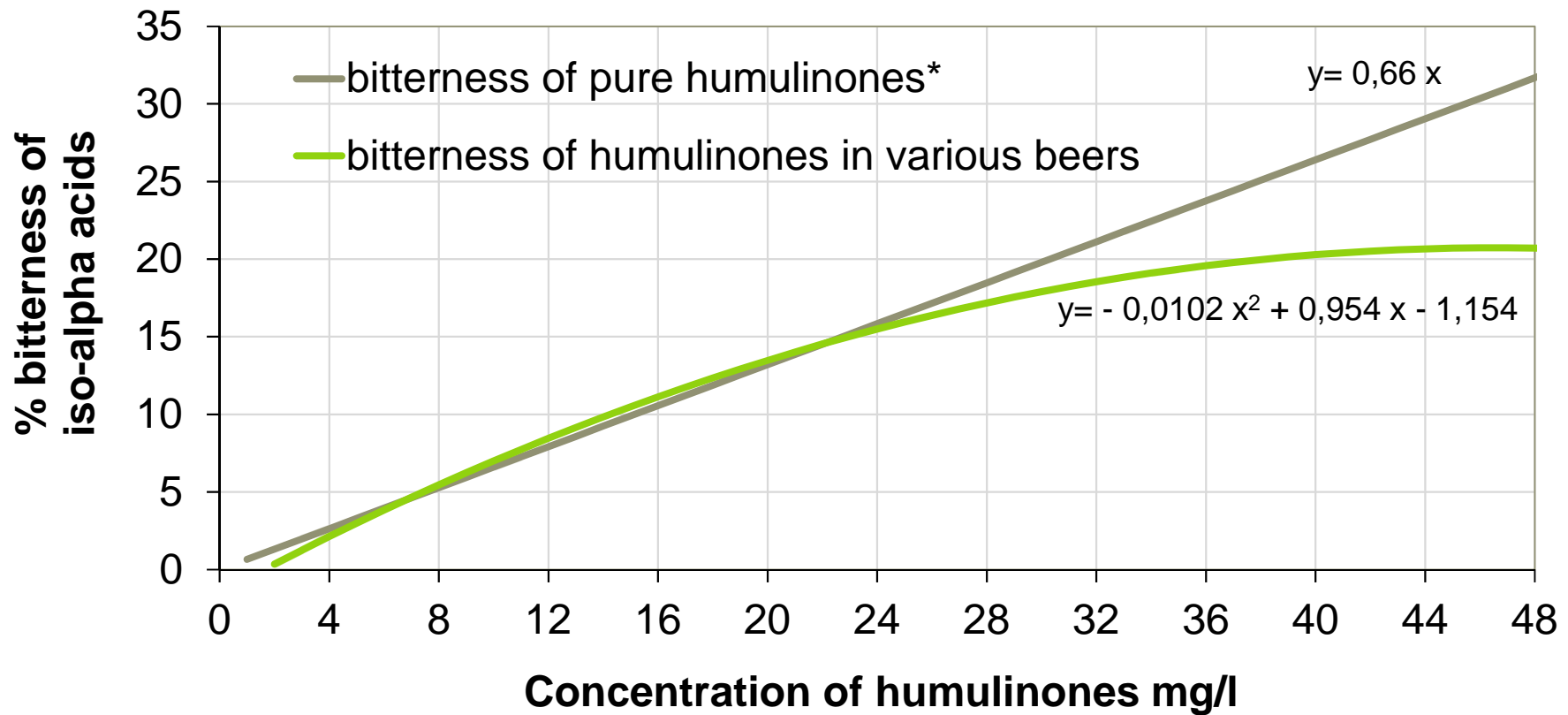
IAA = Iso-alpha acids

AA = Alpha acids

H = Humulinones

\* Source: EBC 2015, T. H. Shellhammer, Beyond iso-alpha acids – Hops contributions to beer bitterness

# Sensory bitterness of humulinones



\* Source: EBC 2015, T. H. Shellhammer, Beyond iso-alpha acids – Hops contributions to beer bitterness



# Application of formula

$$CB = IAA + AA \times 10\% + (-0,0102 H^2 + 0,954 H - 1,154)$$

CB = Calculated bitterness

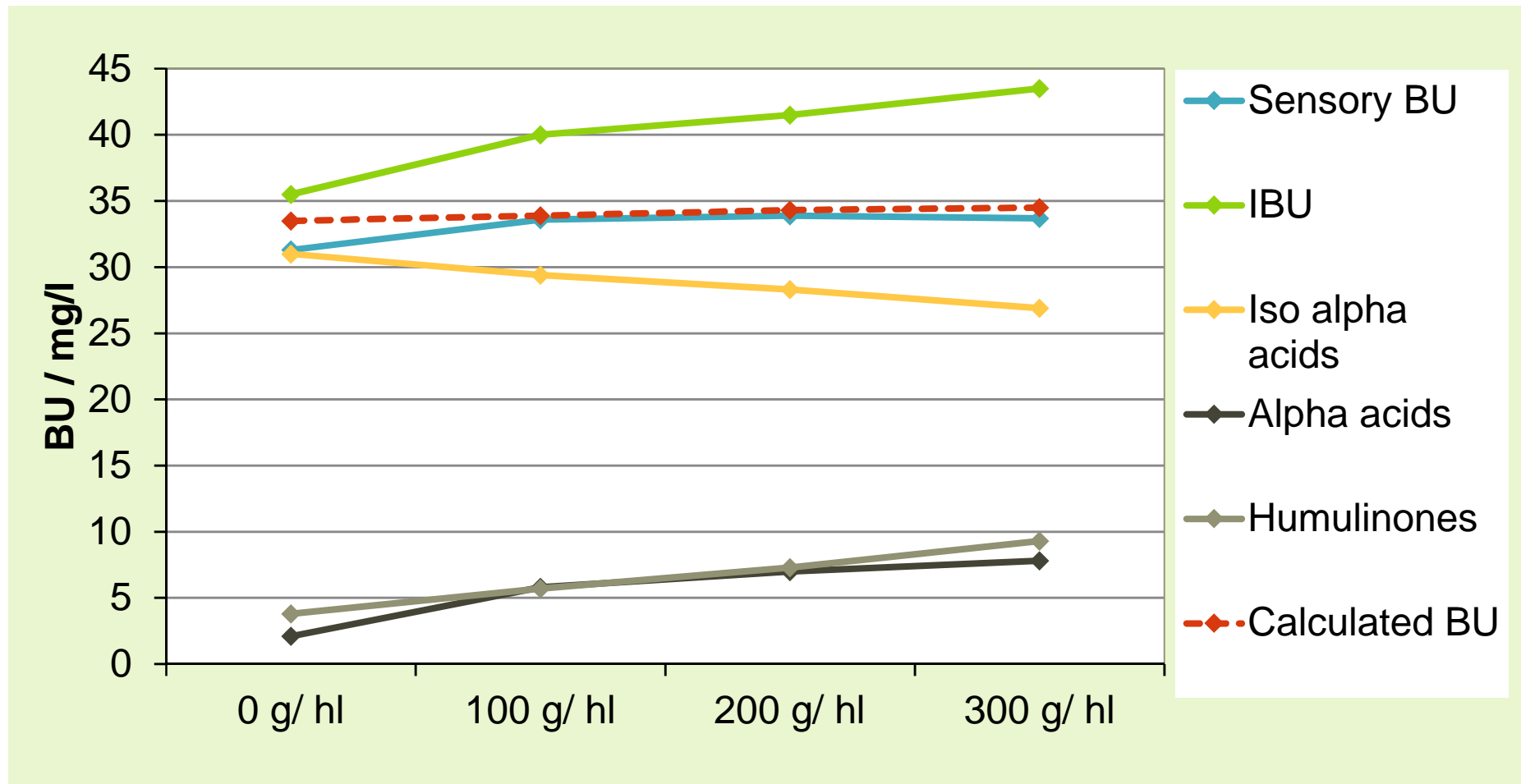
IAA = Iso-alpha acids

AA = Alpha acids

H = Humulinones

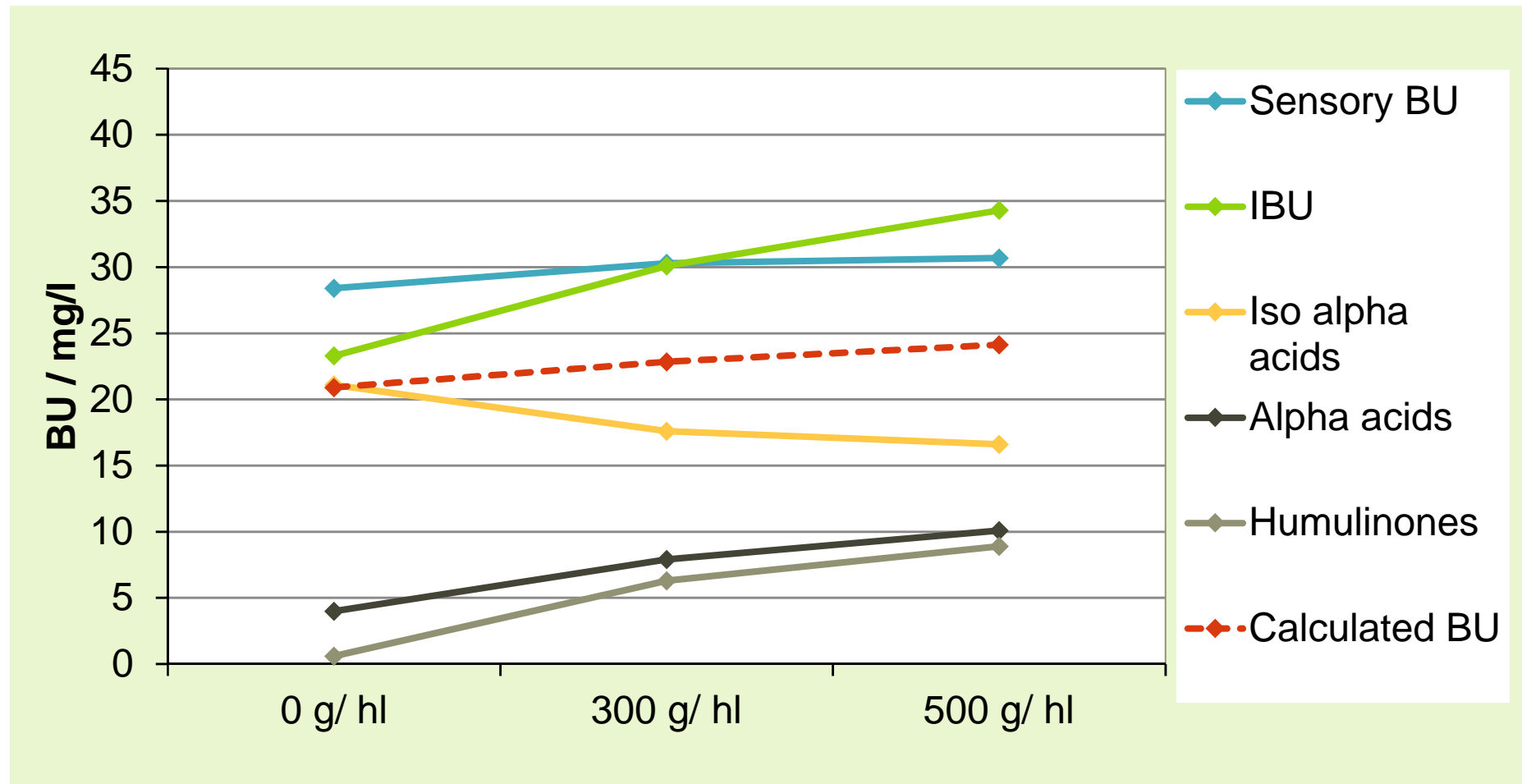
# Behaviour / IBUs & bitter substances

Example 1: Hüll Melon



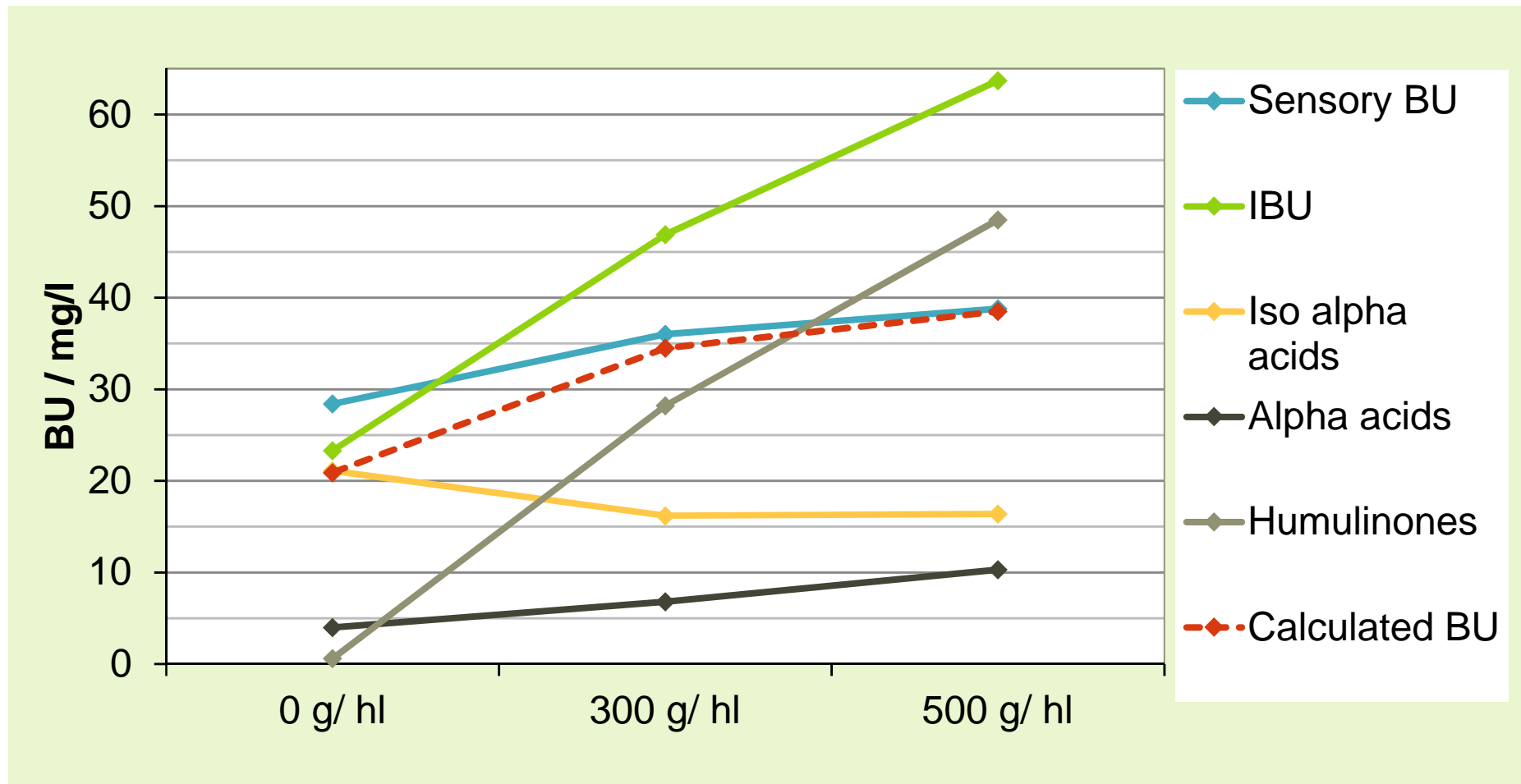
# Behaviour / IBUs & bitter substances

Example 2: Hopsteiner breeding line 09410



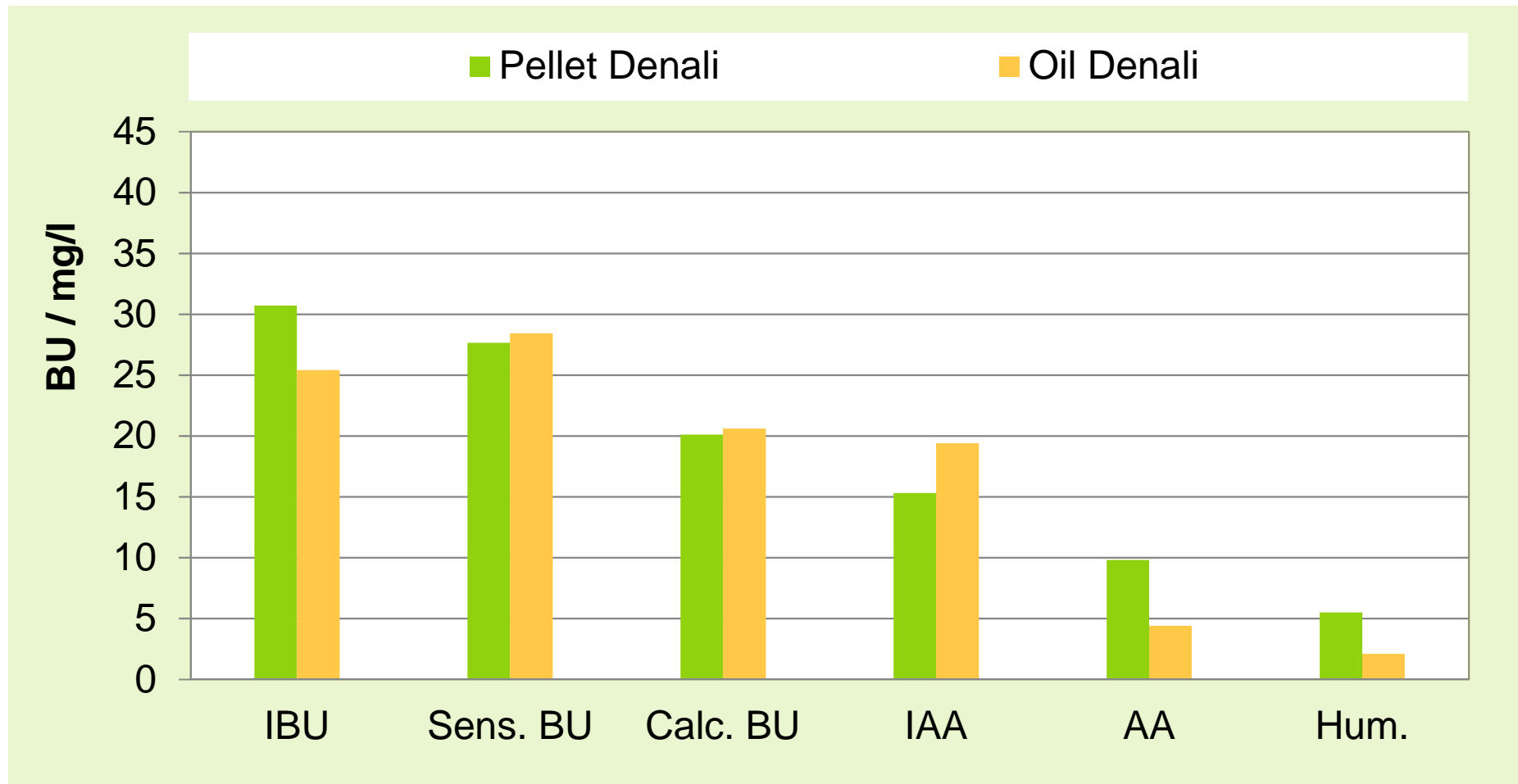
# Behaviour / IBUs & bitter substances

Example 3: Hopsteiner breeding line 10416



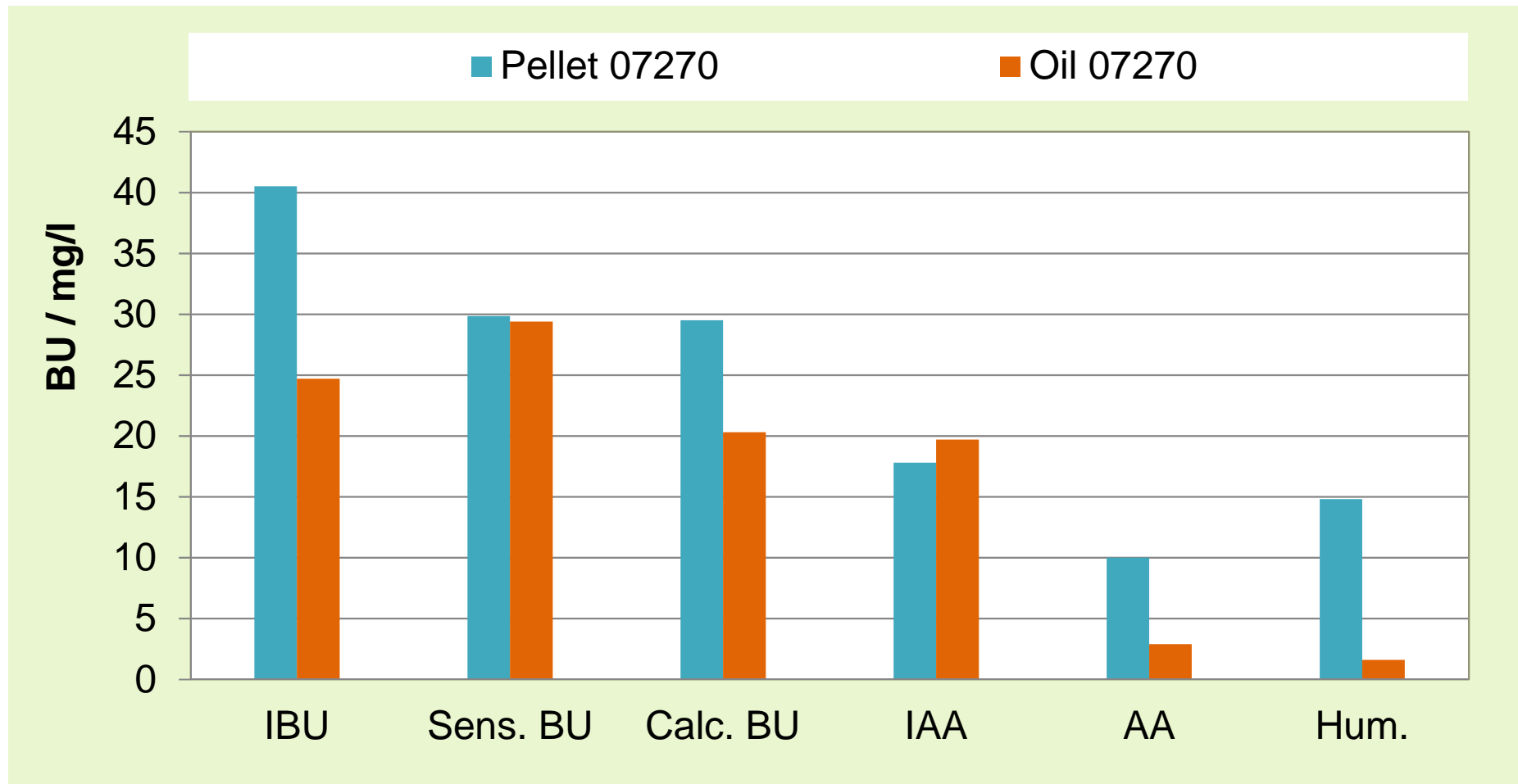
# Comparison

Dry hopping with pellets and hop oils



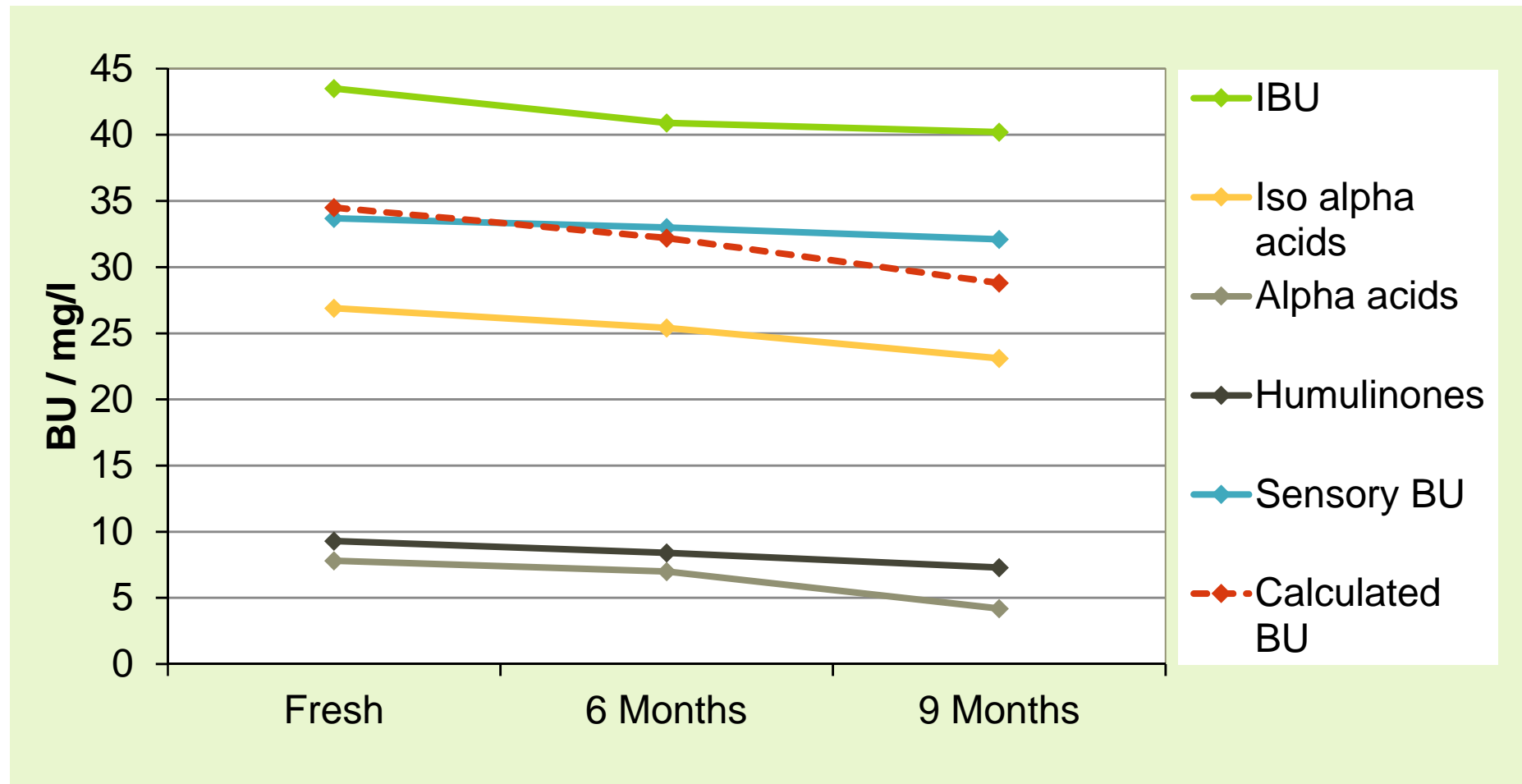
# Comparison

Dry hopping with pellets and hop oils



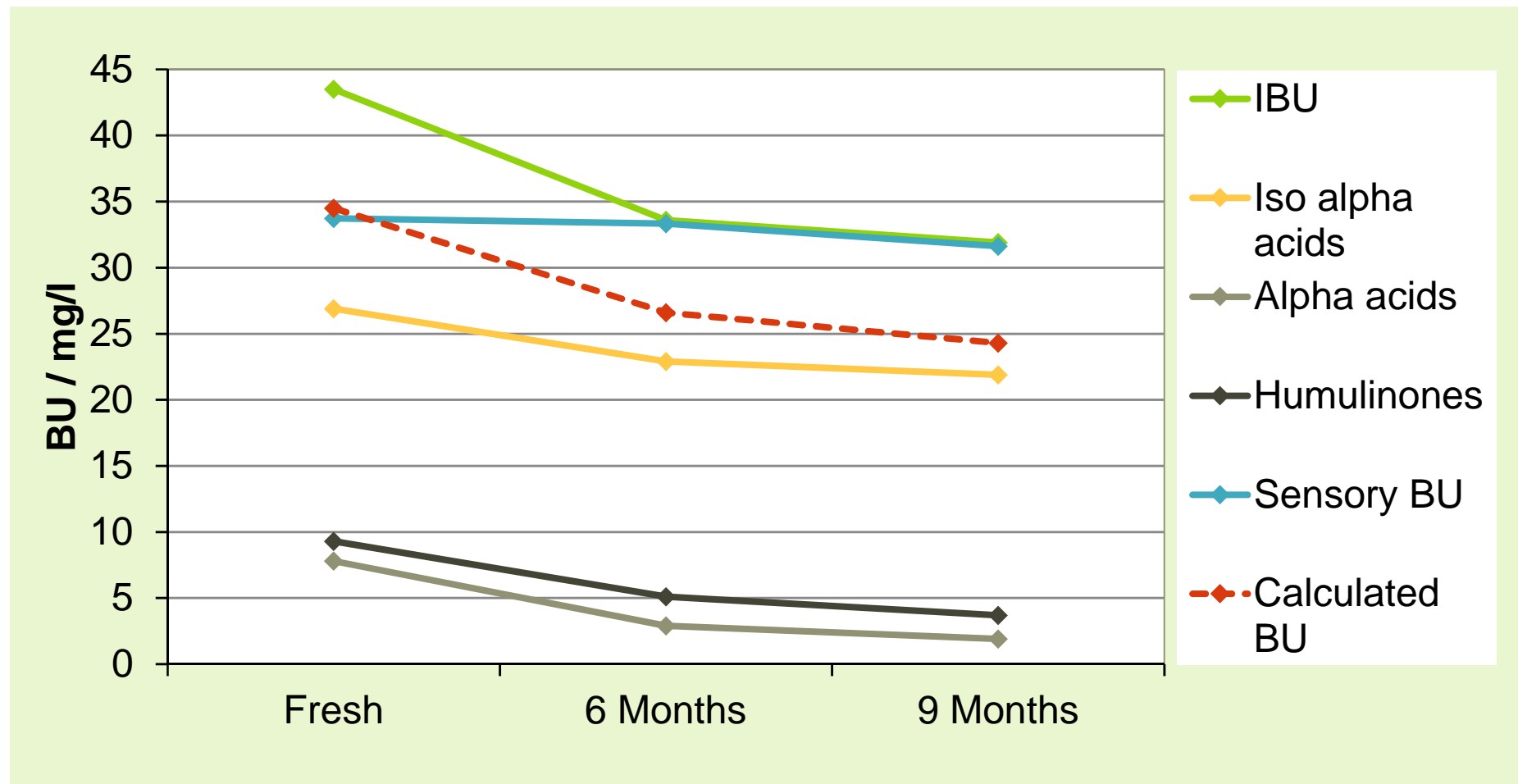
# Behaviour during storage

Example 1: Hüll Melon – cold storage (5°C)



# Behaviour during storage

Example 1: Hüll Melon – warm storage (20°C)





# Summary -1-

- Dry hopping causes:
  - Increase of IBUs, alpha acids, humulinones
  - Reduction of iso-alpha acids
- No correlation between IBU and sensory bitterness
- Calculated bitterness

## Summary -2-

- Dry hopping with pellets and hop oil
  - No significant difference in sensory bitterness
  - Strong difference IBU – sensory bitterness
  - Also difference calculated bitterness – sensory bitterness
- Further bitter substances probably responsible
- Probably no strong influence of polyphenols

# Summary -3-

- Storage trials:
  - Strong degradation of alpha acids and humulinones
  - Sensory bitterness almost unchanged
- Final conclusion:
  - Formula in practice applicable
  - Hulupones have to be included
  - Other oxidation products in aged beers



Thank you for your attention.

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*S. S. Steiner, Inc.*

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*Steiner Asia Limited*