

*Hidden Secrets of
The New England IPA
a.k.a. Hazy IPA
a.k.a Juicy IPA*

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How to Brew a New England IPA

12 Commercial NEIPA Were Analyzed by High Performance Liquid Chromatography (HPLC) for various hop compounds and were compared to West Coast style IPAs.

Haze Testing:

Turbidity, Yeast & Hop Acid contribution to haze, Centrifuge testing, Haze Analysis, Haze Stability

Other Testing: IBU & Foam

Conclusion

How to Brew a New England IPA



Water: 150 – 200 ppm Chloride (mouthfeel/softness)
& 75 – 100 ppm Sulfate (hop character)

Grist: Malt, > 10% flaked oats/wheat (higher protein 16%/13% adjuncts)
10% of oat protein and 80% of wheat protein are prolamins (haze active proteins)

Hops: Fruit Forward & Citrus Varieties (high in geraniol?)

Hopping Regime:

Little to no hops added to the boil

30 – 50% added to Whirlpool (>1.5 lbs/bbl) multiple additions (reduced temp)

Dry Hop with > 1.5 lbs/bbl start adding hops just after fermentation starts, multiple additions over few days – take advantage of biotransformation in the fermenter.

Yeast: medium to low attenuating yeast, med-low flocculating, high ester strains

Beer:

OG: ~ 1.06 – 1.07 (14 – 17 °P) FG: ~ 1.010 – 1.016 (2 – 4 °P)

IBU: 50 – 70 (we measured 41 – 108)

ABV: 6.3% – 7.5%

Color: 4-7 SRM (8-14 EBC)

High Performance Liquid Chromatography



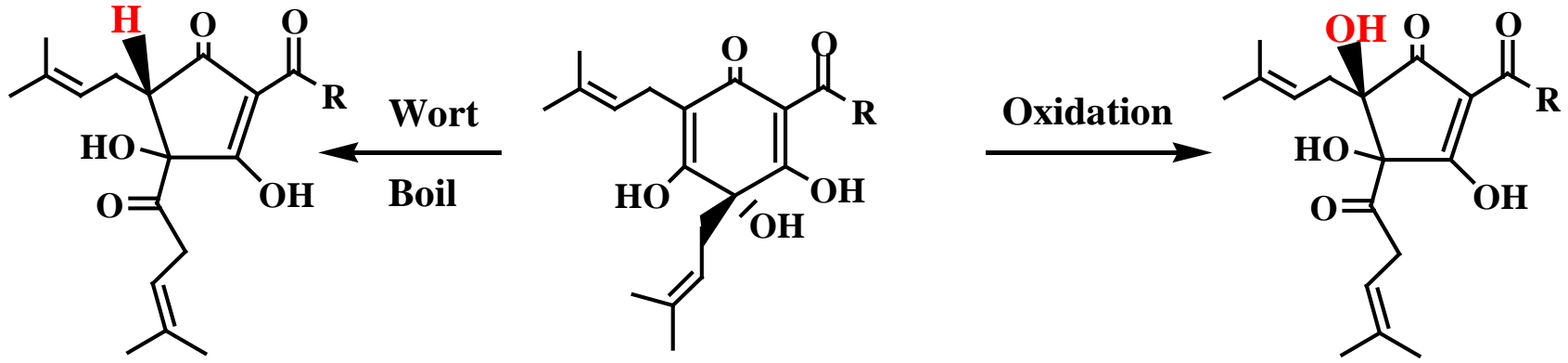
Beers were analyzed for:

Isoalpha Acids & Humulinone

Alpha Acids & Beta Acids

Myrcene (hop oil)

Xanthohumol (polyphenol)



Iso- α -acids

1 ppm ~ 1 IBU

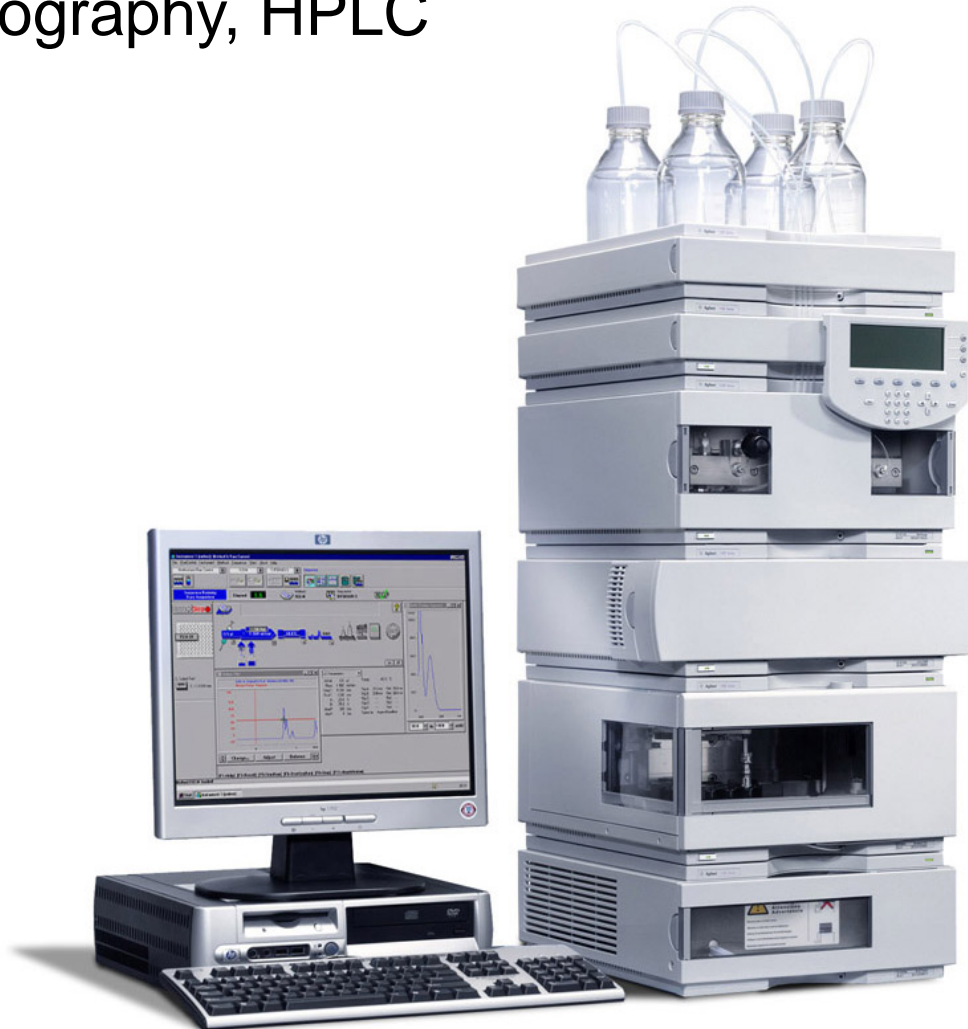
Alpha Acids

1 ppm ~ 0.1 IBU

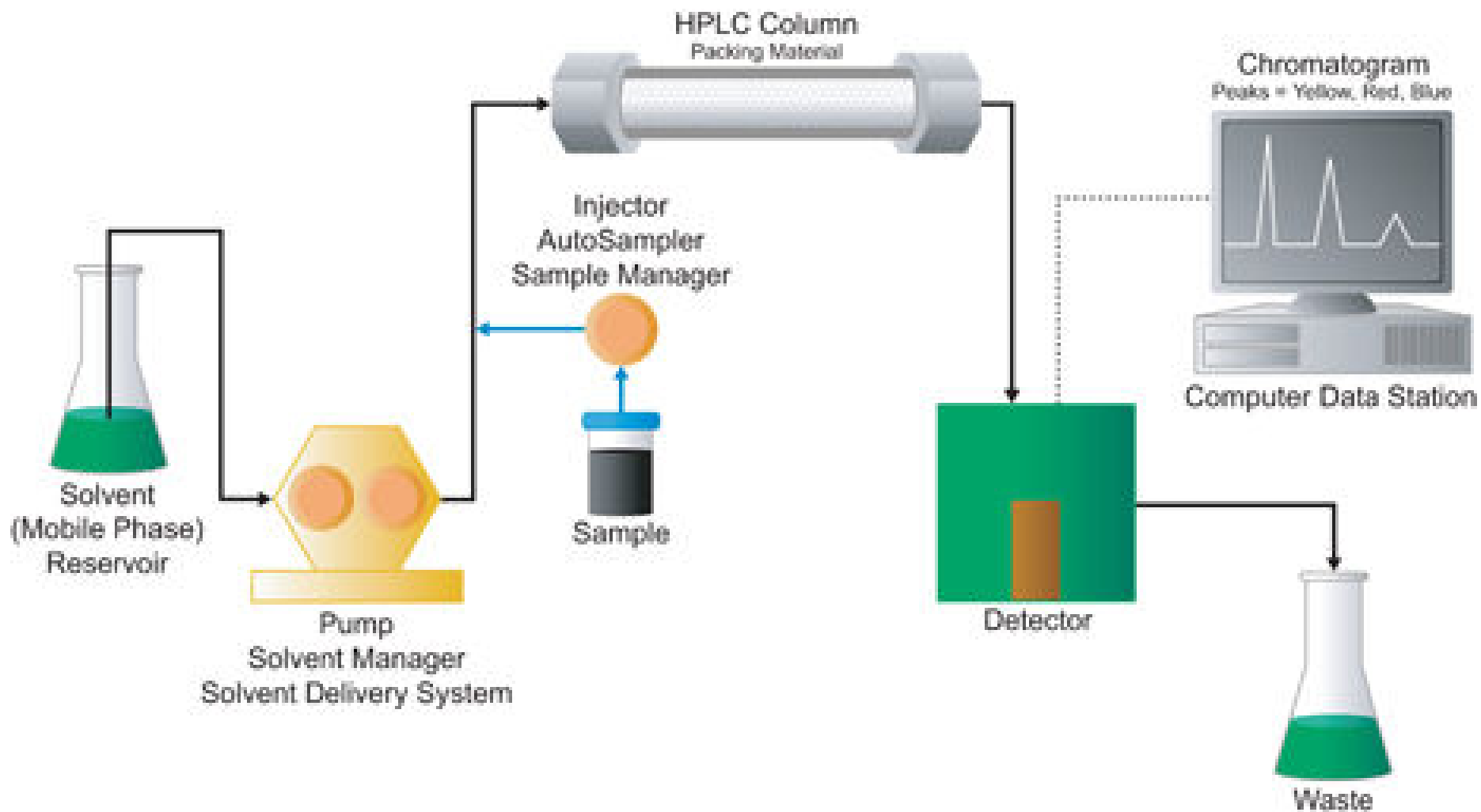
Humulinones

1 ppm ~ 0.66 IBU
0.25% - 0.35% in hops

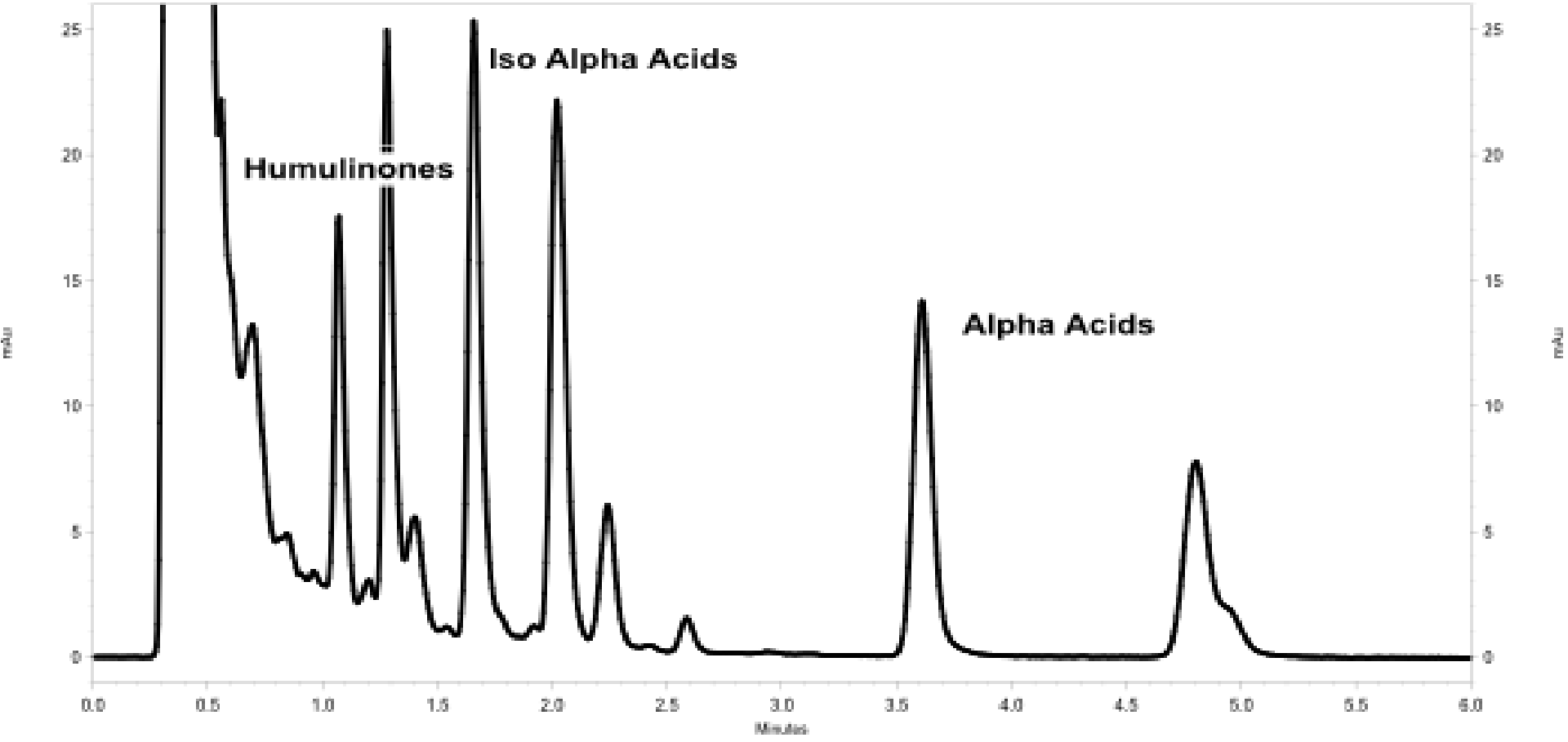
A mixture of hop compounds can be measured very accurately using High Performance Liquid Chromatography, HPLC



HPLC Requires Calibration Standard



HPLC Trace of Hop Acids In Beer

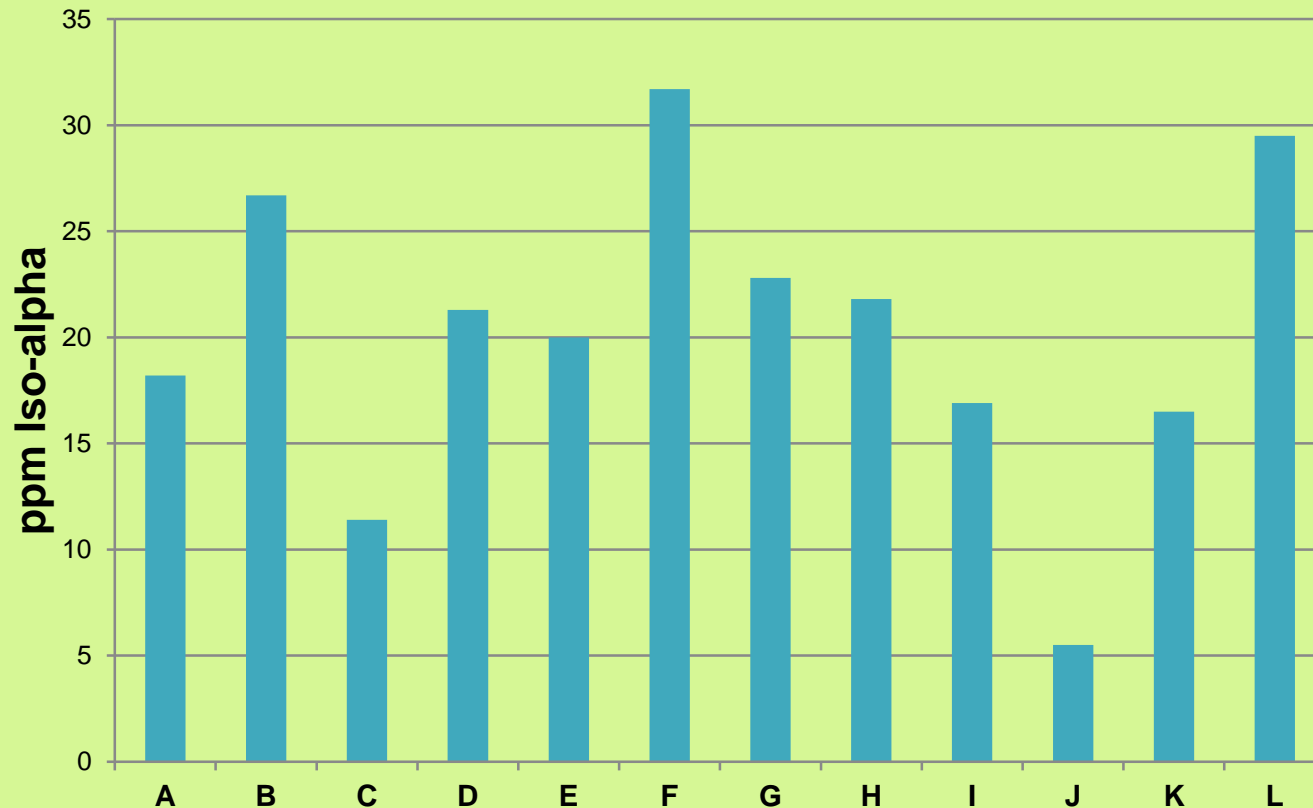


Isoalpha Acid Concentration



Range: 5 ppm – 32 ppm Average: 20 ppm (vs 48 ppm West Coast IPA)

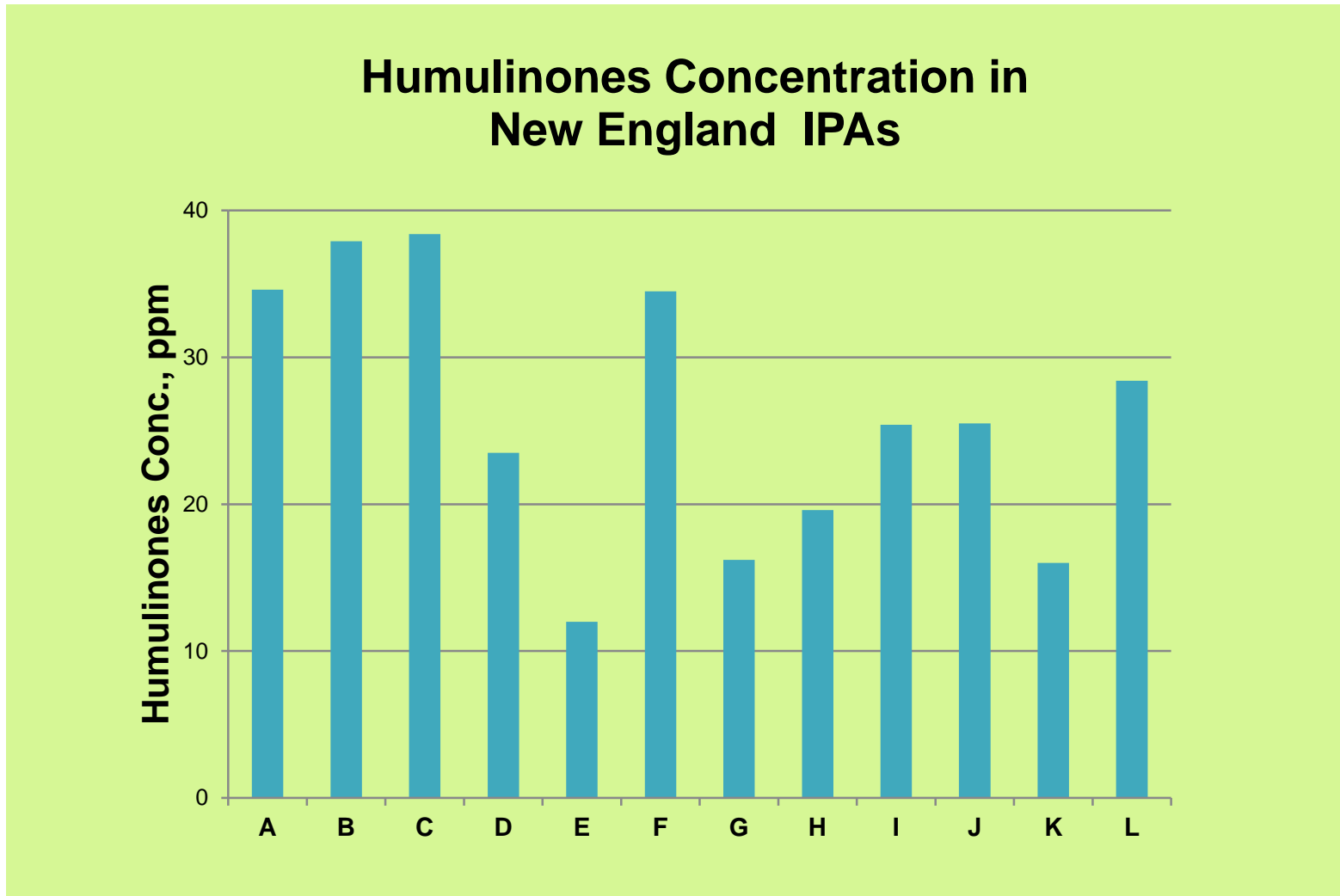
Iso-alpha Concentration of New England style IPAs



Humulinones ~ 66% as bitter as isoalpha acids



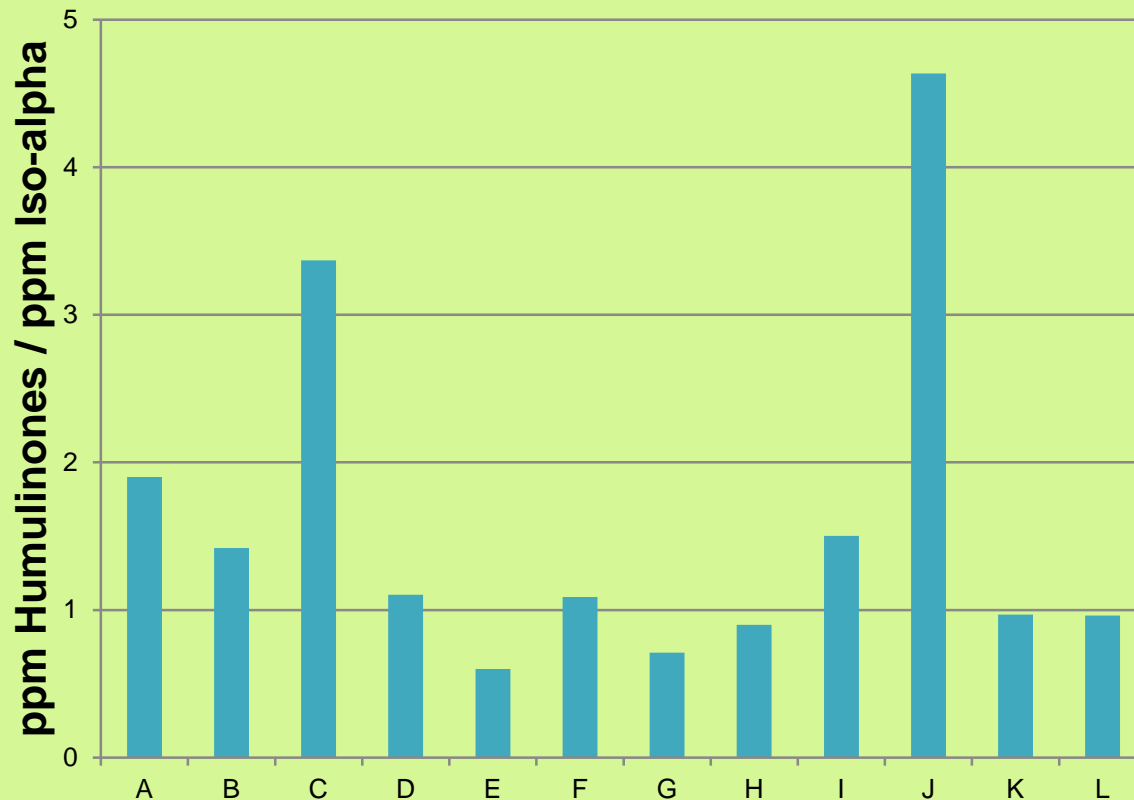
Range: 12 ppm – 38 ppm Average: 26 ppm (vs 11 ppm West Coast IPA)



Bitterness Humulinone : Isoalpha Acid Ratio

Range: 0.5 – 4.6 Average: 1.3 (vs 0.3 West Coast IPA)
Humulinone contribute ~ 50% of the NEIPA's bitterness

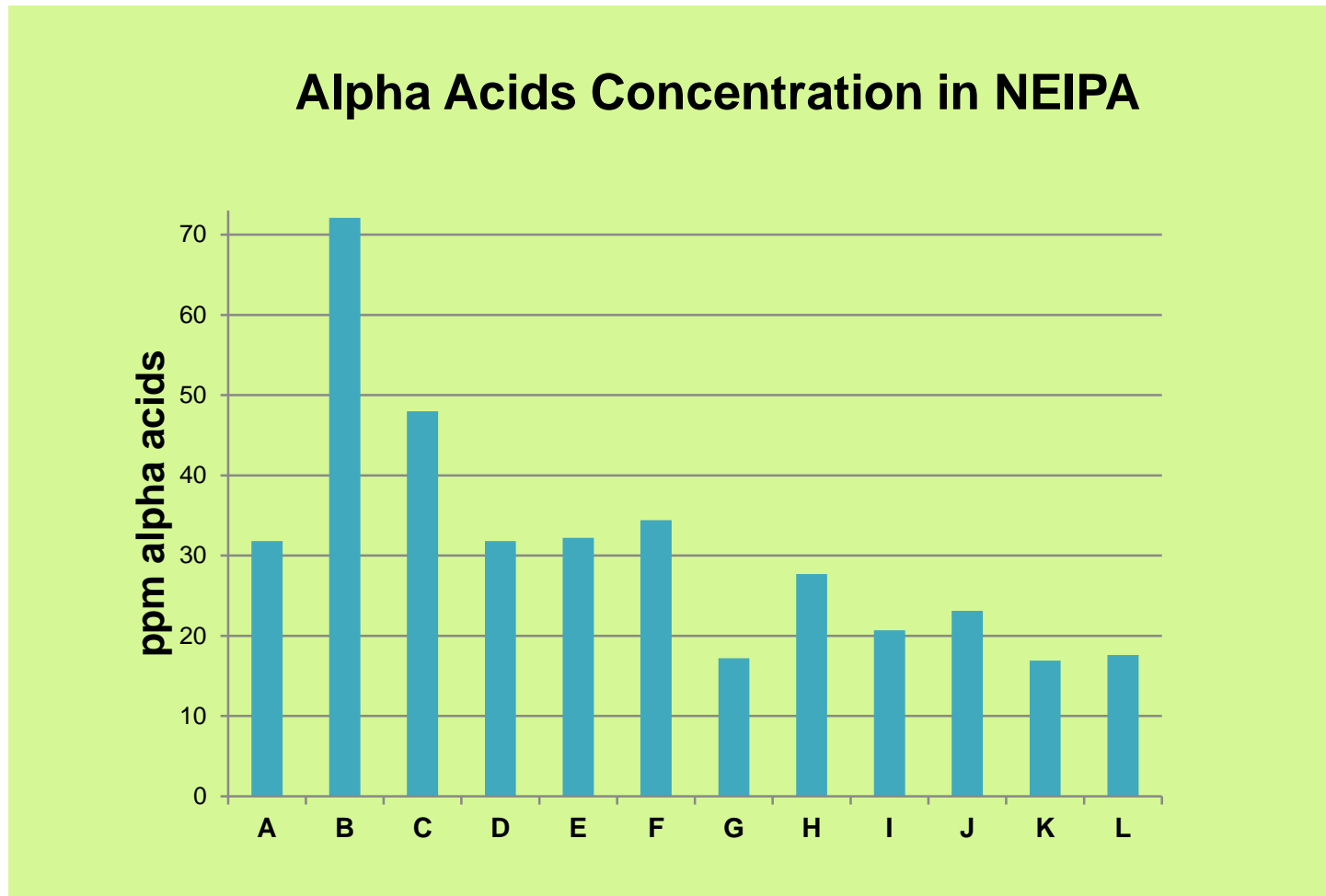
Ratio of Humulinones / Isoalpha Acids



Alpha Acid Concentration



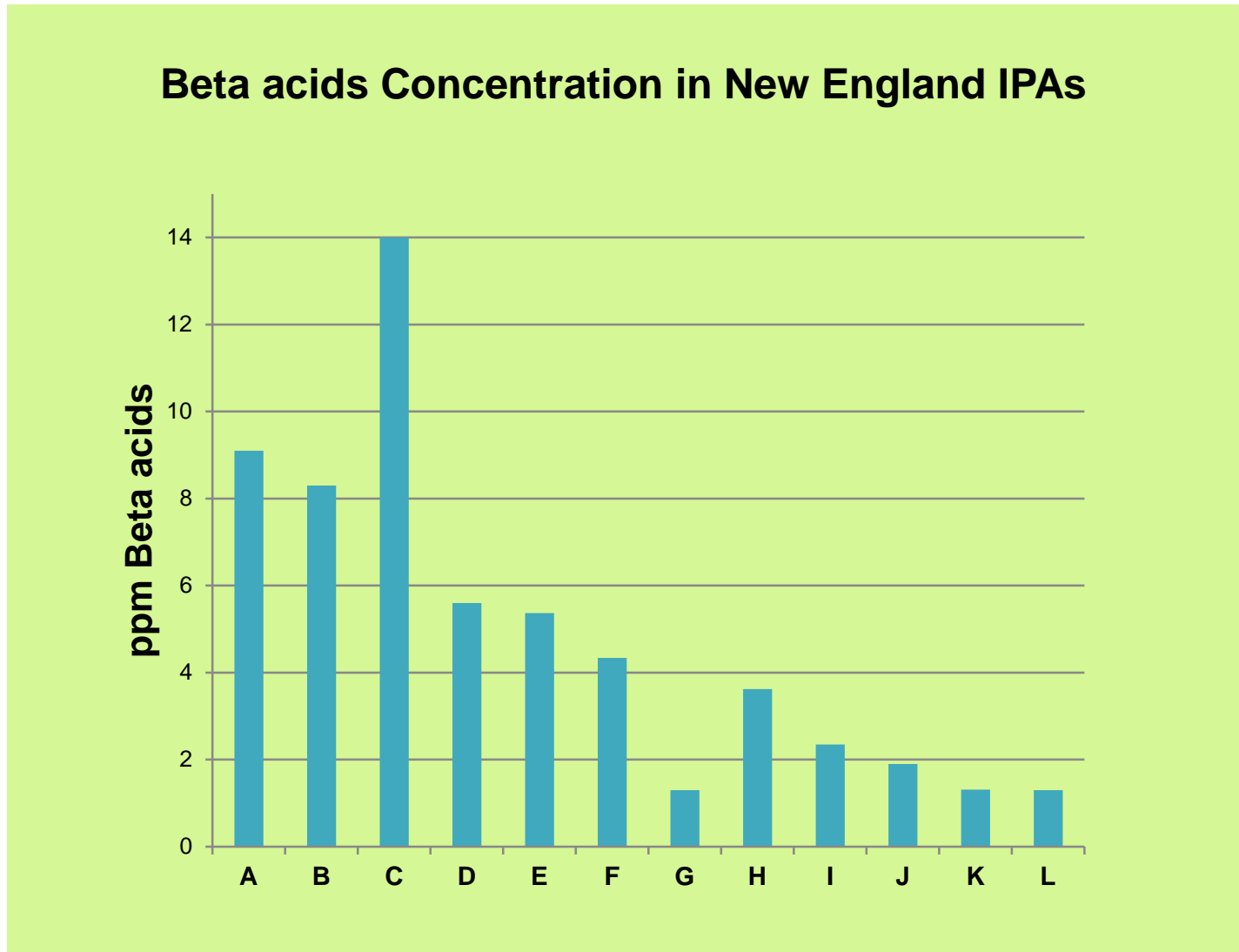
Range: 17 ppm – 72 ppm Average: 31 ppm (vs 13 ppm for West Coast IPA)



Beta Acid Concentration



Range: 1 ppm – 14 ppm Average: 5 ppm (vs 0 ppm West Coast IPA)

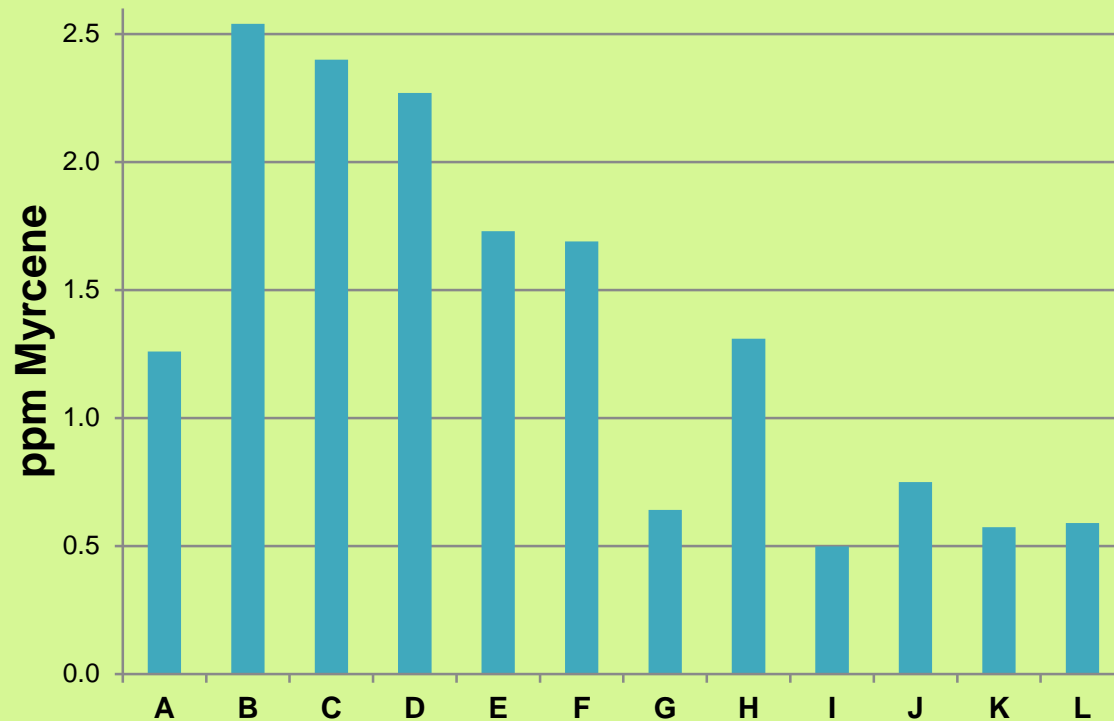


Myrcene Concentration



Range: 0.5 ppm – 2.5 ppm Average: 1.4 ppm (vs <0.3 ppm West Coast IPA)

Myrcene Concentration of New England IPA

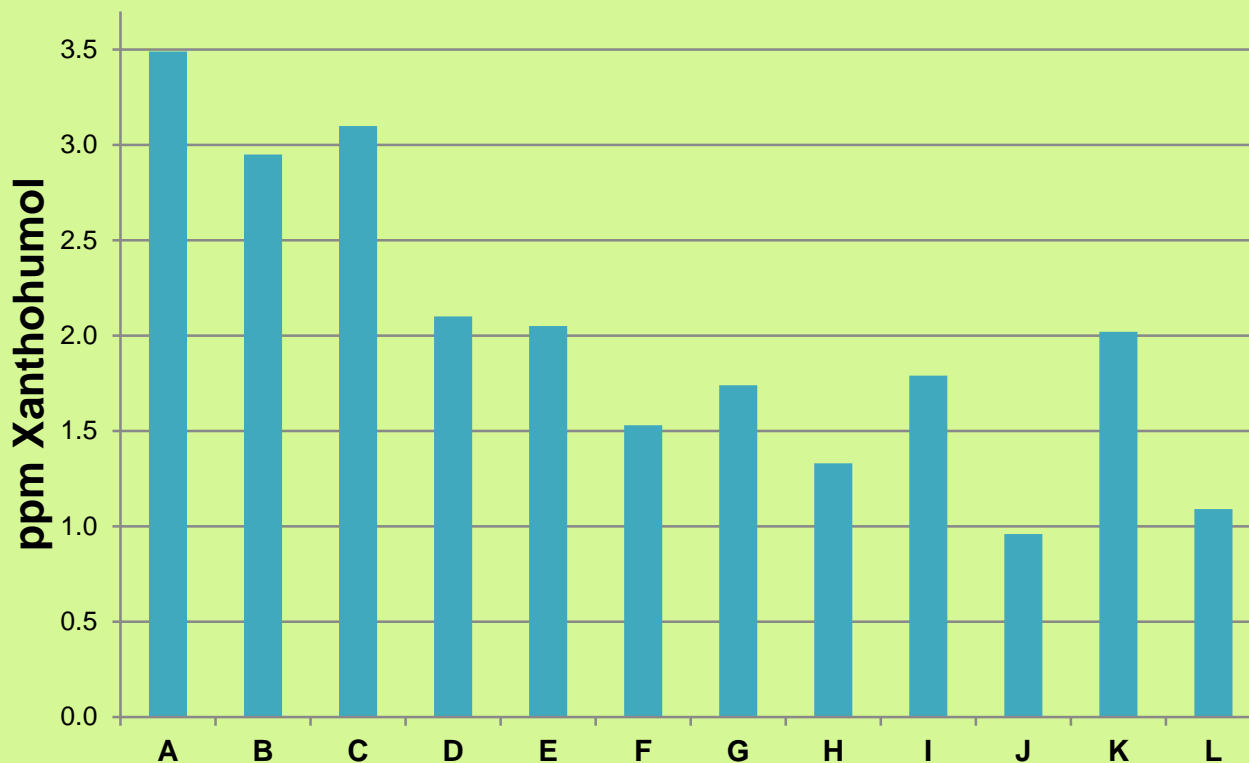


Xanthohumol a unique polyphenol found only in hops



Range 0.9 ppm – 3.5 ppm Ave: 2 ppm (vs 0.7 ppm in West Coast IPA)

Xanthohumol Concentration of NEIPA



Haze Testing



Haze can be measured using a turbidity meter



5 NTU 50 NTU 500 NTU

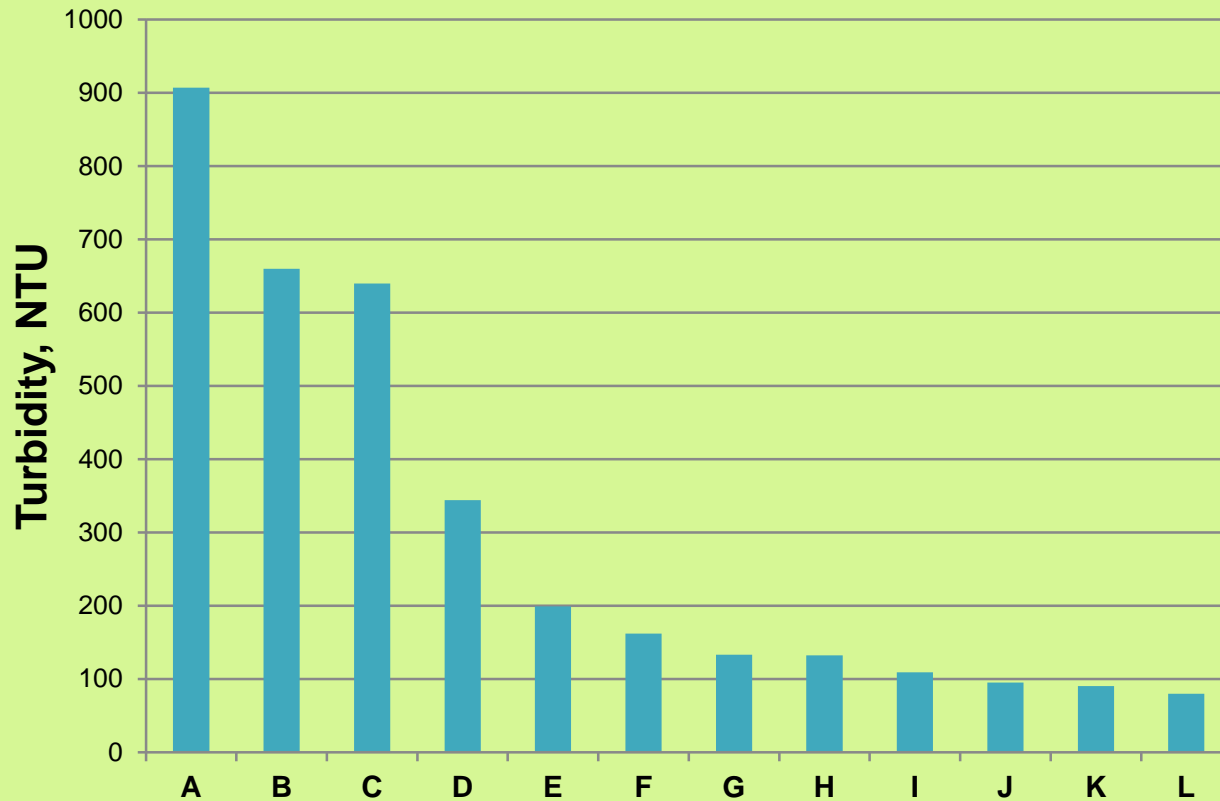


Turbidity Measurements



Range: 80 – 900 NTU Average: 296 (West Coast IPA less than 80)

Turbidity of New England style IPAs



Yeast is generally NOT a Contributor to Haze



A yeast count of 1 million cells/mL contributes 8.5 NTU of Haze

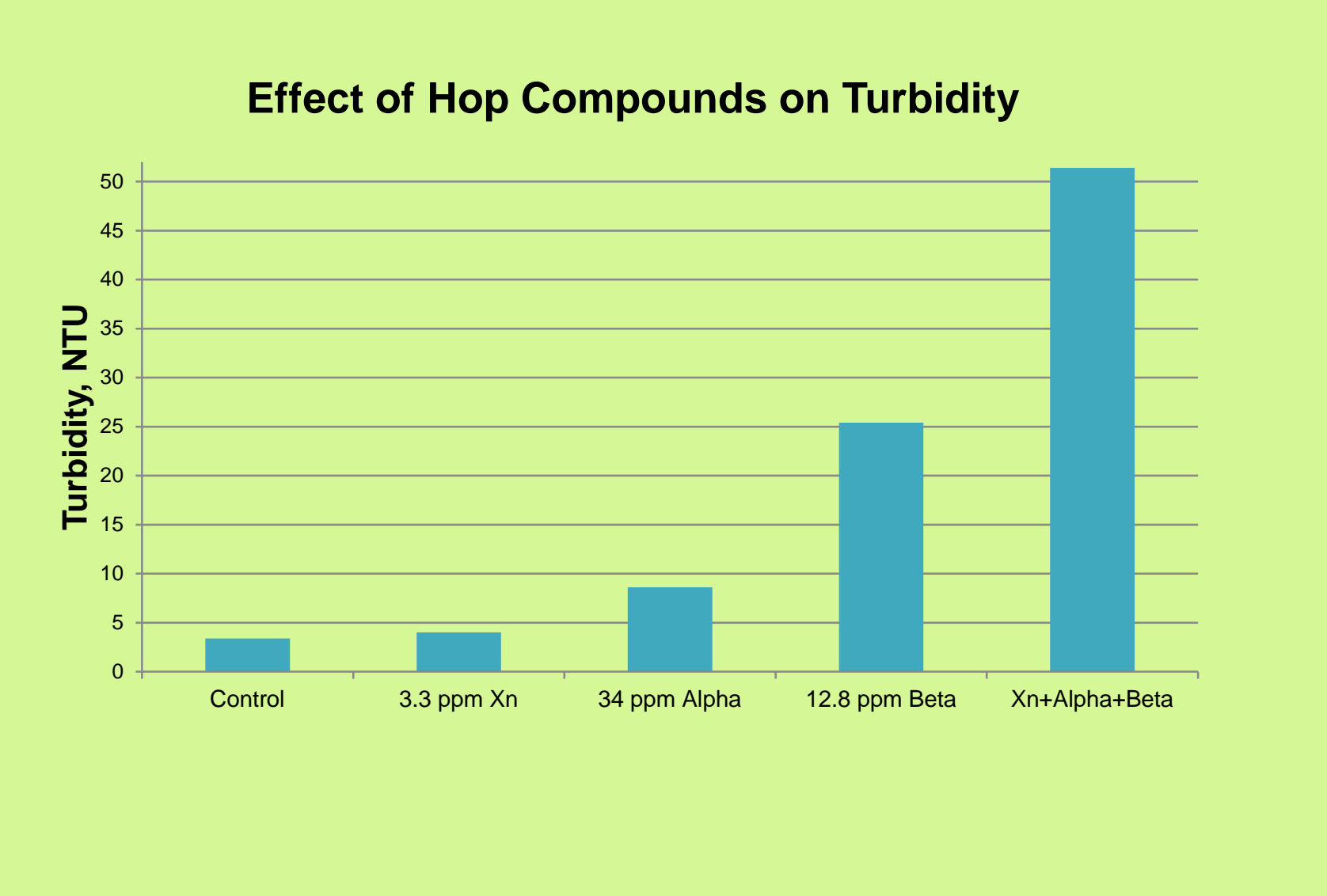
Yeast Counts of New England IPA Beers

Beer	Initial turbidity, NTU	Yeast Count Million cells / mL	Contribution of Yeast to Turbidity
B	660	<1	<1%
E	199	0.1-0.2	<1%
F	162	0.2	1%
H	132	<1	<6%
J	95	5	45%
L	80	0.2	2%

Effect of Hop Compounds on Haze

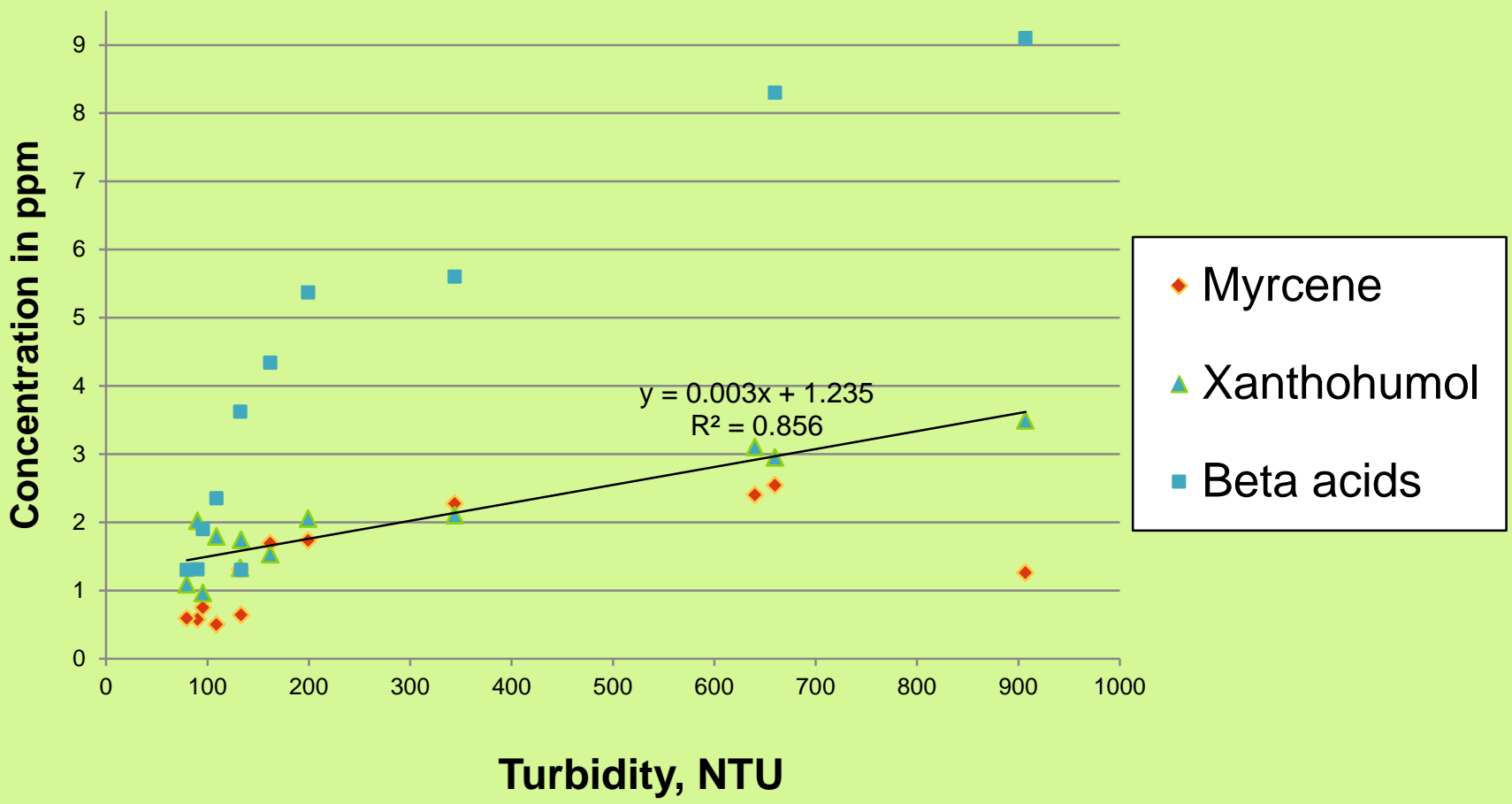


With an average turbidity 296 NTU, hop acids contributed ~ 10-15% of turbidity.



Relationship Between Hop Compound Concentration and Haze

NEIPAs with higher turbidity had higher concentrations of the non-polar hop compounds, myrcene, xanthohumol, and beta acids



HPLC Analysis of NEIPA Before & After Centrifuge

Beer	NTU Turbidity	ppm Humulinone	ppm iso-alpha acids	ppm alpha acids	ppm myrcene	ppm Xantho-humol	ppm Beta acids
1 H	640	38	11.4	48	2.4	3.1	14
1 C	160	37.9	10.7	26.2	1.1	1.5	1.9
2 H	907	34.6	18.2	51.8	1.26	3.49	9.1
2 C	454	33.8	17.5	35.1	0.78	2.1	4.3

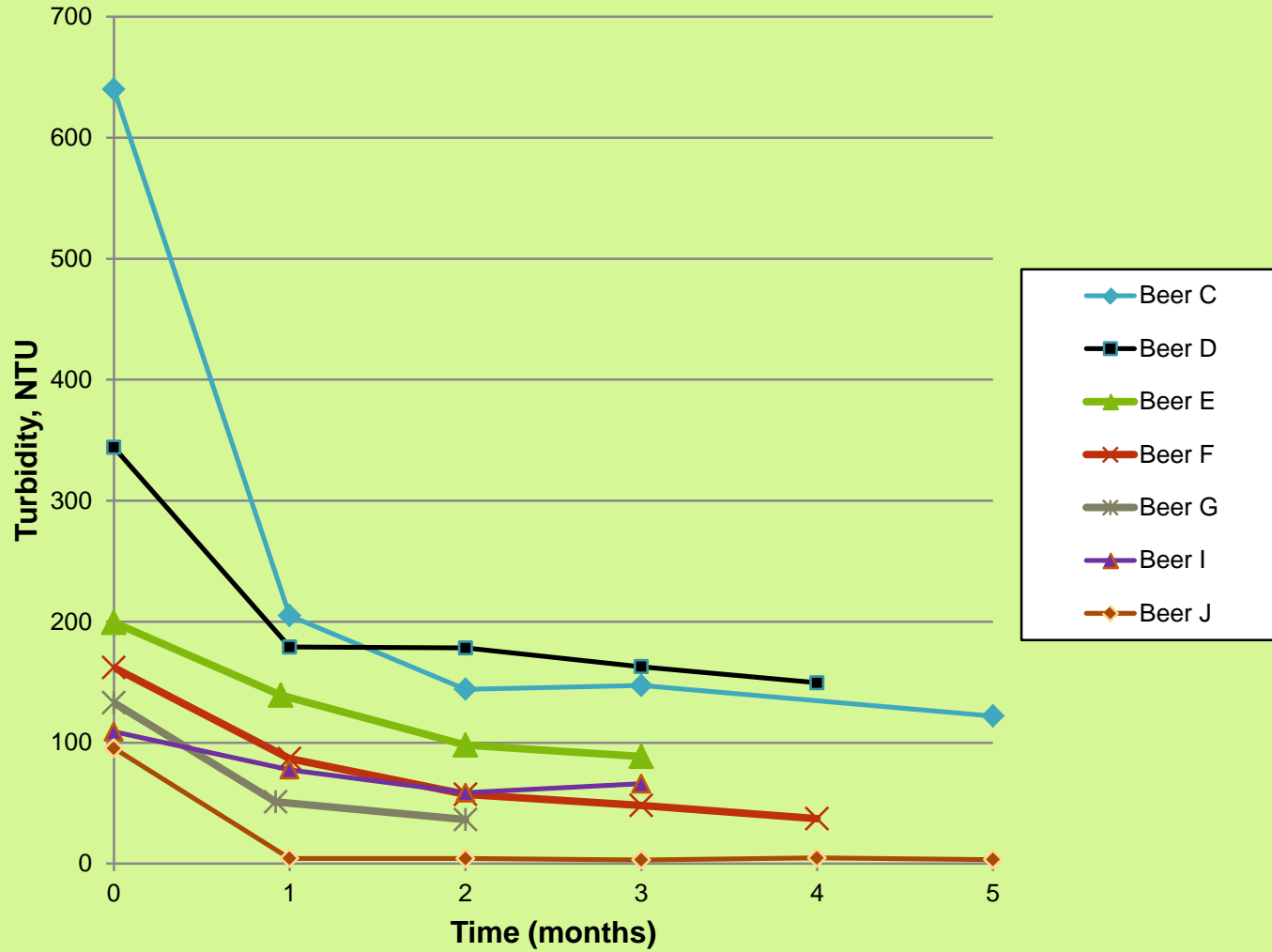
Haze precipitation from a NEIPA was freeze dried & analyzed

Protein	Poly-phenols	Fatty Acids	% Linolenic acid	% Linoleic acid	% Oleic acid	Starch
35.7%	3.4%	0.9%	0.22	0.52	0.19	10%

	Myrcene mL/100g	% Alpha acids	% Beta acids	% Xanthohumol	% Iso-alpha	% Humulones
Freeze-dried	0.1	8	3	0.3	0.3	0.2

Prolamins or Proline-rich proteins are haze active proteins which can hydrogen-bond to polyphenols (monomer, dimer, trimer of proanthocyanidins) to form haze. The ratio of protein to polyphenol is important to haze.

Turbidity of NEIPAs Stored at 3 °C



The IBU Test Method Was Developed to Measure Only Isoalpha Acids In Beer & 1 ppm of isoalpha acids ~ 1 IBU.

The Method:

Add 10 mL beer + 20 mL isooctane + 1 drop Octyl alcohol + 1 mL 3N HCl to 50 mL centrifuge tube, shake 15 minutes, centrifuge, transfer upper clear isooctane layer to cuvette, measure absorbance at 275 nm.

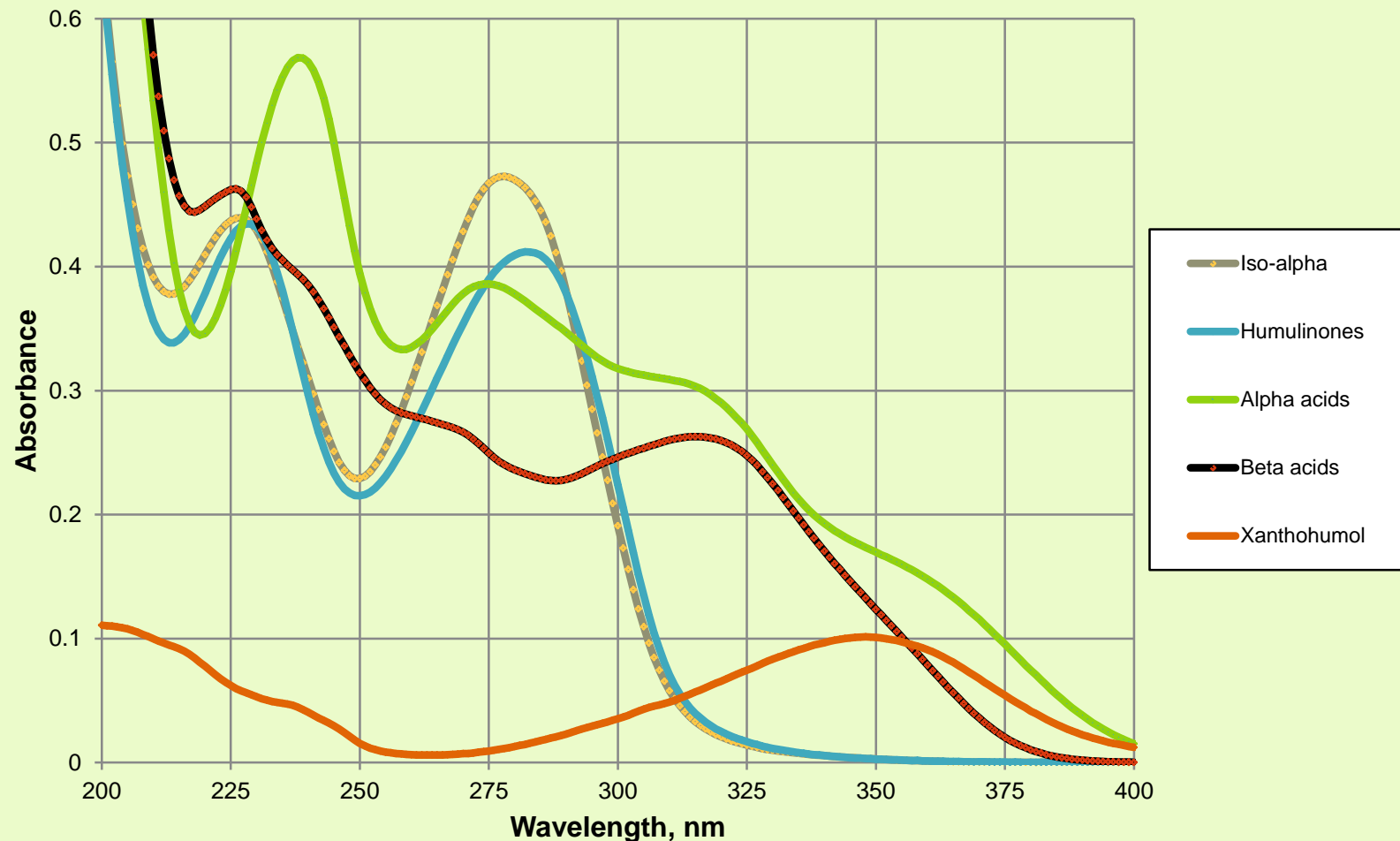
$$\text{BU} = \text{absorbance}_{275} \times 50$$

Note: In addition to isoalpha acids, isooctane will also extract humulinones, alpha acids, beta acids, about 44% of the Xanthohumol & other hop compounds in NEIPAs. Most of these compounds can and do absorb at 275 nm.

Absorbance Spectra of Hop Compounds in TMP



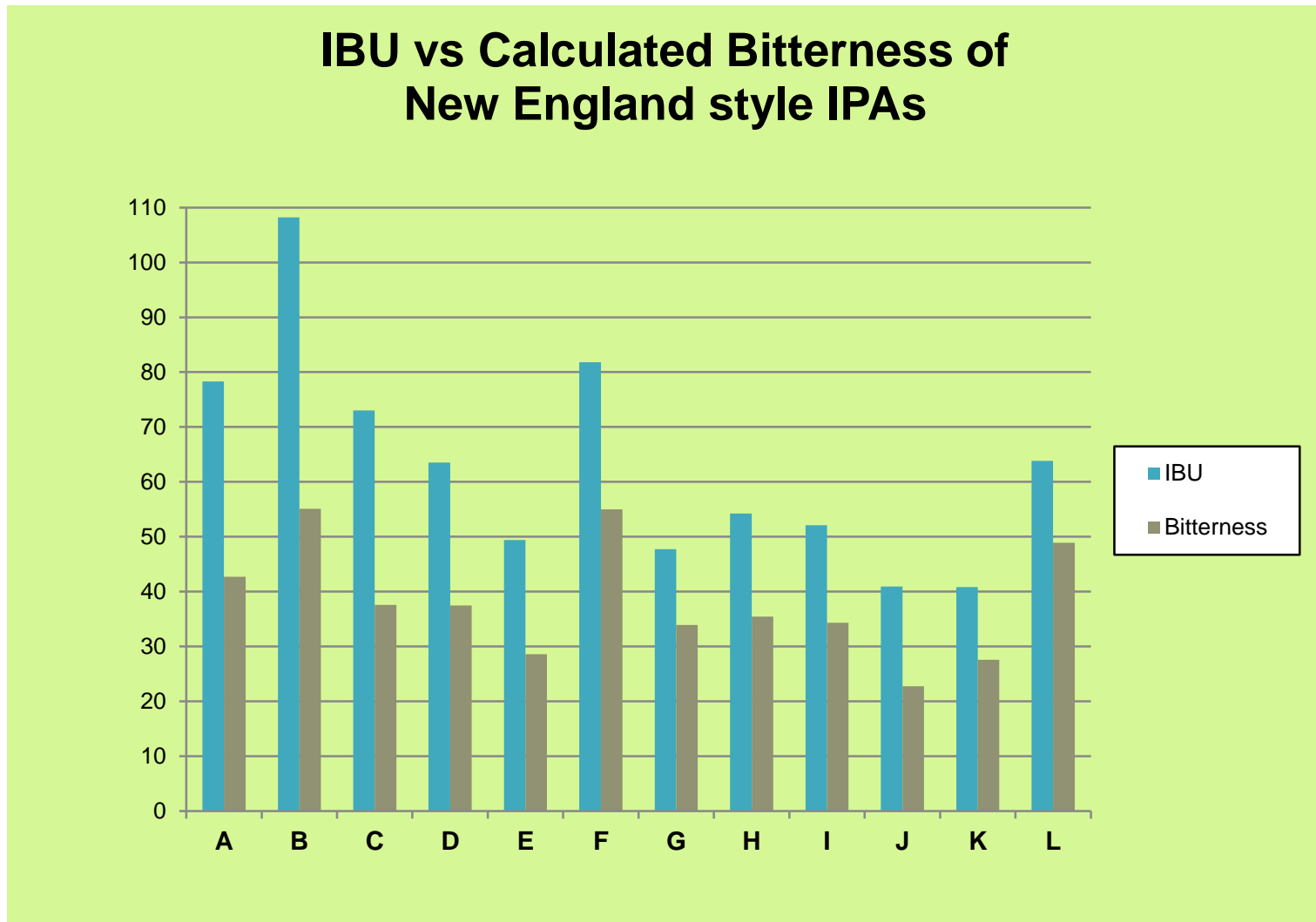
30 ppm Hop Compounds in TMP



Response Factors: Iso- α -acids 0.7; Humulinone 0.6; Alpha Acids 0.6; Beta Acids 0.4 Xanthohumol 0.07 (only 44% is extracted)

NEIPA IBU vs Calculated Bitterness

IBU Range: 41 – 108 Ave IBU: 63 Ave Calculated Bitterness: 37



Calculated Bitterness = ppm IAA + (0.66 x ppm Hum) + (0.1 x ppm AA)

Why the IBU Does Not Work For Dry Hopped Beers

The hop acids in dry hopped beers, like Isoalpha acids, Humulinones, Alpha Acids & Beta Acids absorb light at 275 nm at different intensities, thus interfering with the IBU test. And because each hop acid has a different bitterness you cannot correlate the IBU test result to sensory bitterness.

	<u>IBU Response Factor</u>	<u>Relative Bitterness</u>
1 ppm Iso-alpha Acids	0.7 IBU	1
1 ppm of Humulinone	0.6 IBU	0.66
1 ppm of Alpha Acids	0.6 IBU	0.1
1 ppm of Beta Acids	0.4 IBU	0.05
1 ppm of Xanthohumol	0.08 IBU	Not Bitter

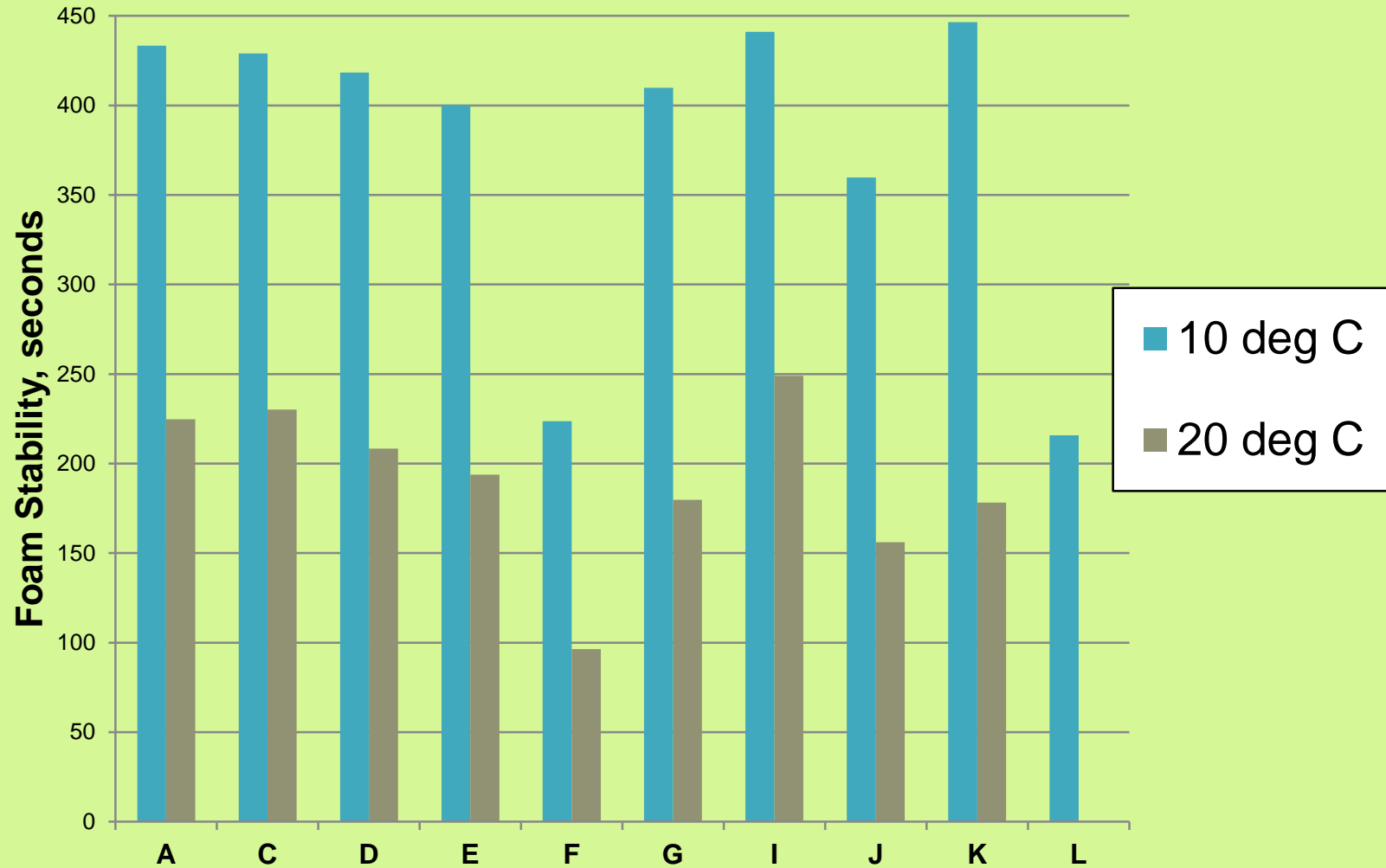
HPLC analysis of isoalpha acids, humulinones, & alpha acids allows one to calculate the bitterness of NEIPAs.

Nibem Foam Stability Tester

Beer is transferred from a bottle or can to a glass. A flasher will fill the glass with highly reproducible foam. The beer foam collapse is measured over 30 mm and the results are reported in seconds.



Nibem Foam Stability of New England IPAs



Conclusion



The smooth bitterness that many people experience drinking NEIPAs is due to the high humulinone concentrations in these beers and the relatively low concentration of isoalpha acids.

Like West Coast IPAs the sensory bitterness of NEIPA's is a little more than half of what the IBU test result would indicate. This is due to the fact that humulinones, alpha acids, & beta acids absorb & interfere with the IBU test measurement of isoalpha acids yet are only 2/3, 1/10 & 1/20 as bitter as isoalpha acids.

The foam quality of NEIPA are very good and this is due to the high protein and high alpha acid concentrations in these beers.

The haze stability of NEIPA isn't very good with most beers dropping to less than 100 - 200 NTU within one to two months after packaging.

Analysis of the haze shows ~36% protein, ~ 3% polyphenols, 0.9% fatty acids ~ 10% carbohydrate and 12% hop compounds. The use of high protein adjuncts rich in prolamines like wheat (haze proteins) are known to combine with polyphenols to form haze. Hops acids can also add to haze but it's small and due to the very low yeast count in most of these beers, yeast is generally not a contributor to haze but can be at higher concentrations.

The big secret here is that the haze in New England style IPAs can act as a carrier and increase the concentration of non-polar hop compounds like myrcene, alpha acids, xanthohumol, beta acids and most likely other flavor compounds which contribute to the unique flavors this style of beer has to offer.



Acknowledgements

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Thank You For Your Kind Attention

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