Bitterness contributions to Fuller's beers

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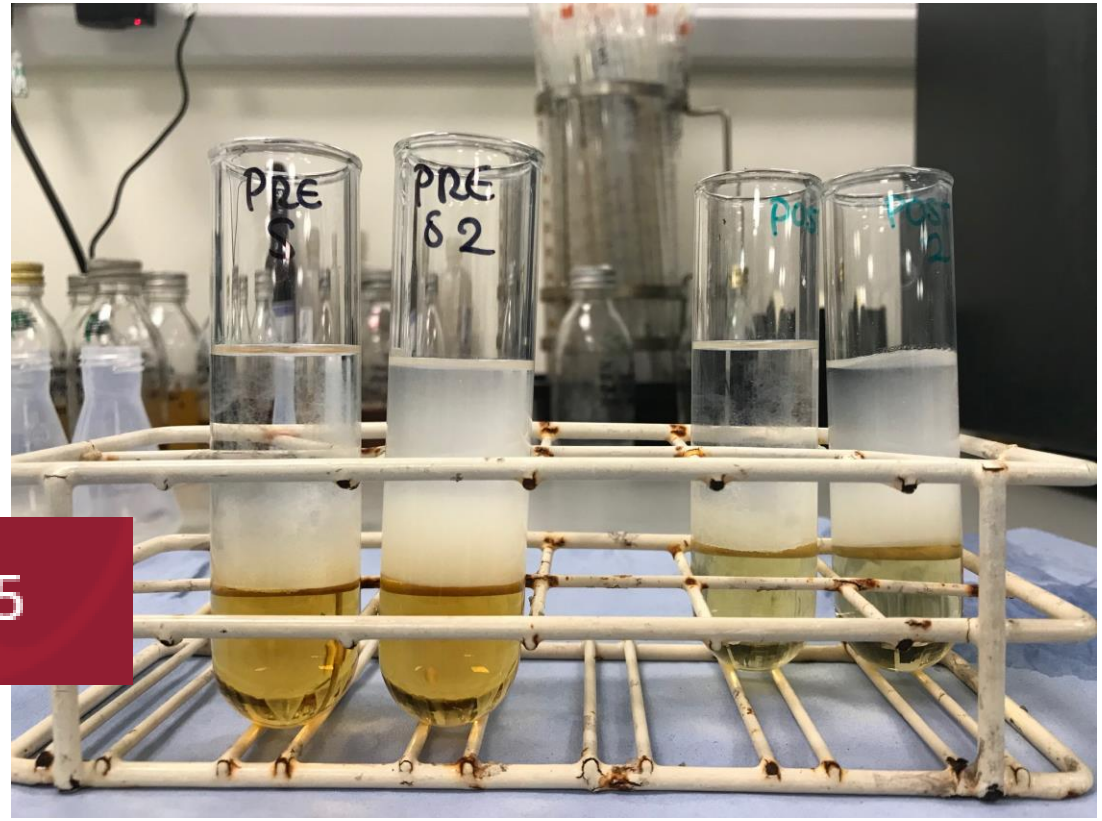
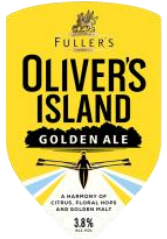
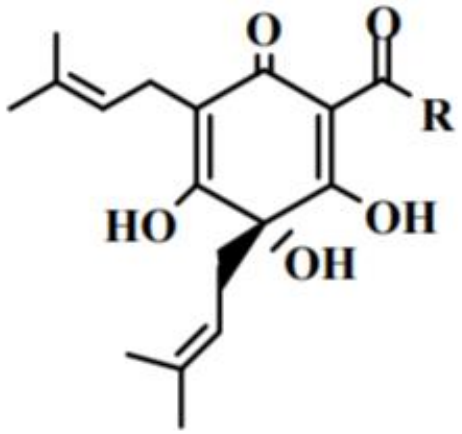
Why bitterness?

NUTRITION Per 100ml	Keg/Bottle
Energy (Kcal)	39.45
Energy (KJ)	165.39
Protein (g)	0.49
Bitterness (IBU)	**35**
ABV	4.7



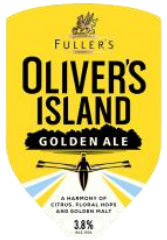


What is bitterness?



Alpha Acids

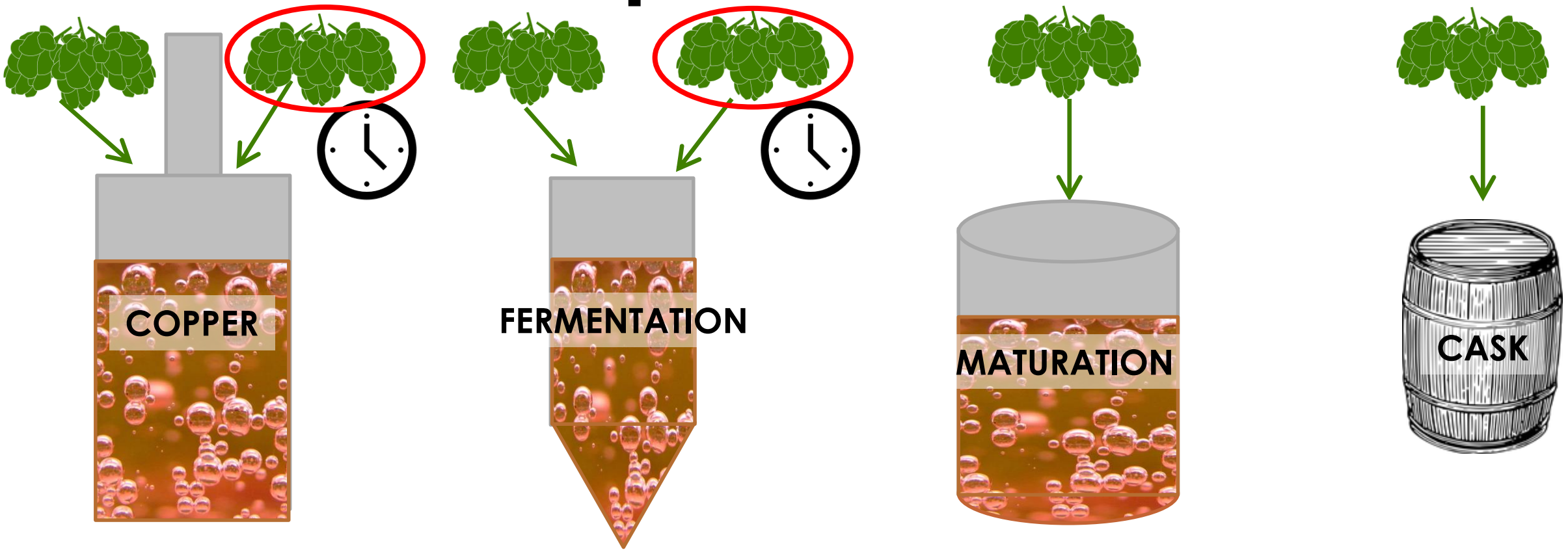
(1) Algazzali, V. and Shellhammer, T. (2016). Bitterness Intensity of Oxidized Hop Acids: Humulinones and Hulupones. *Journal of the American Society of Brewing Chemists*, 74(1), pp.36-43.
(2) Maye, J. and Smith, R. (2016). Dry Hopping and Its Effects on the International Bitterness Unit Test and Beer Bitterness. Technical Quarterly.



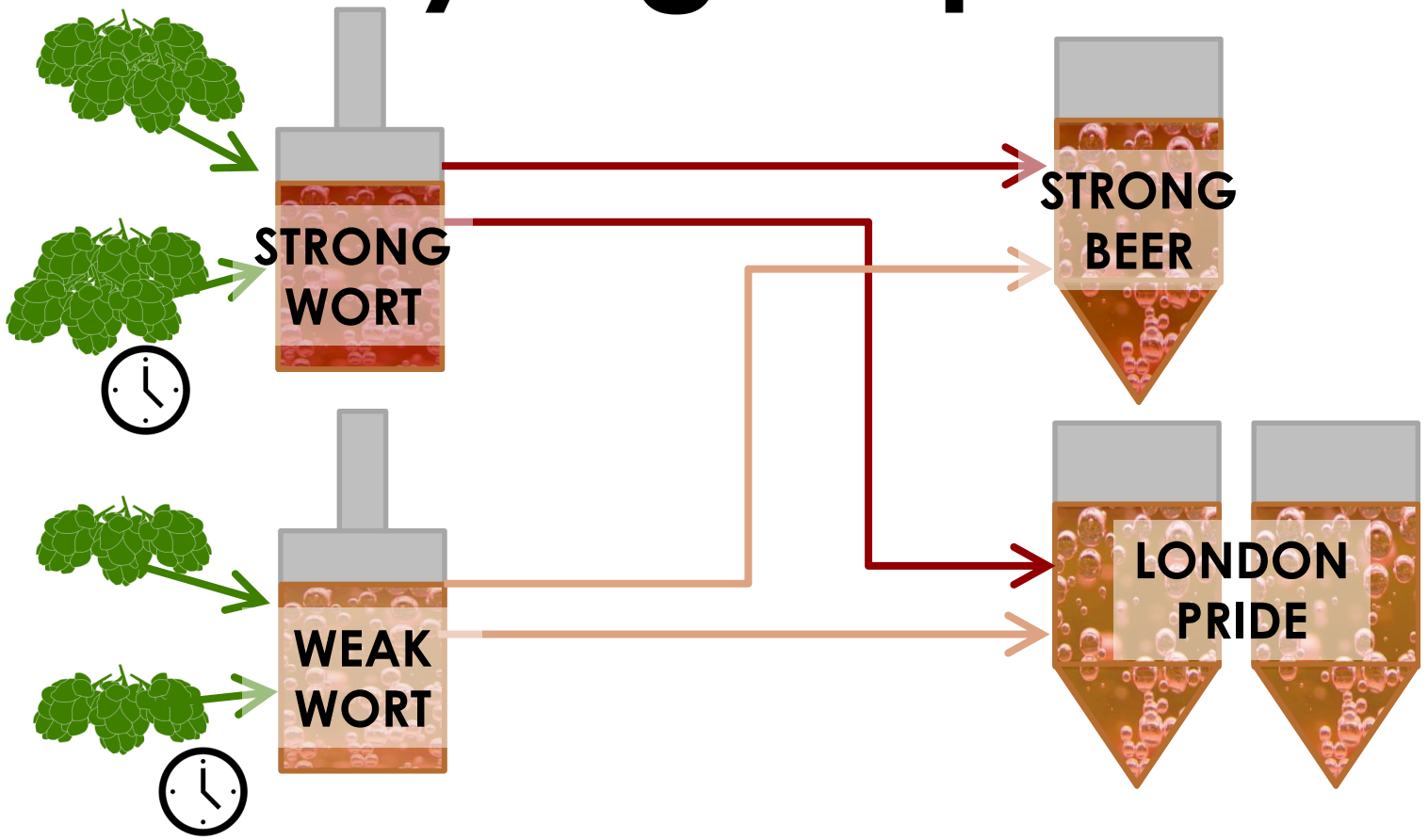
Aims

- Bitterness utilisation within individual parti-gyles
- Whirlpool utilisation on single gyles
- The impact on final IBU of dry hopping
- IBU levels pre & post filter

Hop Additions

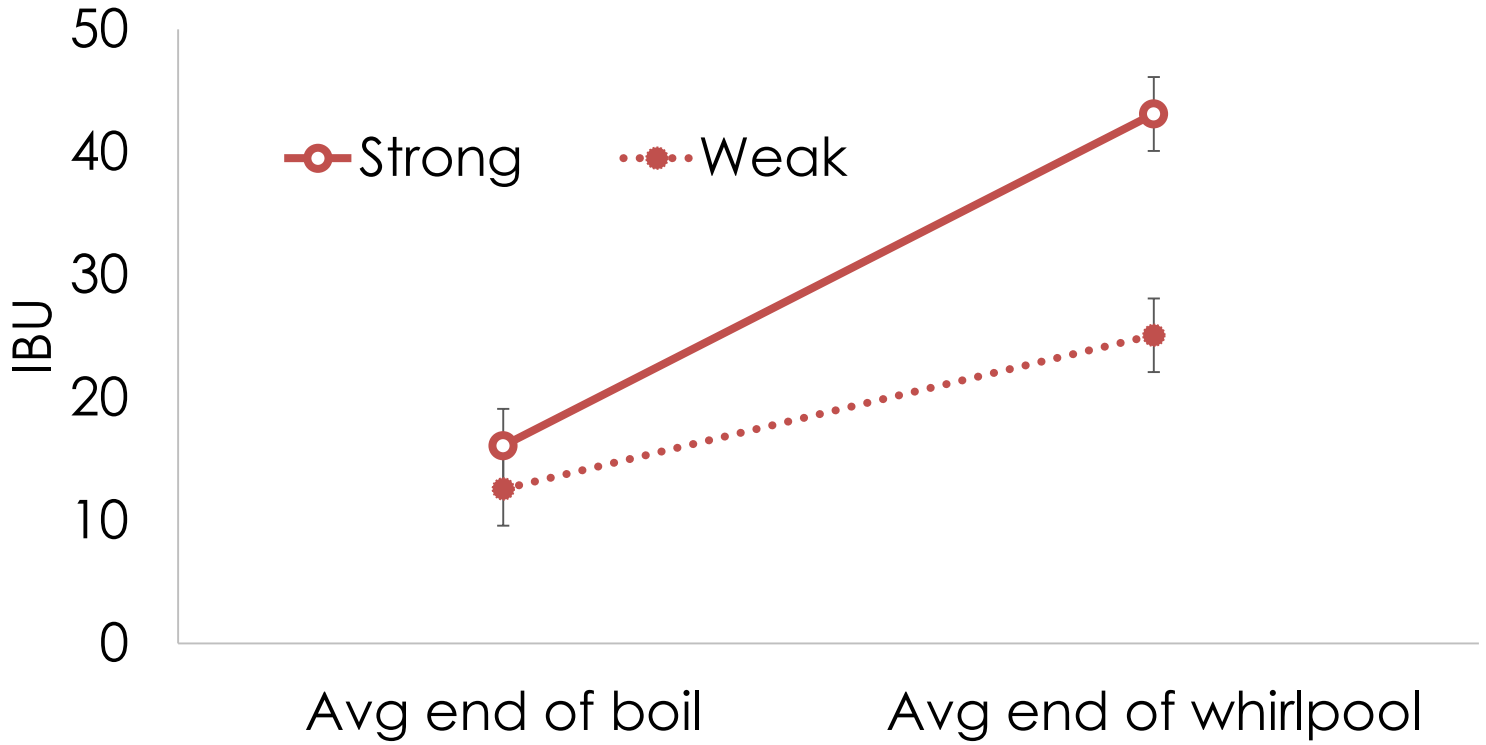


Parti Gyling Hop Additions



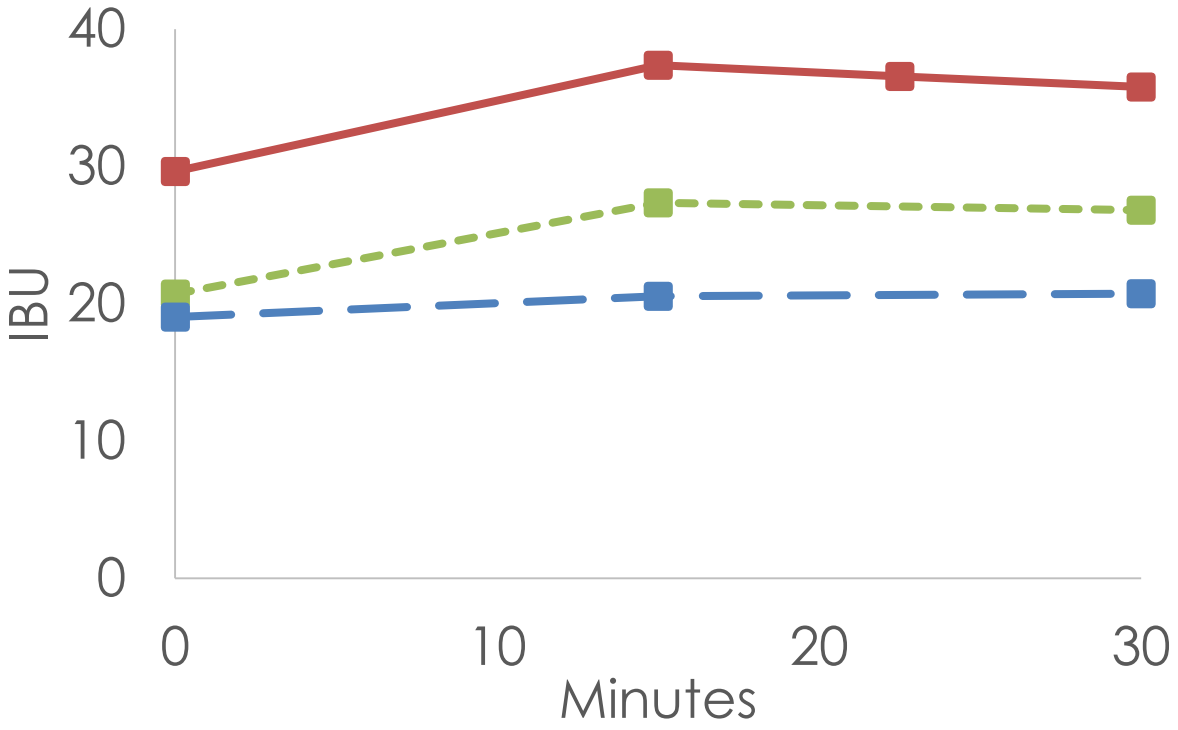
Complete IBU journey of London Pride

Parti-gyle



Hop addition	Bittering hops	Aroma hops (estimate)
Strong	70%	75%
Weak	30%	25%

Whirlpool (single gyle)



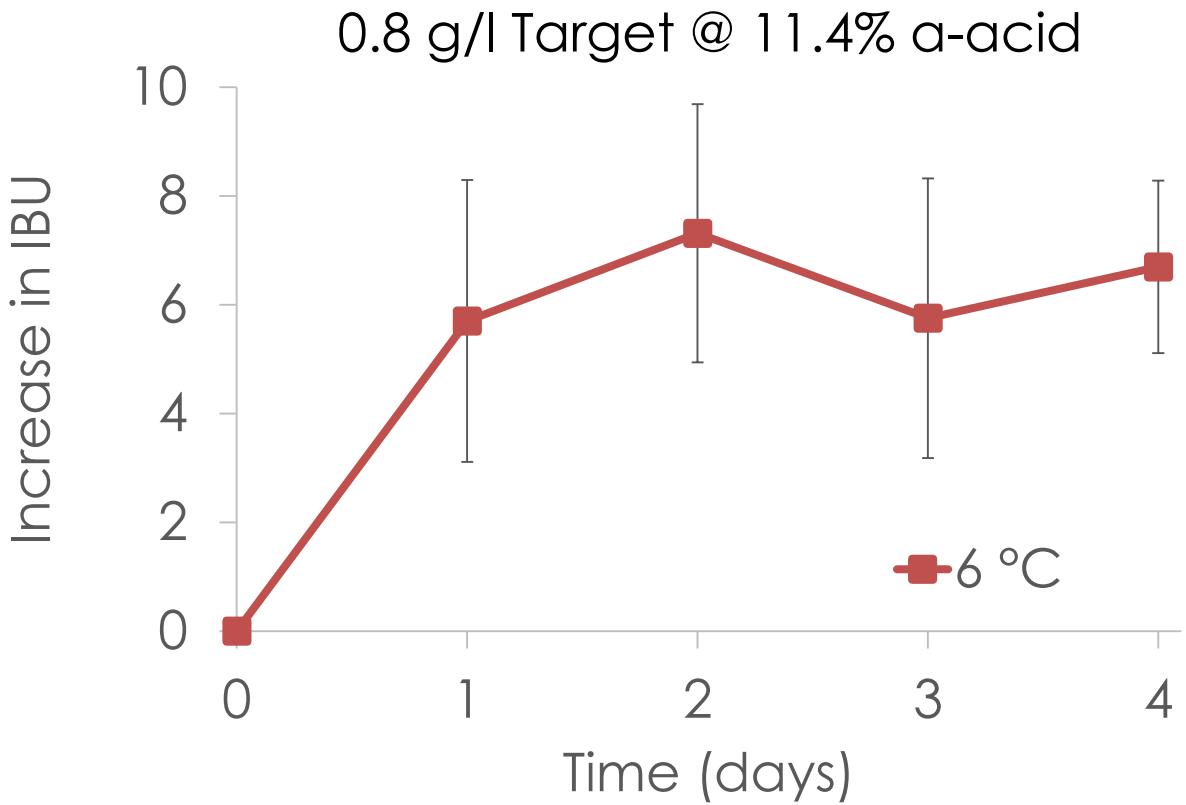
London Pride:
0.06 g/l a-acid

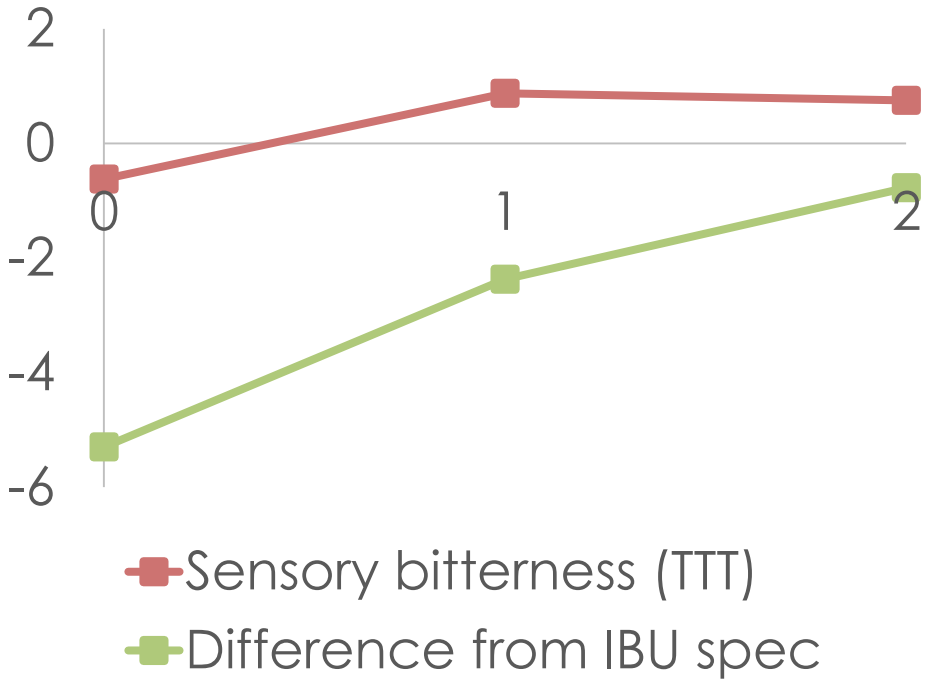
Frontier:
0.05 g/l a-acid

Seafarers:
0.02 g/l a-acid

Whirlpool temperature:
99.5°C

Dry hopping

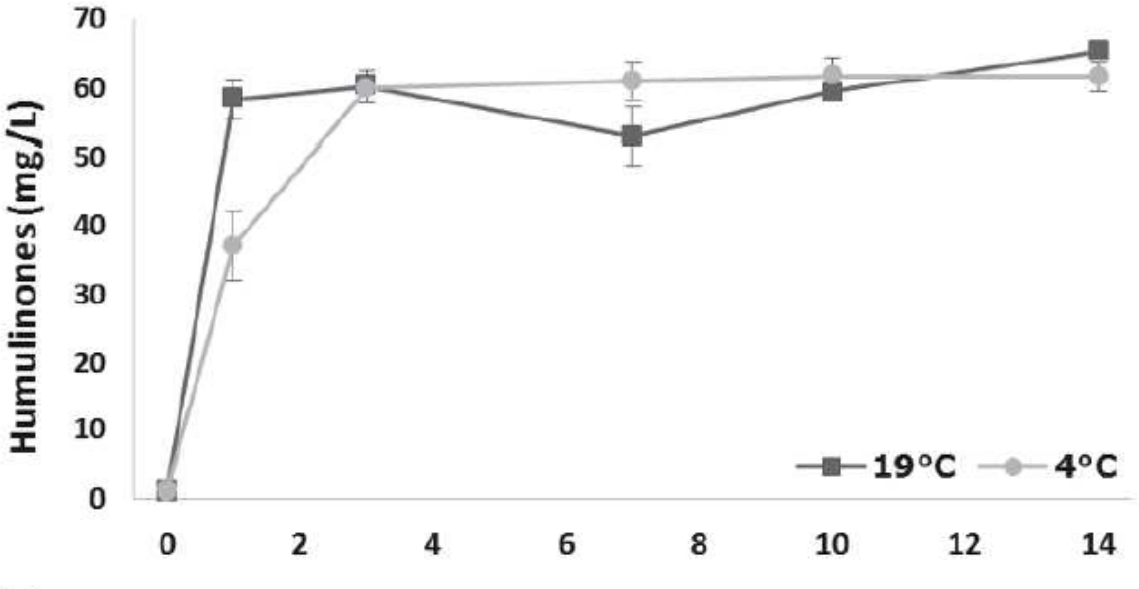

0.8 g/l Target @ 11.4% a-acid
Increase in IBU
10
8
6
4
2
0
0
1
2
3
4
Time (days)
6 °C


2
0
-2
-4
-6
0
1
2
Sensory bitterness (TTT)
Difference from IBU spec

Dry hopping: A closer look

A

4 g/l Zeus @ 17% a-acid

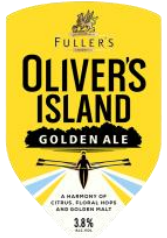


iso-a-acids ↓

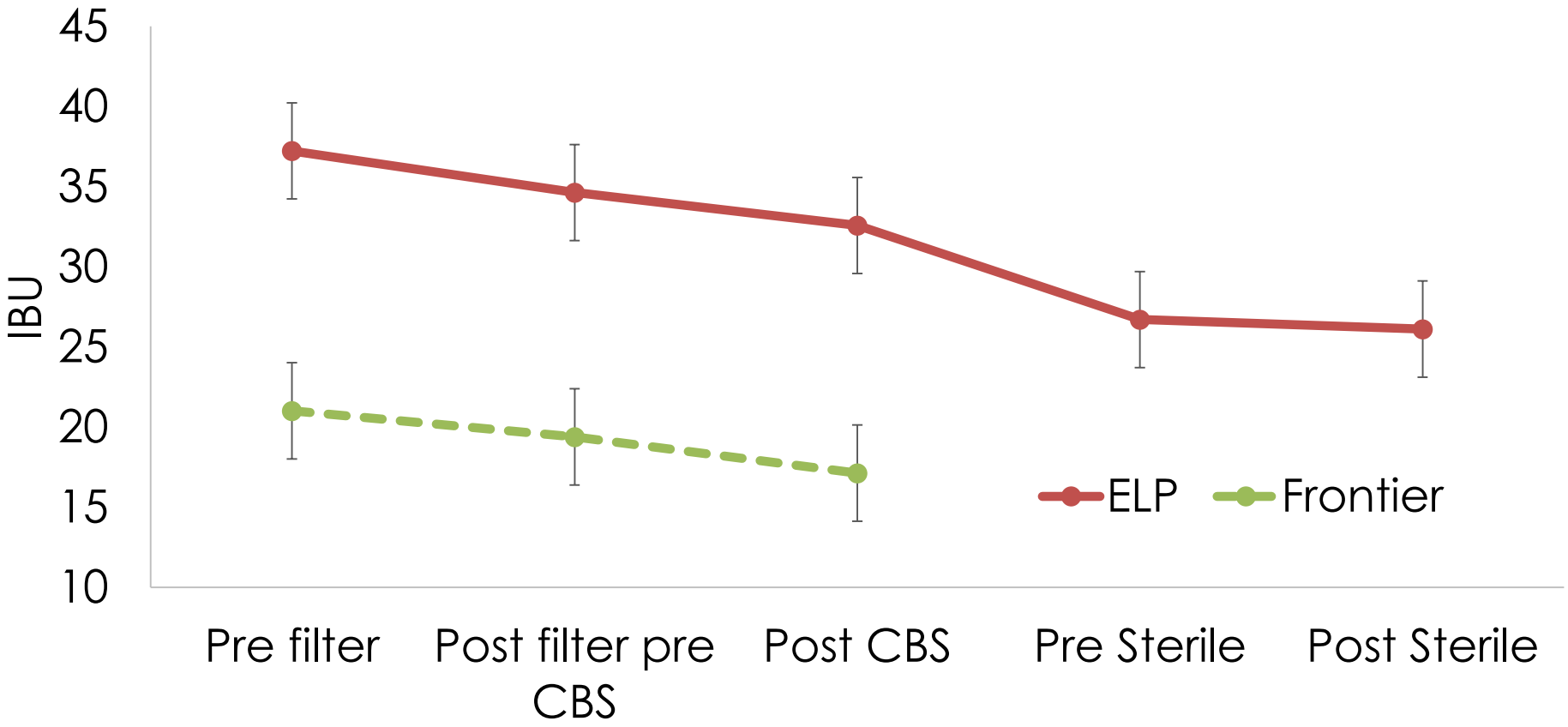
a-acids -

humulinones ↑↑

(3) Oladokun, O. and James, S. and Cowley, T. and Smart, K. and Hort, J. and Cook, D. (2017) *Dry-hopping: the effects of temperature and hop variety on the bittering profiles and properties of resultant beers.* BrewingScience, 70 (6). pp. 187-196.

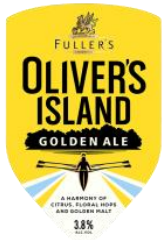


Filtration


45
40
35
30
25
20
15
10
IBU
ELP
Frontier
Pre filter
Post filter pre CBS
Post CBS
Pre Sterile
Post Sterile

Conclusions

- Better recipe development
- Process improvements
- Next steps: aroma



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THANKS FOR LISTENING!