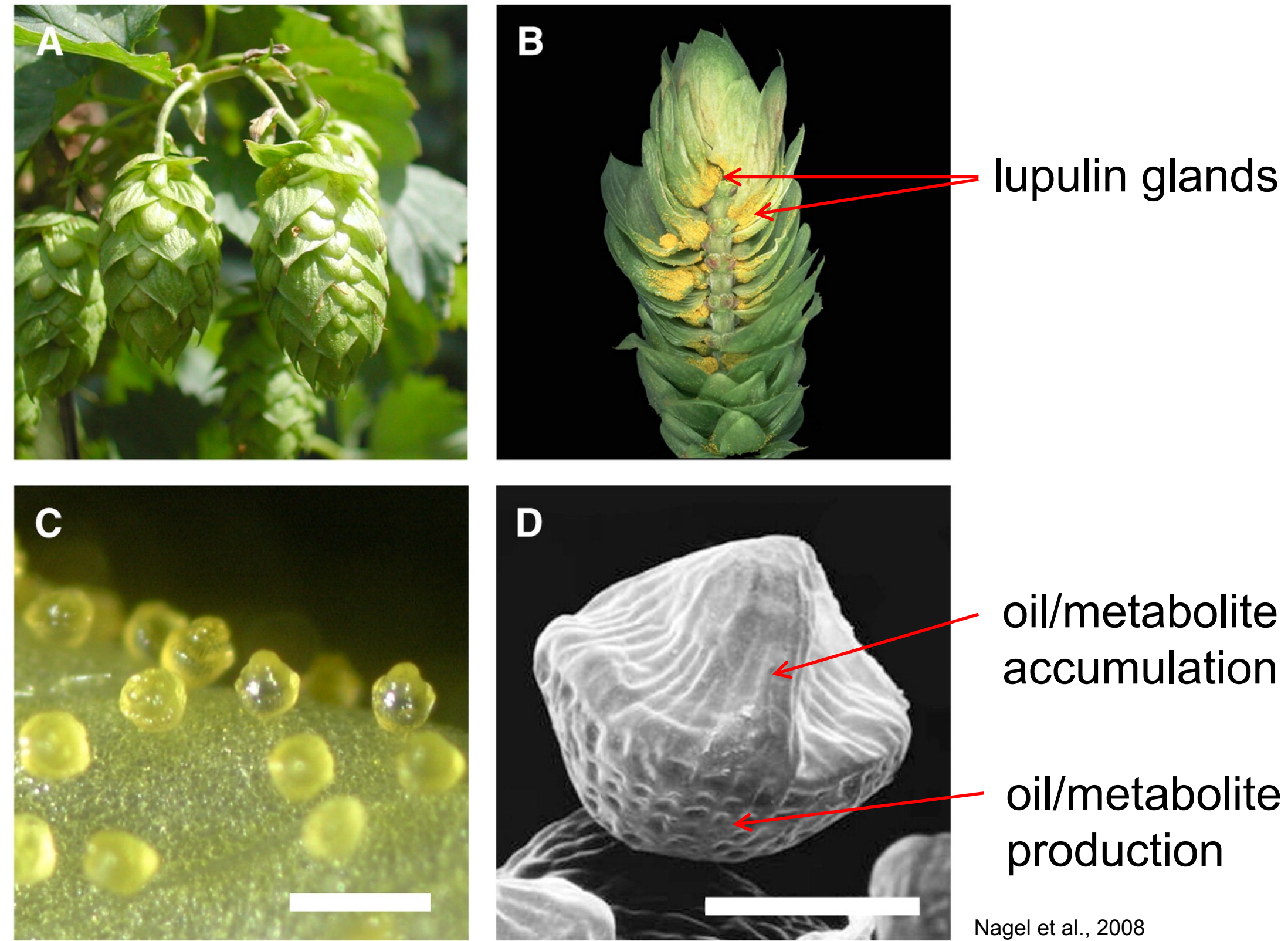




Hops produce a variety of specialized metabolites in glandular trichomes



The metabolites that give the economic value to hops are alpha and beta acids (bitter acids) and volatile aromatic compounds such as terpenes. As hop cones (A) mature they develop numerous glandular trichomes (also known as lupulin glands) which are visible to the naked eye as small yellow particles that can be seen in a bisected hop cone (arrows in B). The lupulin glands develop on the surface of the cone bracts, as can be seen under higher magnification (C). Under even higher magnification, the individual lupulin glands look similar to an ice-cream cone (D). Using this analogy, the 'ice-cream cone waffle' represent the living cells which produce the metabolites, and the 'ice-cream' itself represent the oil rich cavity where those metabolites accumulate.

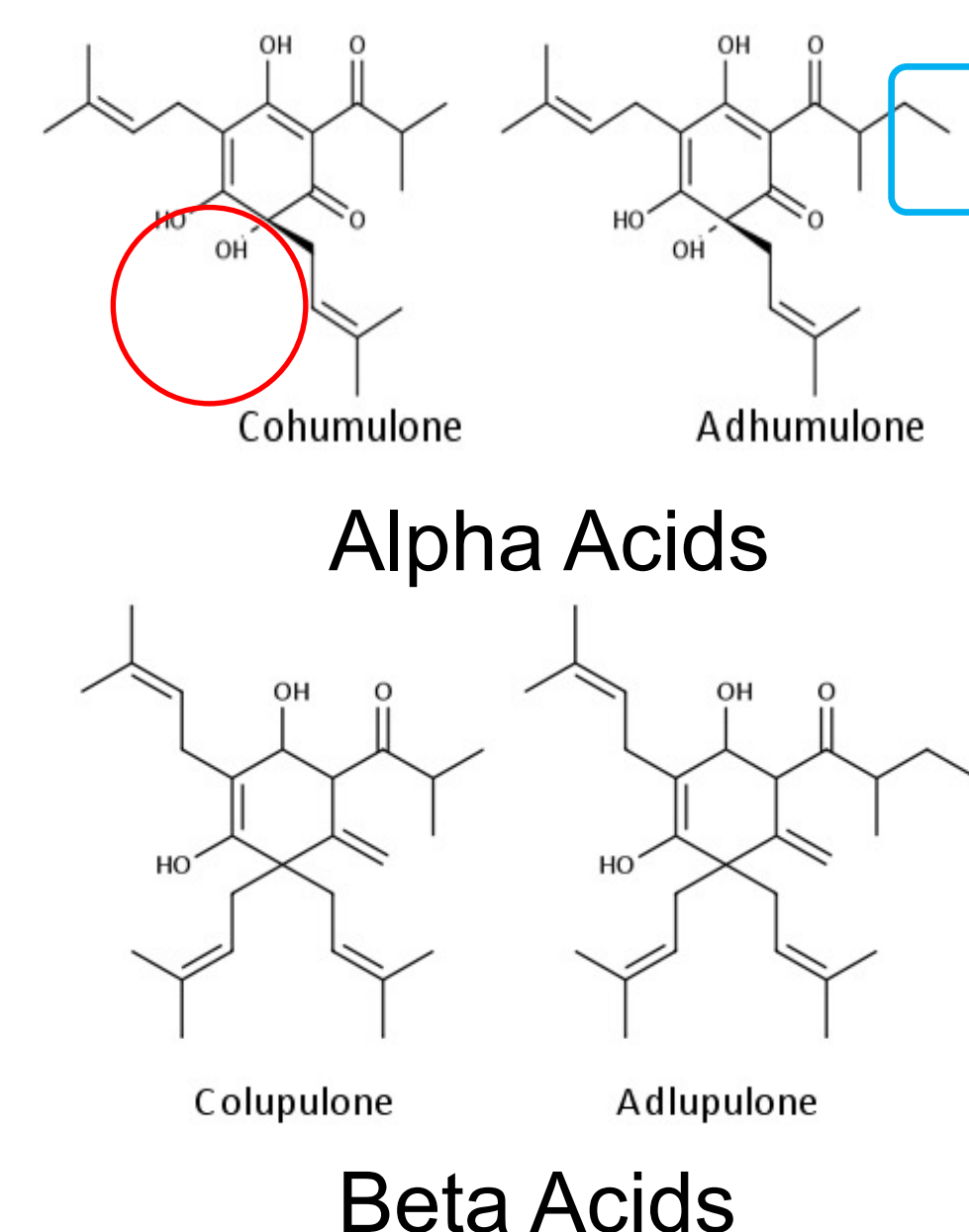
Terpenes (aroma and flavour)

Terpenes impart characteristic aromas to hops. Different hop varieties can accumulate different terpenes and thus impart select aromas and flavour notes to beer. Thus precision brewing will leverage knowing the types of terpenes that are present in hops in order to reduce batch to batch variation in the brewhouse and support brewing innovation.

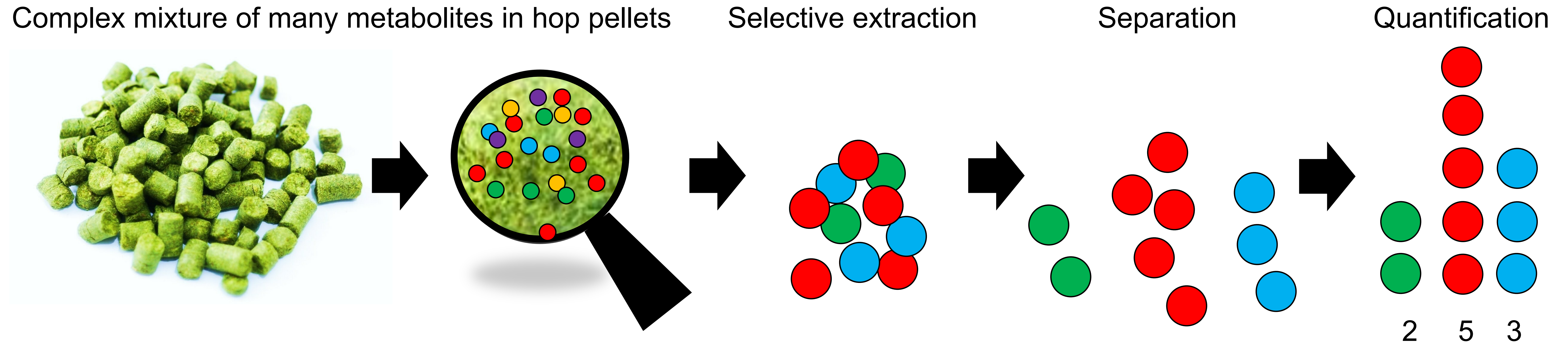
Terpene	Structure	Aromas and Flavours
β -Caryophyllene		Bitter, floral, Peppery, Woody
α -Humulene		Clove, dry, spicy, Woody
(+)-Limonene		Citrusy, sweet
Linalool		Floral, rose, woody
Myrcene		Celery-like, herbaceous Turpentine-like, woody

Alpha and Beta Acids (flavour)

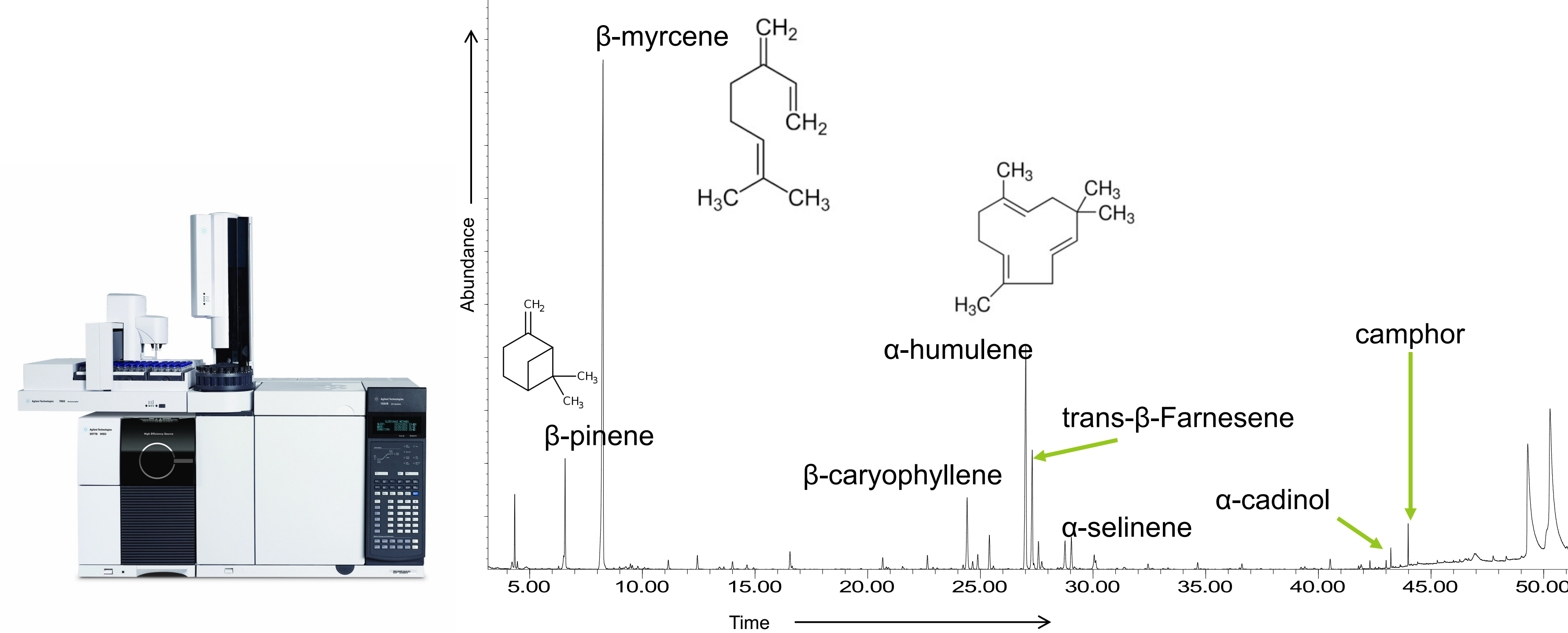
Collectively termed bitter acids, the alpha and beta acids are important contributors to beer flavour and stability. Alpha and beta acids are further subdivided into two variants termed co-humulone and adhumulone, and coluplone and adlupone, respectively. The alpha acids are sought after for their superior bittering qualities due to their ability to isomerize into water soluble iso-alpha acids during the beer brewing process.



How does chromatography-based testing work?

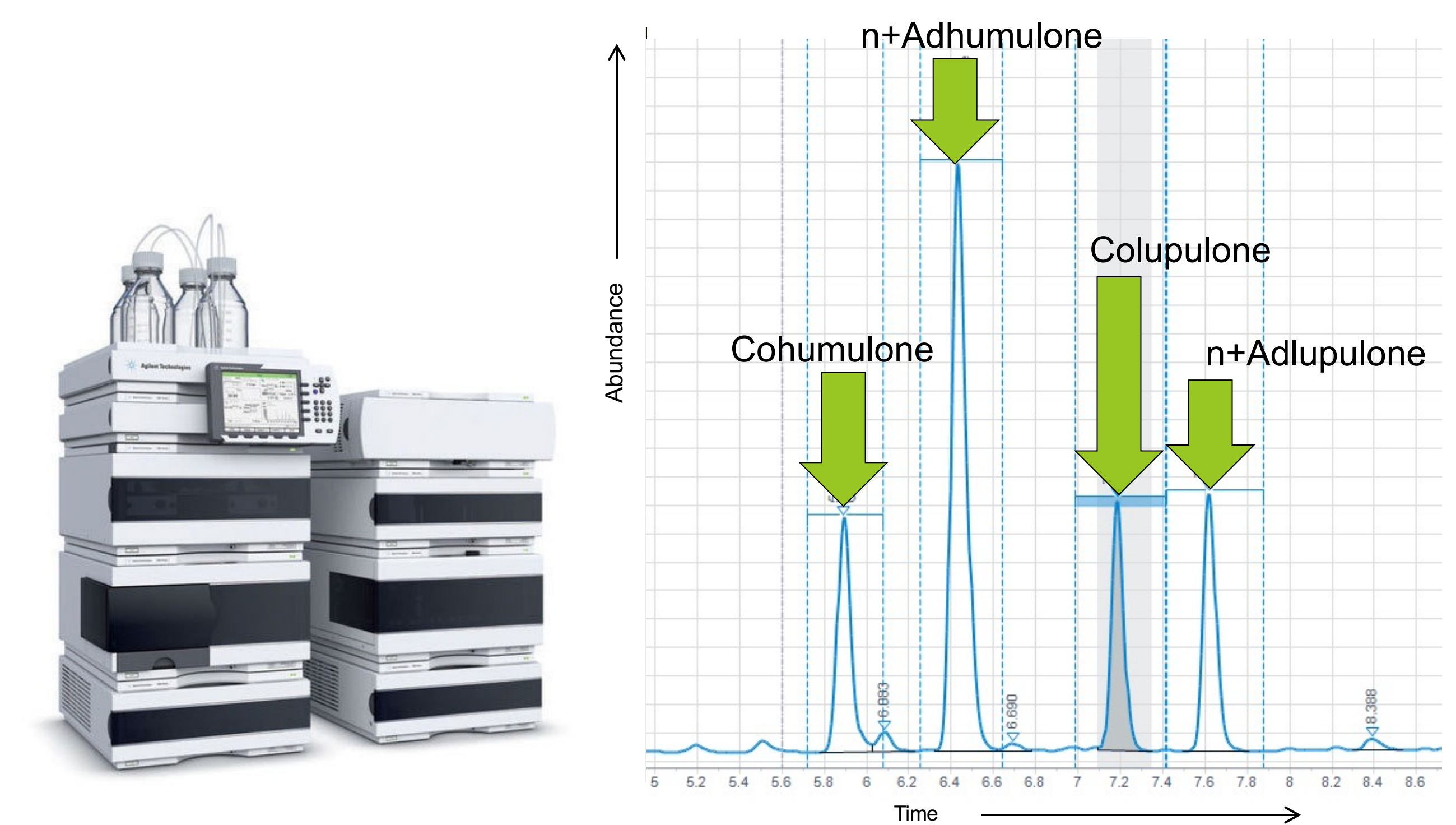


Terpenes (aroma and flavour)



Gas Chromatography Mass spectrometry (GC-MS)

Bitter acids (flavour)

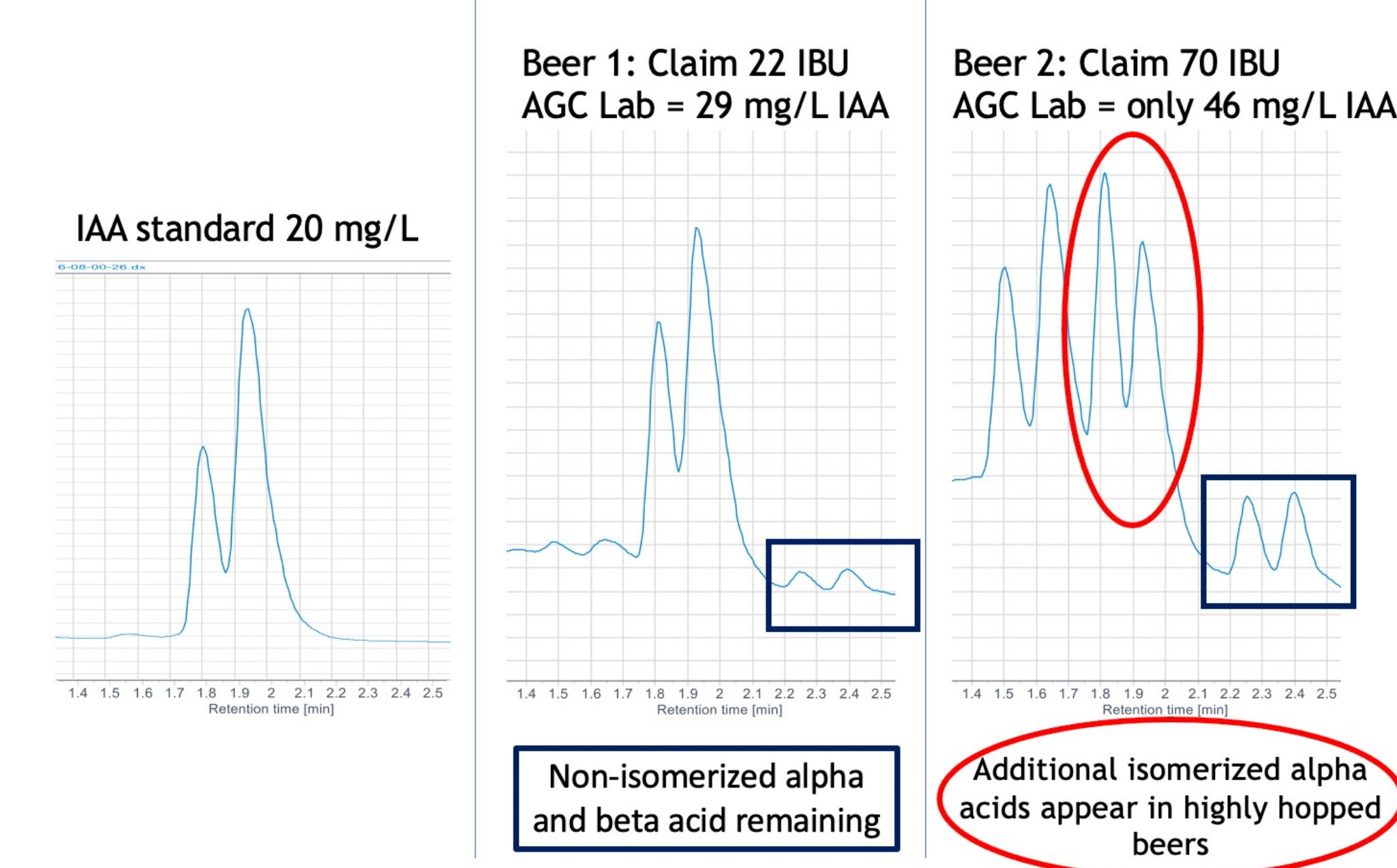


Liquid Chromatography Diode array detector (UPLC-UV)

Coming soon!

Iso alpha acid testing (IBU)

Alpha acid isomerization during brewing can lead to 6 different isomers of iso- α acid; each isomer has varying degrees of bitterness and influence on mouthfeel and flavor



Olfactory sensory analysis

Gas chromatography coupled with an olfactory port will facilitate human sensory testing of the aromatic profiles derived from hops and beer. This complements the empirical data derived from the MS detector with human sensory analysis.



Contact us for R&D partnerships!

- Residual sugar analysis (attenuation)
- Alcohol content
- Microbiology analysis (sequencing based)
- Yeast strain genotyping

Learn more at: www.kpu.ca/agc/lab-services

Contact us: agc@kpu.ca or 604.599.2282

Analytical chemistry methods used are prescribed by:
American Society of Brewing Chemists (ASBC)
European Brewery Convention Analytica (EBC)

