RENEGADE

YTN BREWERY FST

Runaway Beers

Low/Zero alcohol beers – challenges, opportunities and approaches

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Challenges with low/zero alcohol beers

- Sensory challenges
  - Flavour matching low/zero alcohol beer to a standard beer
  - Low body, perceived “thinness”
  - Undesirable flavours e.g. wortiness, aldehydes (“cardboard”), sulphur cpds
  - High sweetness due to unfermented carbs, extra body
  - Cooked notes if thermal processes used
  - Removal of alcohol invariably means removing other, desirable volatiles/small molecules e.g. higher alcohols and esters
- Other
  - Potentially less microbiologically stable product - alcohol is a good preservative
  - Enhanced cost of pasteurisation – higher PUs
  - Equipment/capital costs
  - Use of preservatives or positive release may be required
  - Potential for fermentable carbs in-pack

Opportunity - why consider low/zero alcohol as a brewer?

- No duty – lower costs => lower RRP/trade price or better margin
- One of the fastest growing beer segments – see recent BBPA quarterly report (fastest growing on draught), Tesco sales up 40% last 2 years
- Consumer need - trend towards lower alcohol for health benefits, perceived reduced calories, allows cycling/driving whilst still having a beer

Technologies

Two basic approaches:

1. Reduce the amount of alcohol produced

or

2. Make the alcohol and then remove

Both approaches have their pros and cons and most breweries tend to use only one approach. Option 1 tends to be favoured by smaller breweries and Option 2 by large multi-national breweries.

Reducing the alcohol produced - approaches

- Higher mash temperature – reduces activity of β-amylase, result is reduced fermentable sugar
- Low gravity wort – reduced malt or dilution of wort, result is reduced fermentable sugar
- Arrested fermentation – e.g. crash cooling early, removing yeast
- Cold fermentation – slows conversion of sugars to alcohol
- Novel organisms - e.g. maltose/maltotriose negative yeast strains and non-ethanol producers e.g. *Torulaspora delbrueckii*, *Saccharomycodes ludwigii*, *Zygosaccharomyces lentus* and *Pichia kluyveri*

Reducing the alcohol produced – pros and cons

Main advantages of these approaches - can usually be achieved with existing equipment and are easy

- Higher mash temperature – allows full fermentation so little or no worty/oxidised character in final beer, but high residual carbs with potential micro issues in pack, and enhanced sweetness. Wortiness can be reduced by using adjuncts
- Low gravity wort – allows full fermentation, little residual carbs but thin beer, lower esters, thinness can be offset with additions such as lactose
- Arrested fermentation – worty/oxidised character, high residual carbs/sweetness
- Cold fermentation – slows conversion of sugars to alcohol, worty/oxidised and high residual carbs/sweetness
- Novel organisms – depends on organism, removes worty/oxidised character, provides esters, but may result in unusual flavours and high organic acids

Removing alcohol - approaches

Thermal technologies

- Distillation – separation of alcohol and water based on boiling point
- Vacuum distillation – various technologies, work as above but under partial vacuum to reduce boiling point
  - Falling film evaporation – short heating time
  - Continuous vacuum rectification – volatiles collected in CO_2 and can be added back (0.05% ABV)
  - Thin layer evaporation – short heating time (0.05% ABV)
  - Spinning cone – used by flavour industry, volatiles can be added back

Membrane technologies

- Reverse Osmosis – separation of alcohol, water and small flavour molecules across a semi-permeable membrane using high pressure
- Dialysis – alcohol removed across a membrane using a counter-current stripping liquid
- Pervaporation – removes volatile flavour compounds across a membrane into a vapour phase before alcohol removal, volatiles can be added back. Can be used for alcohol removal

Removing alcohol – pros and cons

Some of these technologies can deliver very low alcohol beers with good flavour but high capital and running costs make them less attractive to smaller brewers

Thermal technologies

- Distillation – removes all volatiles but cooked beer (!), rarely used
- Vacuum distillation – minimal heat damage but still lose volatile flavour cpds, very low alcohol levels possible depending on the technology, and in some cases volatile flavour cpds can be added back

Membrane technologies

- Reverse Osmosis – good for 0.5% ABV
- Dialysis – needs a large membrane, good for 0.5% ABV
- Pervaporation – allows good flavoured beers to be produced

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