BREW SMARTER, NOT HARDER

Enzymes, Flavor & Flow for Modern Beer

BREWING WITH ADJUNCTS

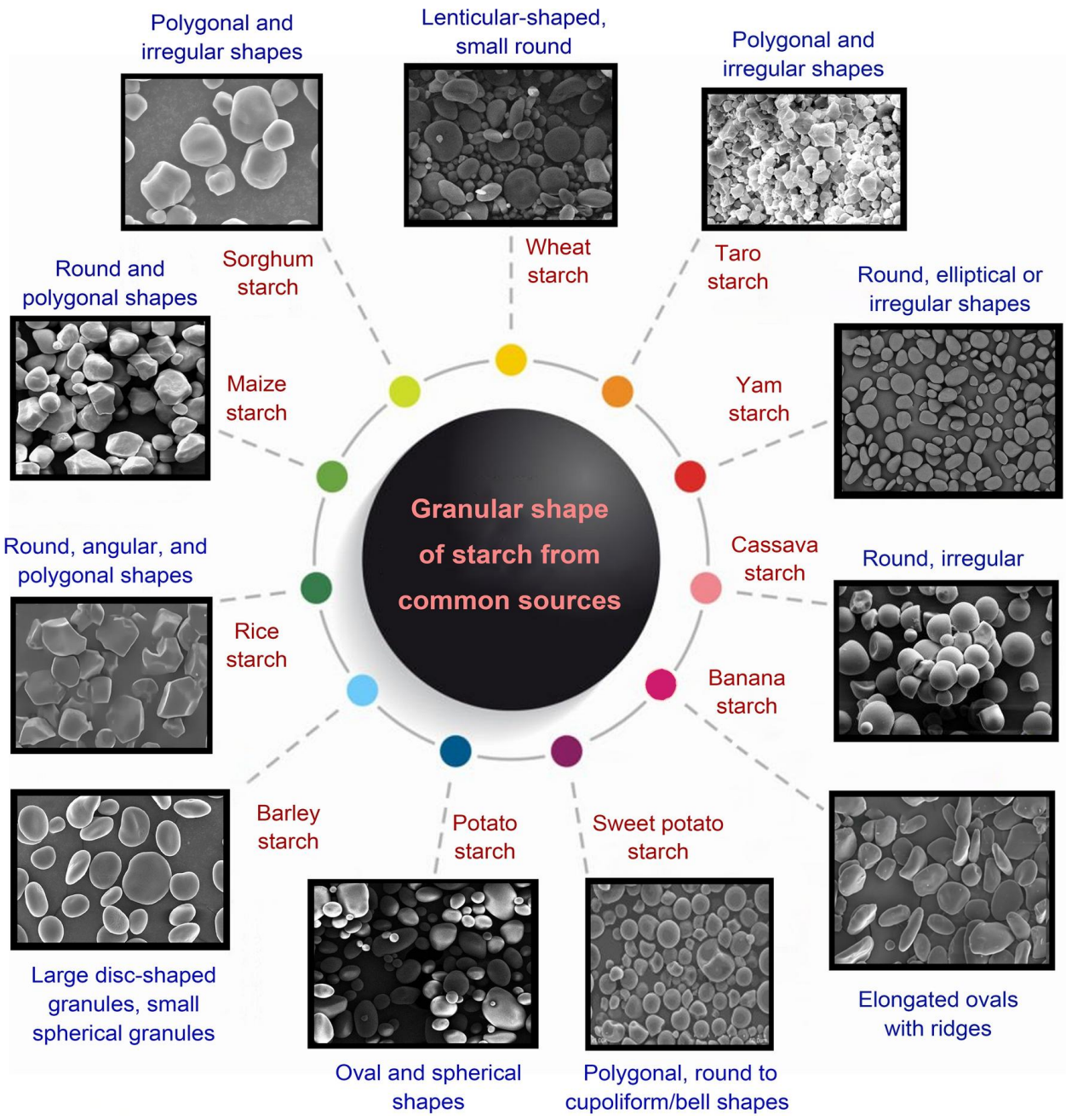
Brewing with Adjuncts

CHALLENGES

- Rice and maize grits have been the predominant solid adjuncts used in North American adjunct lagers since the mid 1800's.
- Rice and maize starches have a wider range of gelatinization temperature than barley, wheat, rye, oats.
- Solid adjuncts most often cooked as a cereal before combining with the malt mash.

Starch Granules Differ by Source

- Different sizes
- Different shapes
- Different ratios of amylopectin and amylose
- Different ranges of granule sizes
- Starch is not starch!



Rashwan, A.K., Younis, H.A., Abdelshafy, A.M. *et al.* Plant starch extraction, modification, and green applications: a review. *Environ Chem Lett* **22**, 2483–2530 (2024).

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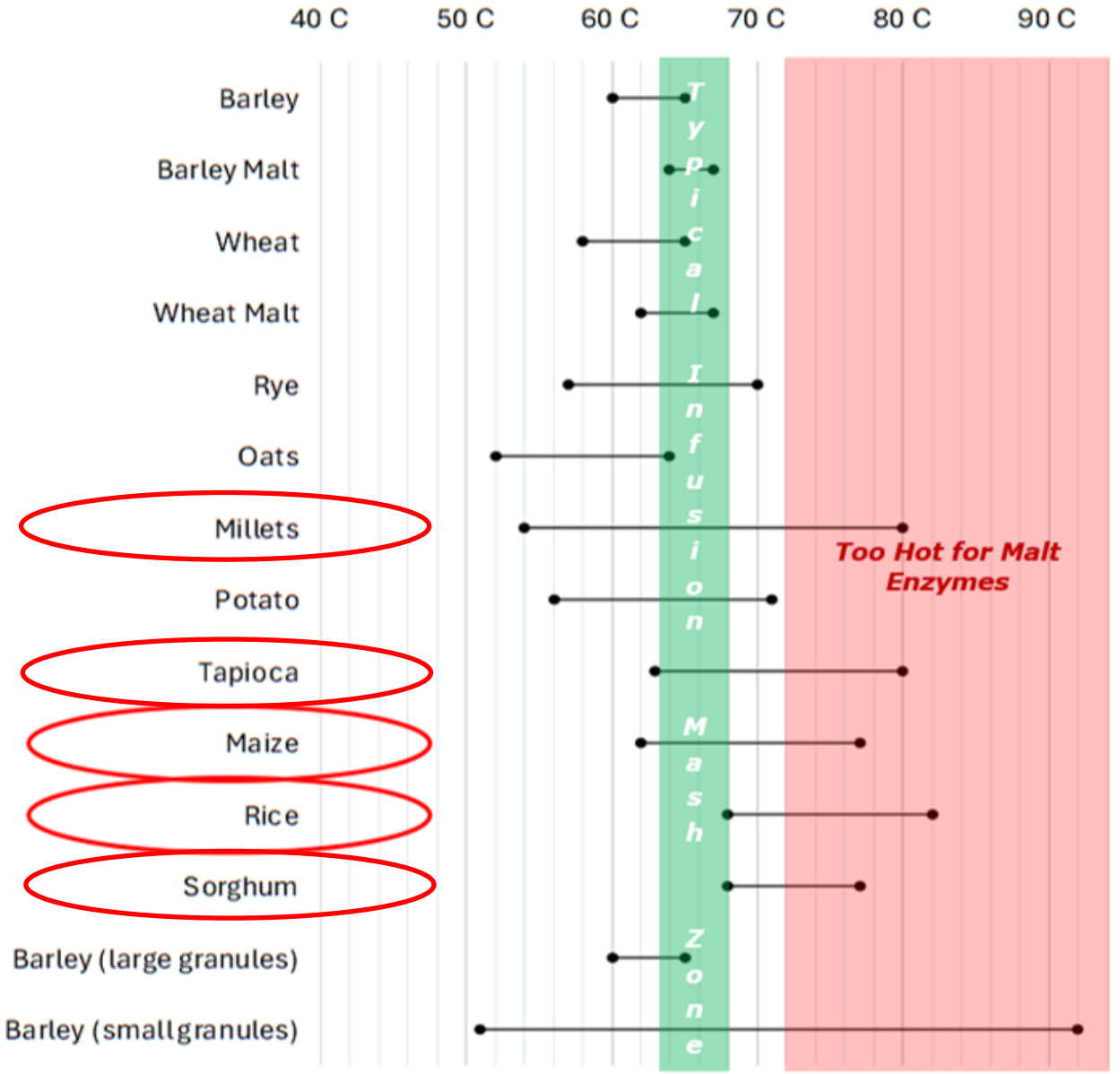
Gelatinization Also Differs by Source

- Barley, wheat, rye, and oats typically have gelatinization temperatures below mashing temperatures.
- Some rice, maize (corn), and other starch types have gelatinization temperatures above mash temperatures.



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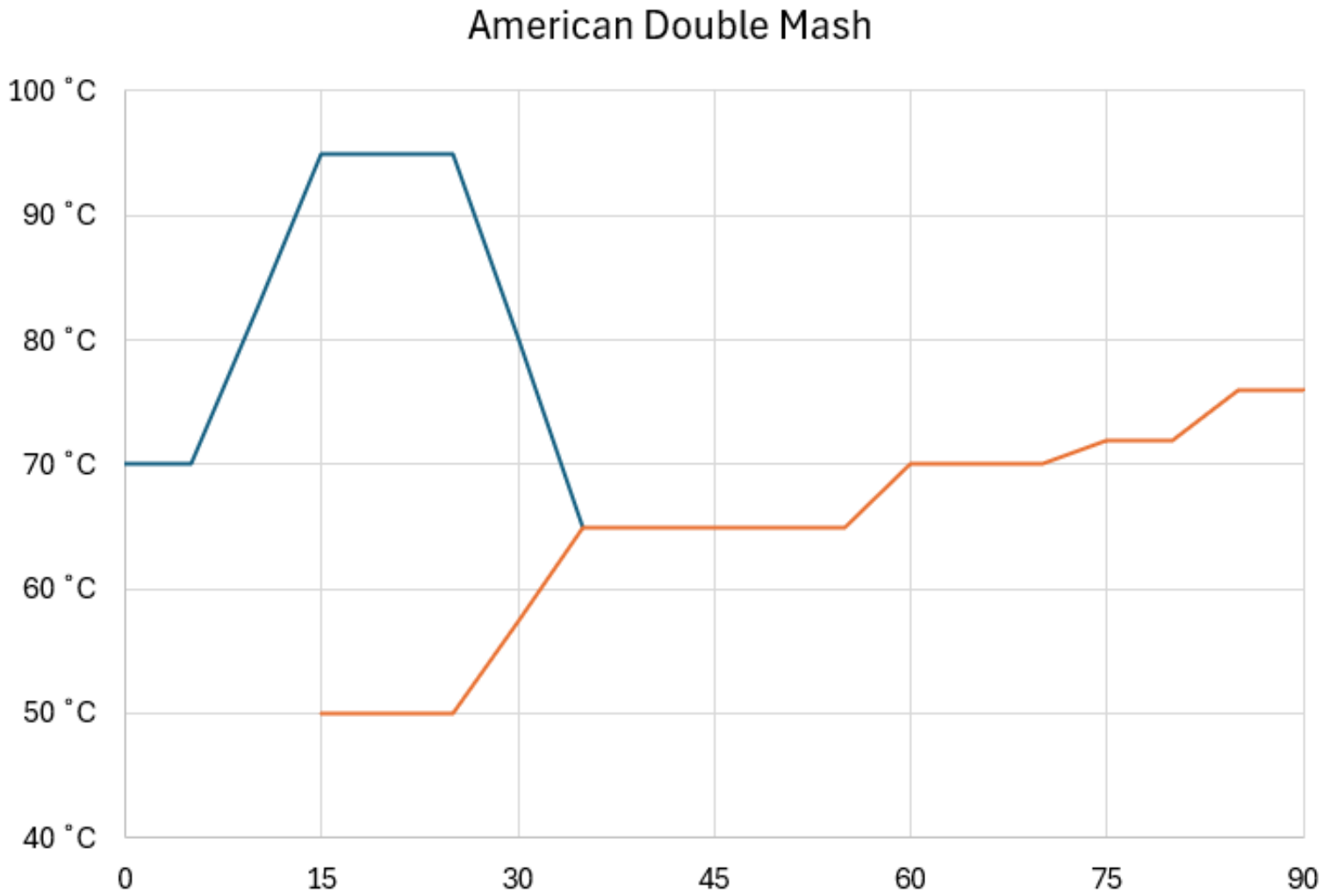
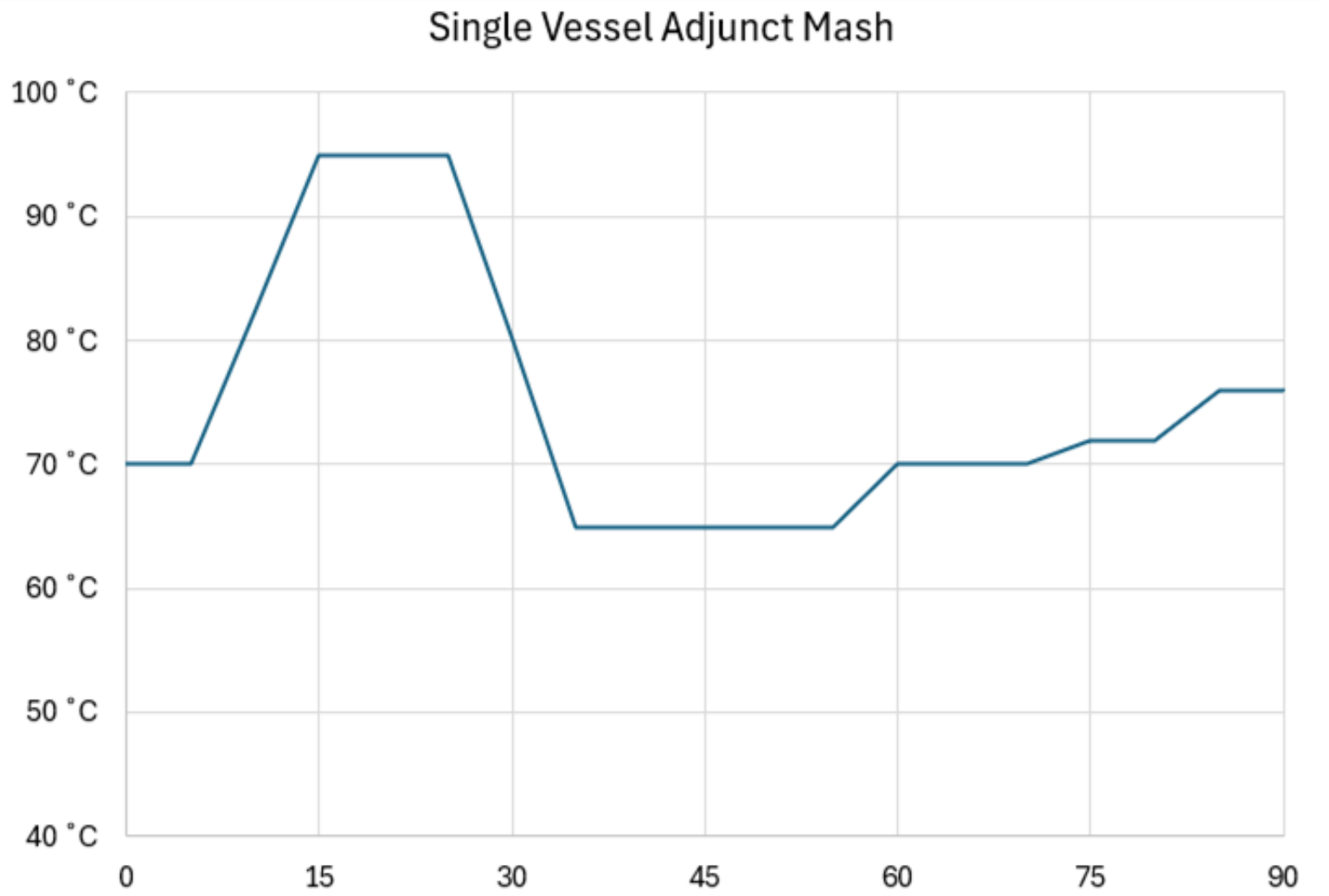
Process Options:
Buy a Cereal Cooker



Process Options:
Use Mash Mixer as Combo Cooker/Mash Mixer



Process Options:
Get Creative with Infusion Brewhouse!

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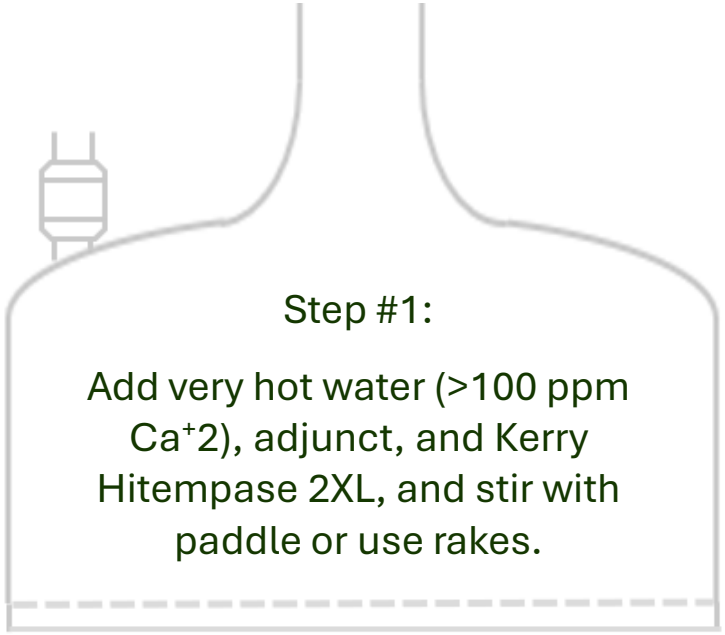
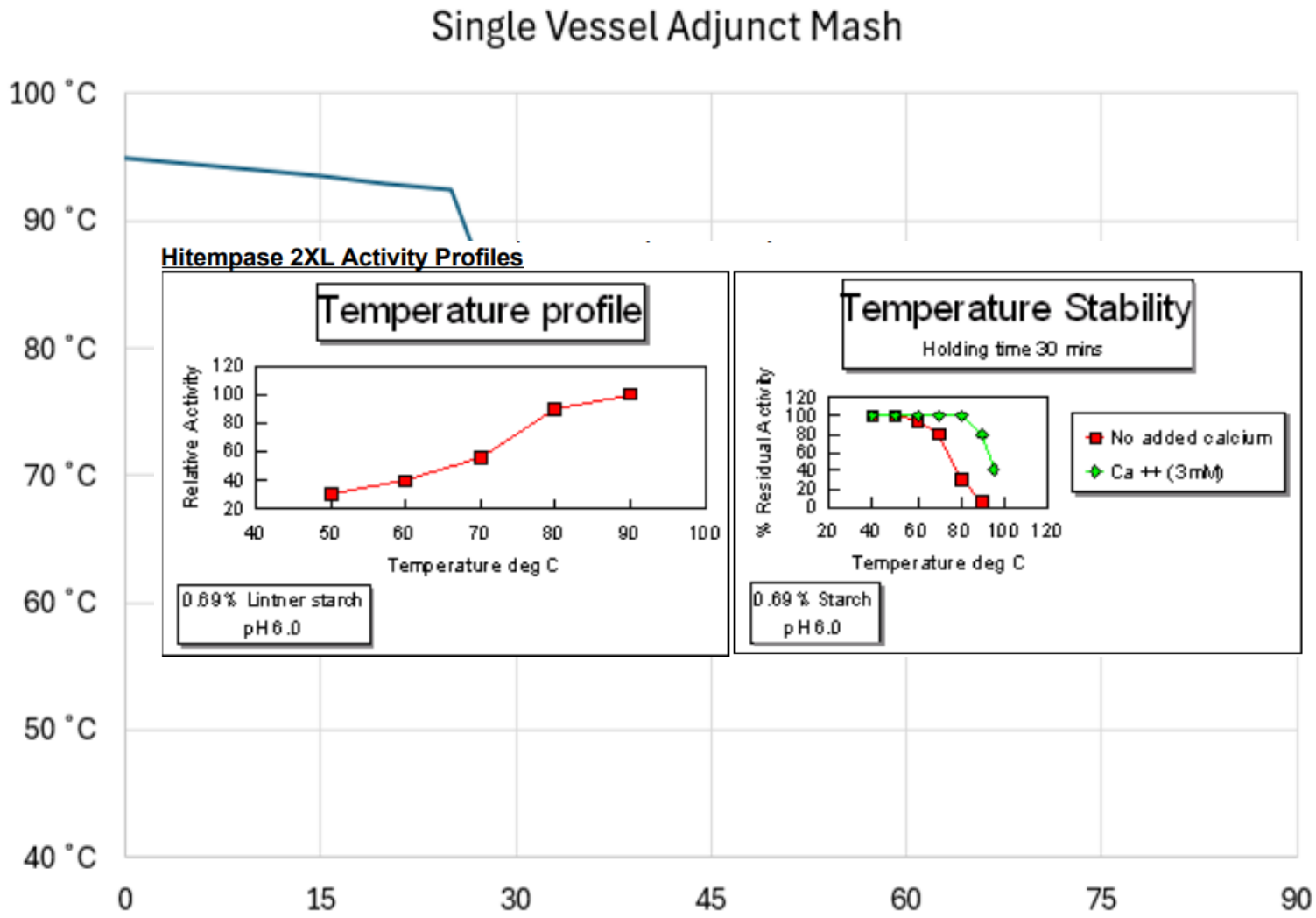


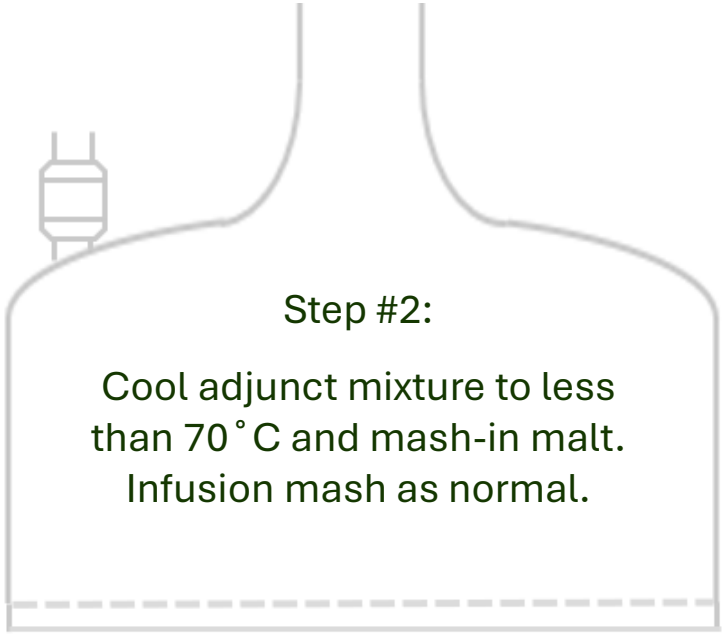
Step #1:

Add very hot water (>100 ppm $Ca^{+}2$), adjunct, and Kerry Hitempase 2XL, and stir with paddle or use rakes.

Starch will gelatinize and bacterial alpha-amylase will liquify starch during rest period. Note that temperature cools quickly due to small volume and high ΔT.



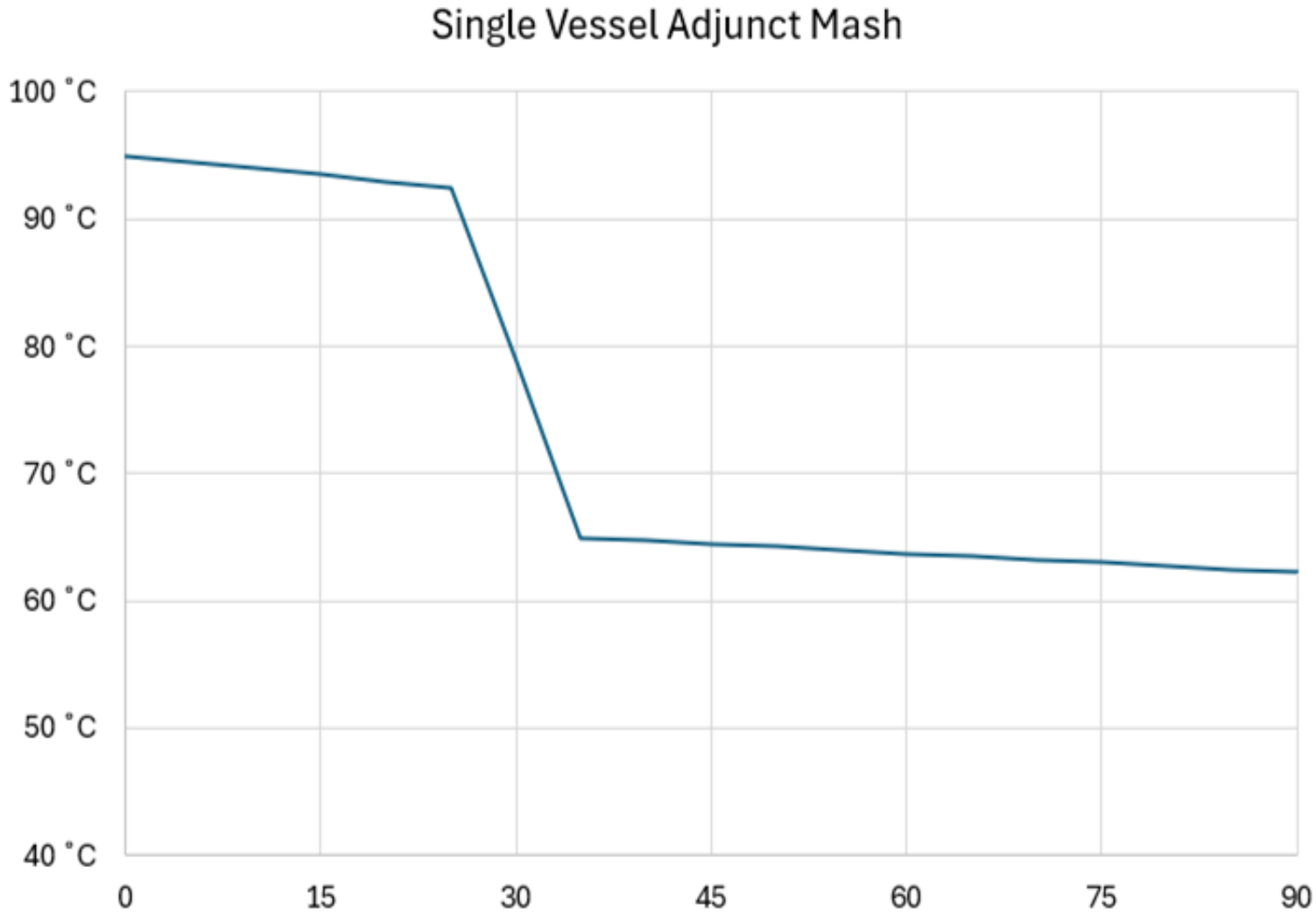
Process Options:
Get Creative with Infusion Brewhouse!



Step #2:

Cool adjunct mixture to less than 70˚C and mash-in malt. Infusion mash as normal.

Starch will gelatinize and bacterial alpha-amylase will liquify during rest period. Note that temperature cools quickly due to small volume and high ΔT.



PLACEHOLDER

Challenge > Kerry Solution

LOW-CARB BEERS

Mash Profile M1

Grist:

- Rahr Standard 2-Row

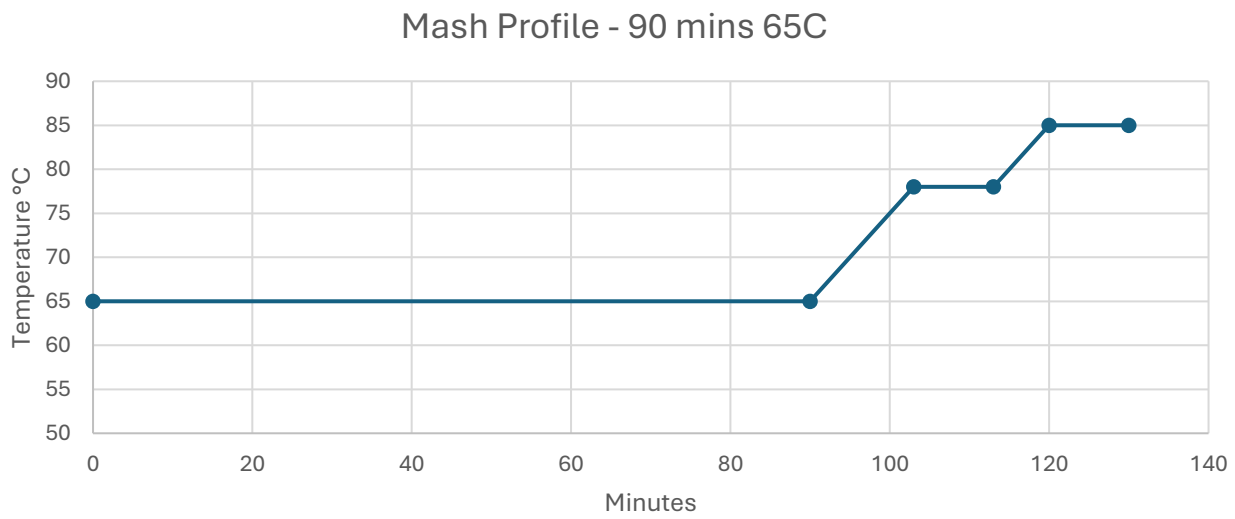
Malted Barley – 100%

- Grist to Water ratio- 1:3

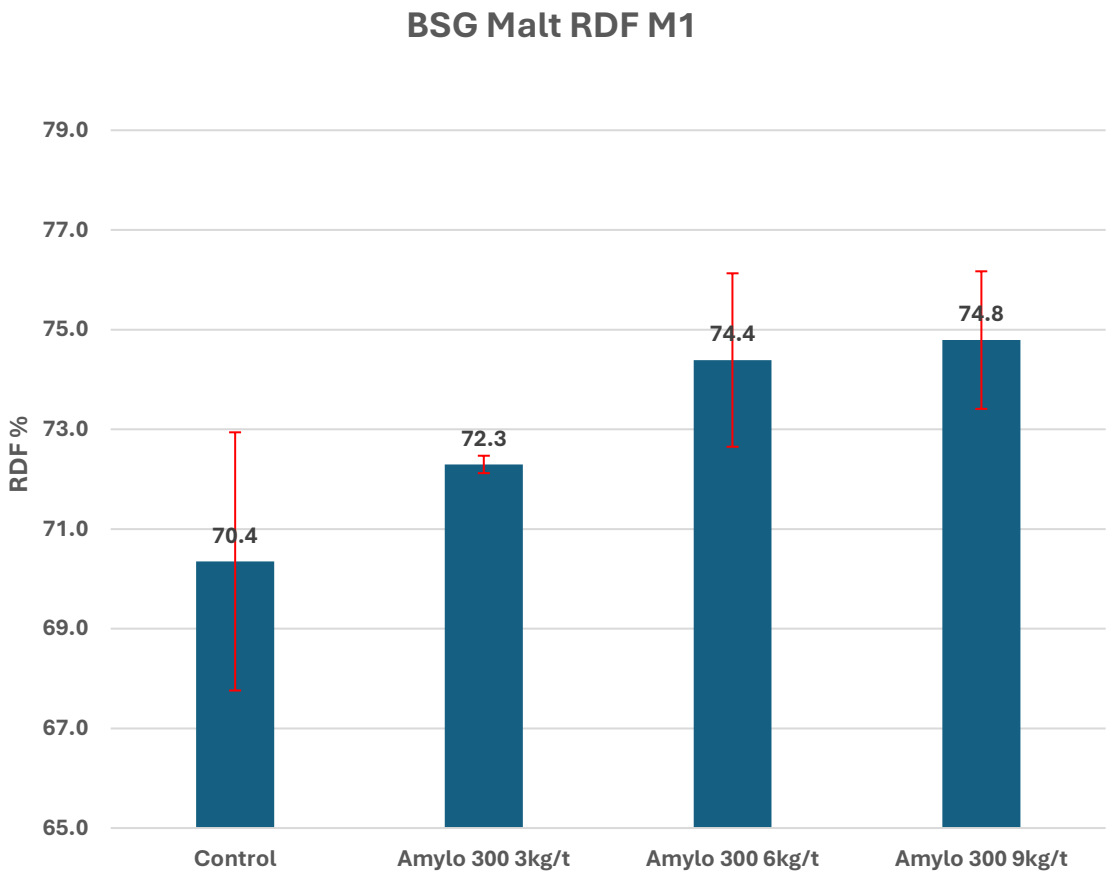
Enzymes

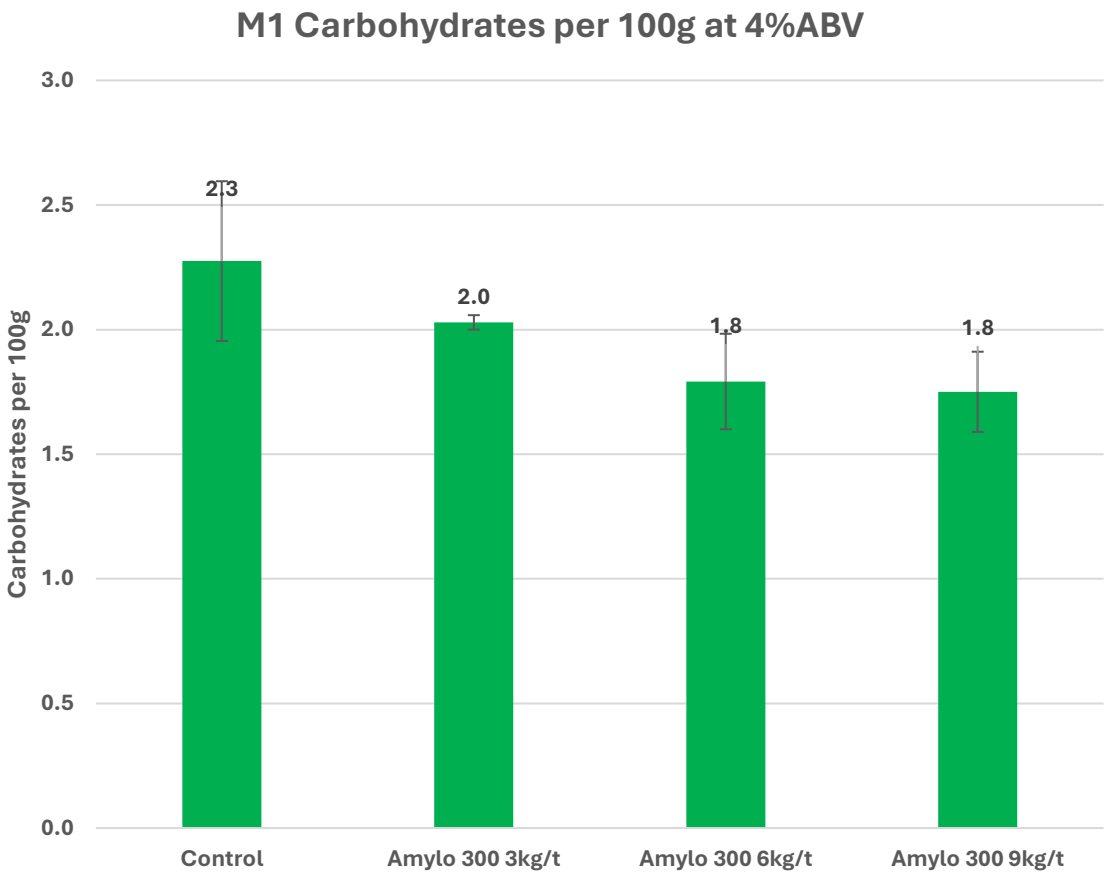
Amylo 300 @ 3, 6 and 9kg/tonne

Time	Temp (Degrees C)
5	50
90	65
10	78
10	85



Mash 1:
Amylo 300 in mash





Mash Profile M2

Grist:

- Rahr Standard 2-Row

Malted Barley – 100%

- Grist to Water ratio- 1:3

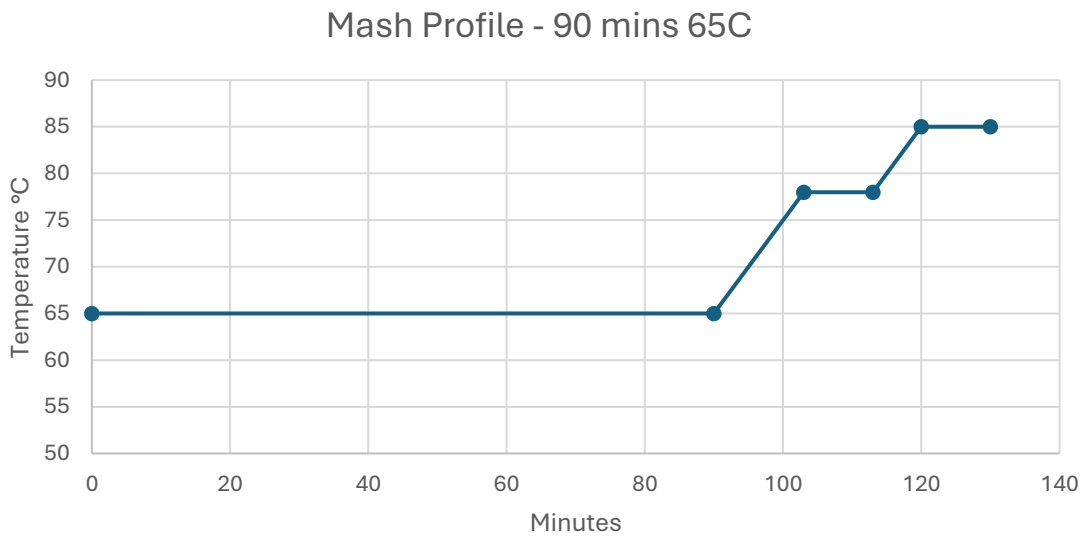
Time	Temp (Degrees C)
5	50
90	65
10	78
10	85

Enzymes

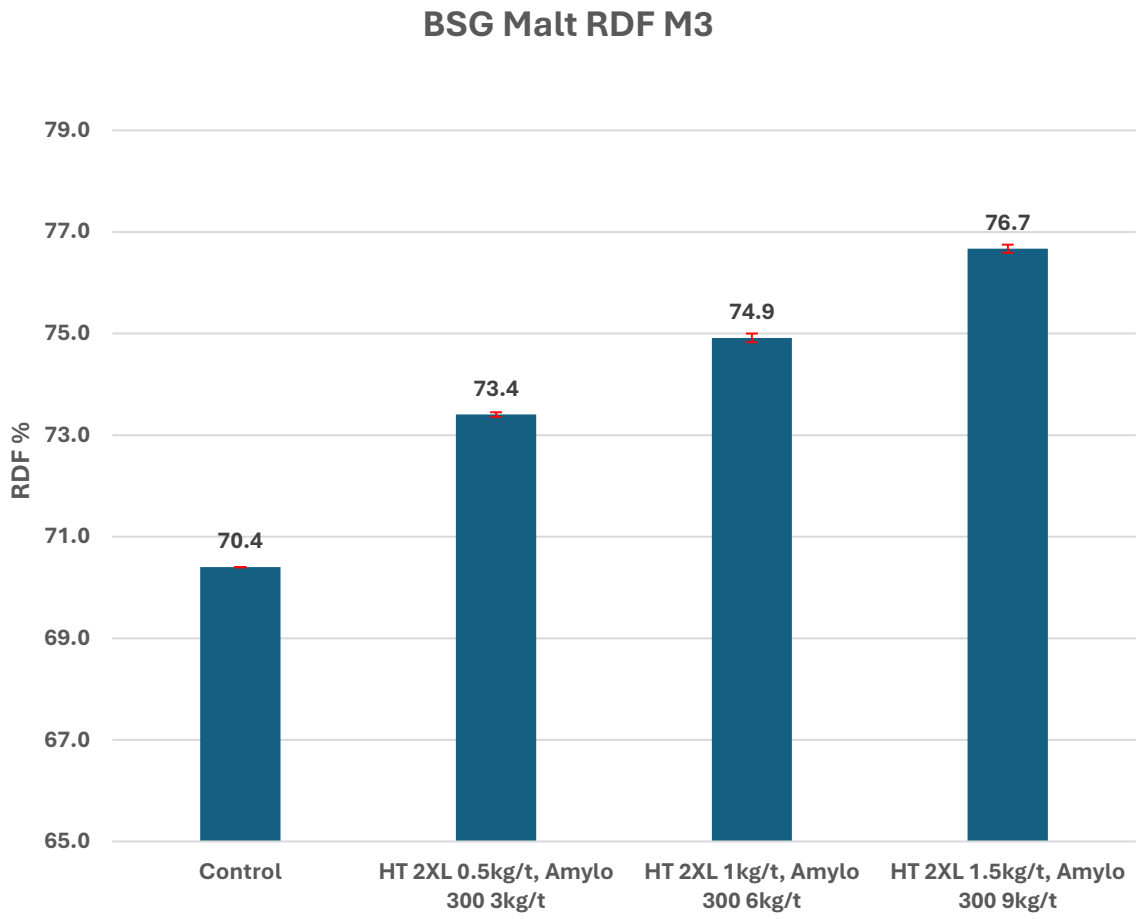
Amylo 300 @ 3, 6 and 9kg/tonne

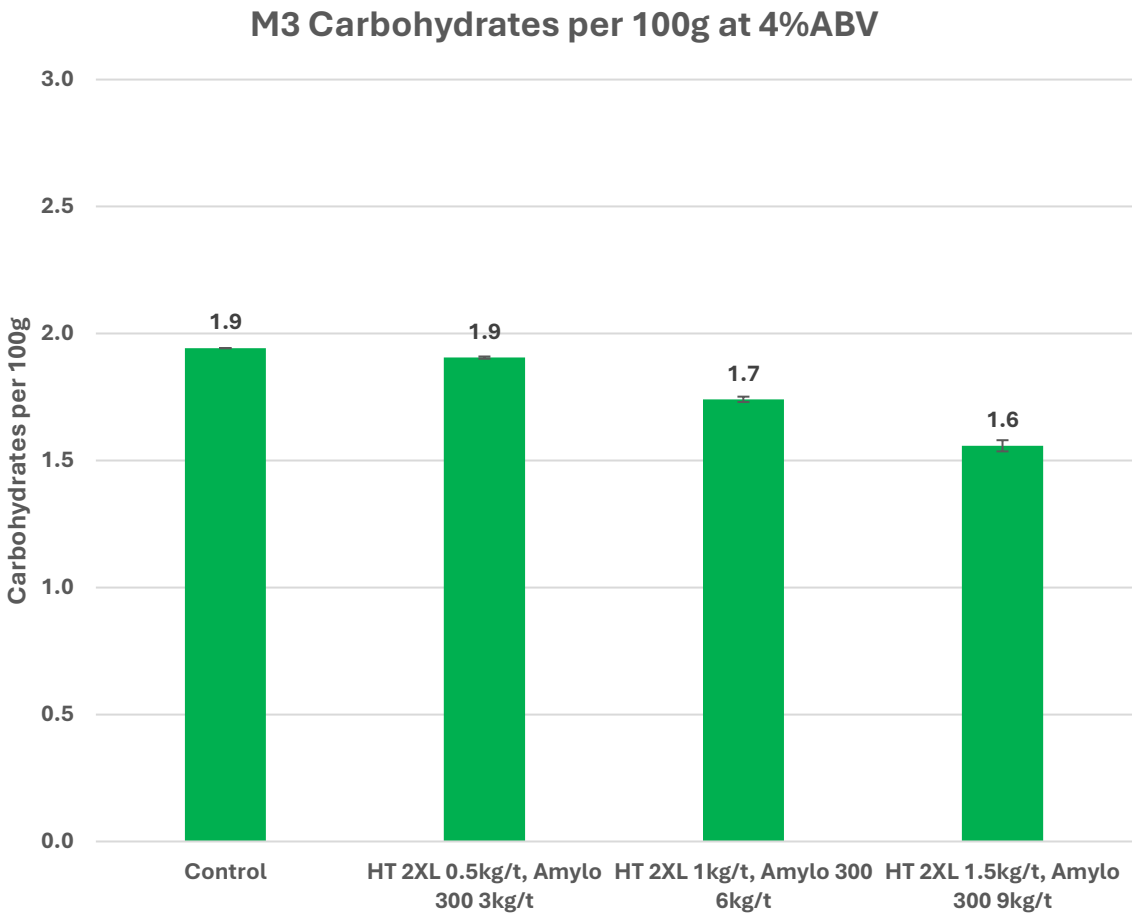
+

Hitempase 2XL @ 0.5, 1 and 1.5 kg/tonne



Mash 2:
Amylo 300 & Hitempase combination in mash





Mash Profile M3

Grist:

- Rahr Standard 2-Row

Malted Barley – 100%

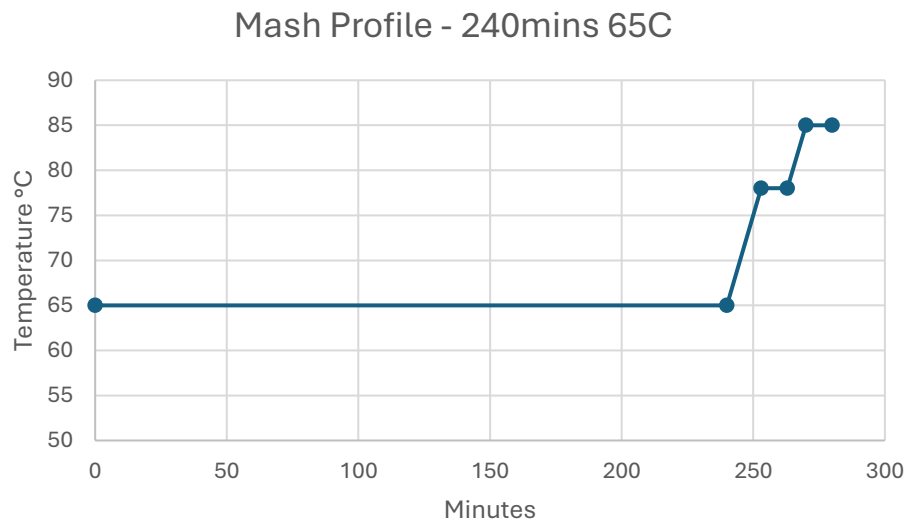
- Grist to Water ratio- 1:3

Enzymes

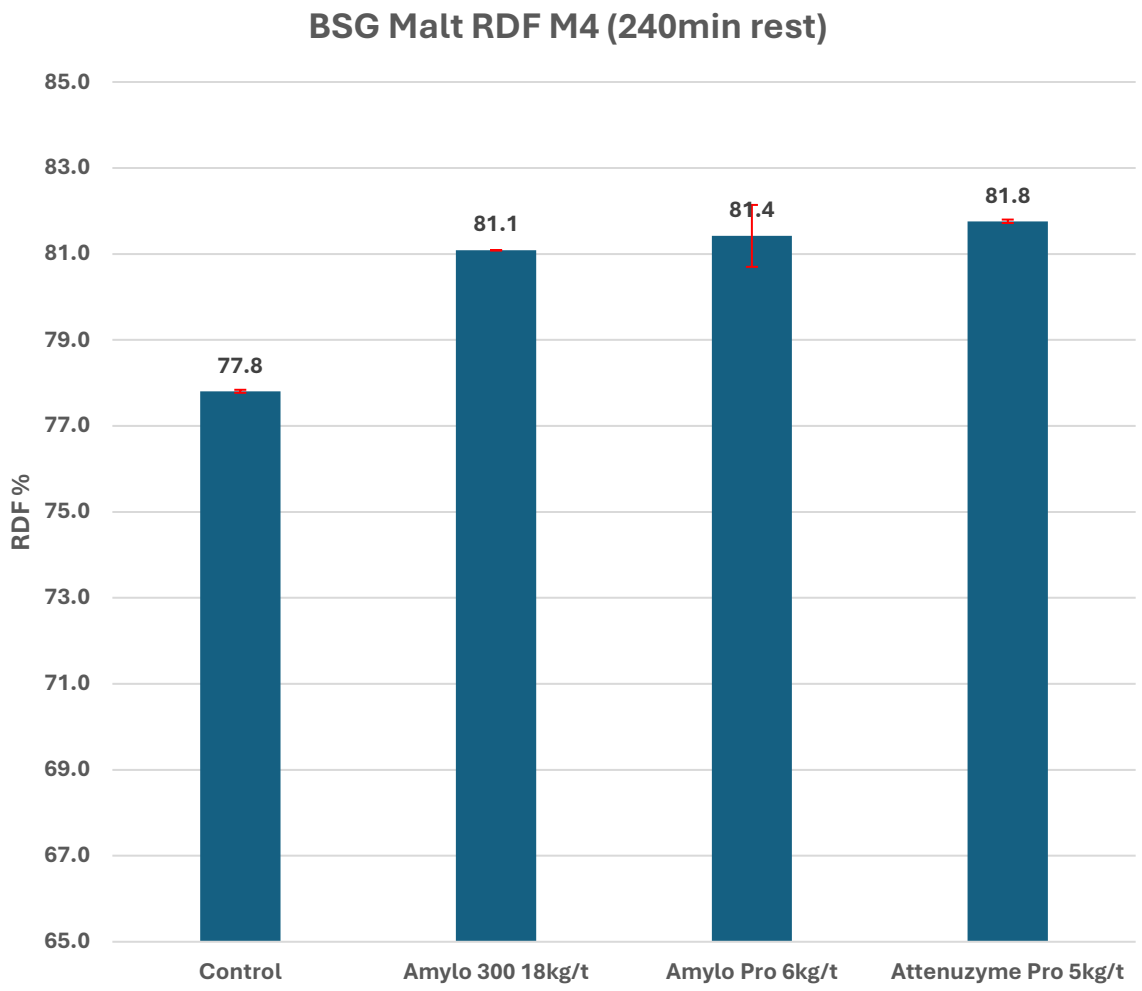
Amylo 300 and Amylo Pro

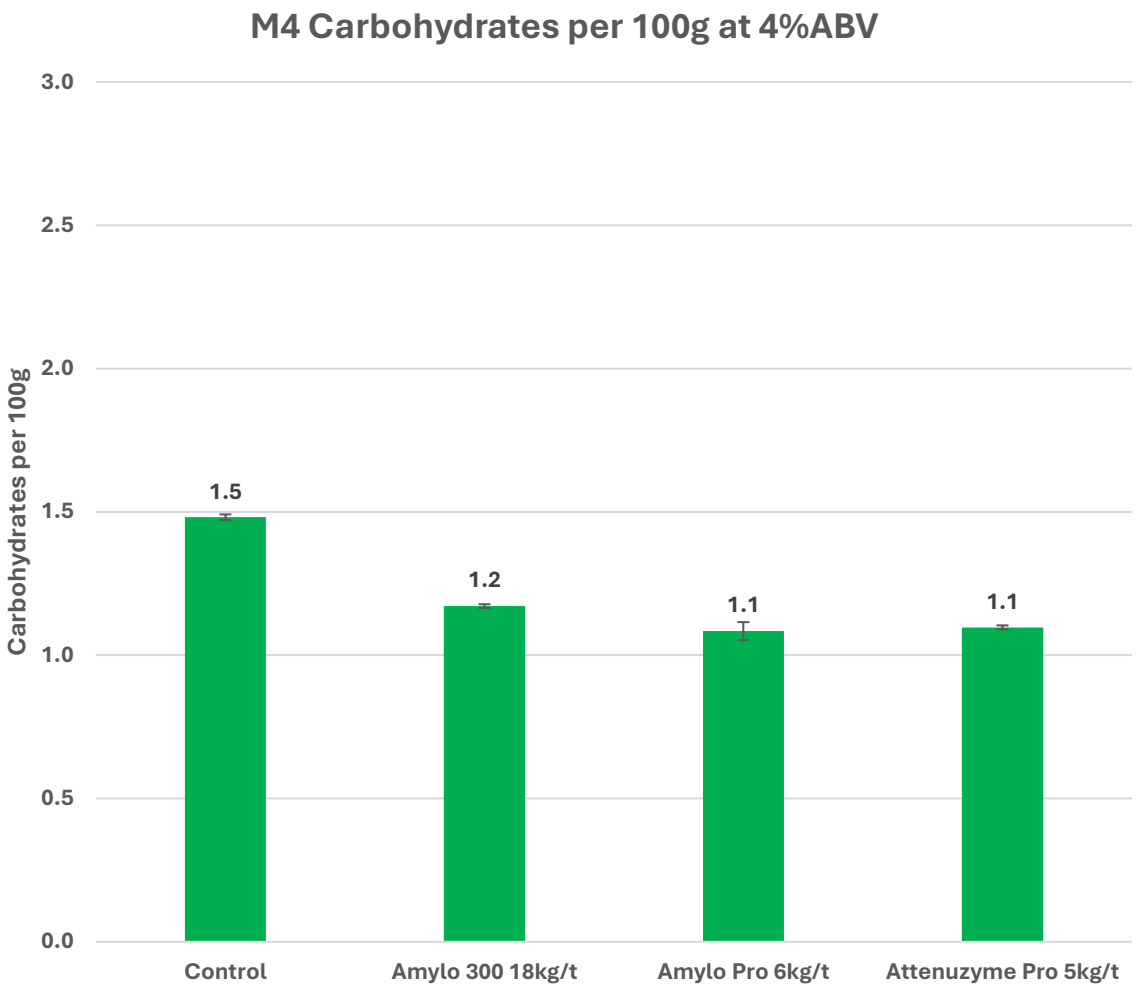
@18kg/T and 6kg/T respectively

Time (Min)	Temp (Degrees C)
5	50
240	65
10	78
10	85



Mash 3:
Amylo 300, Amylo Pro & Attenuzyme Pro – High dose rate in mash





Mash Profile M4

Grist:

- Rahr Standard 2-Row

Malted Barley – 100%

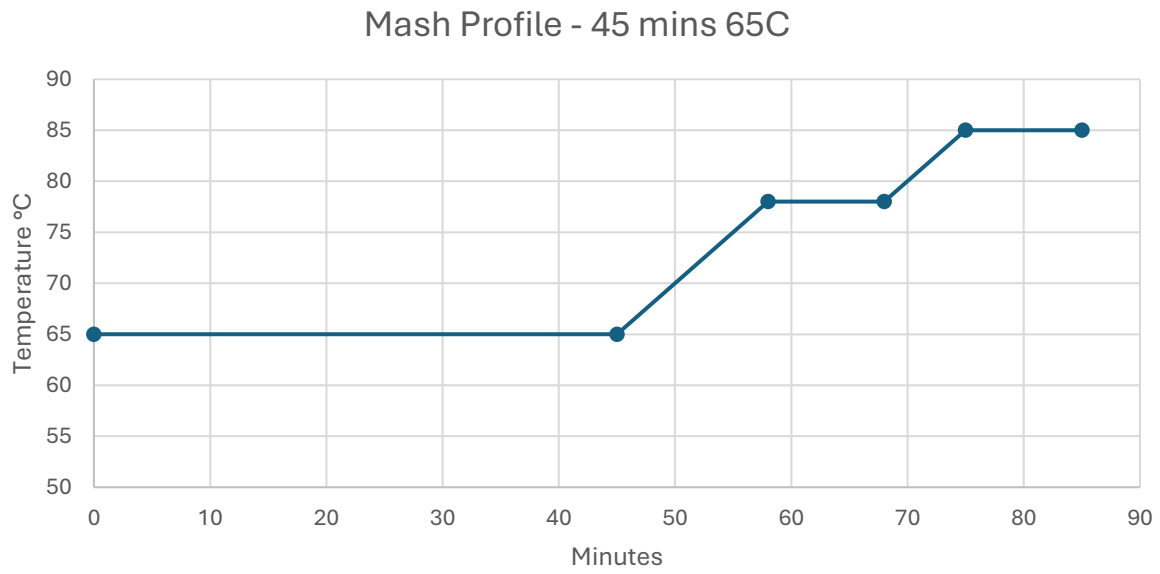
- Grist to Water ratio- 1:3

Enzymes added in fermenter

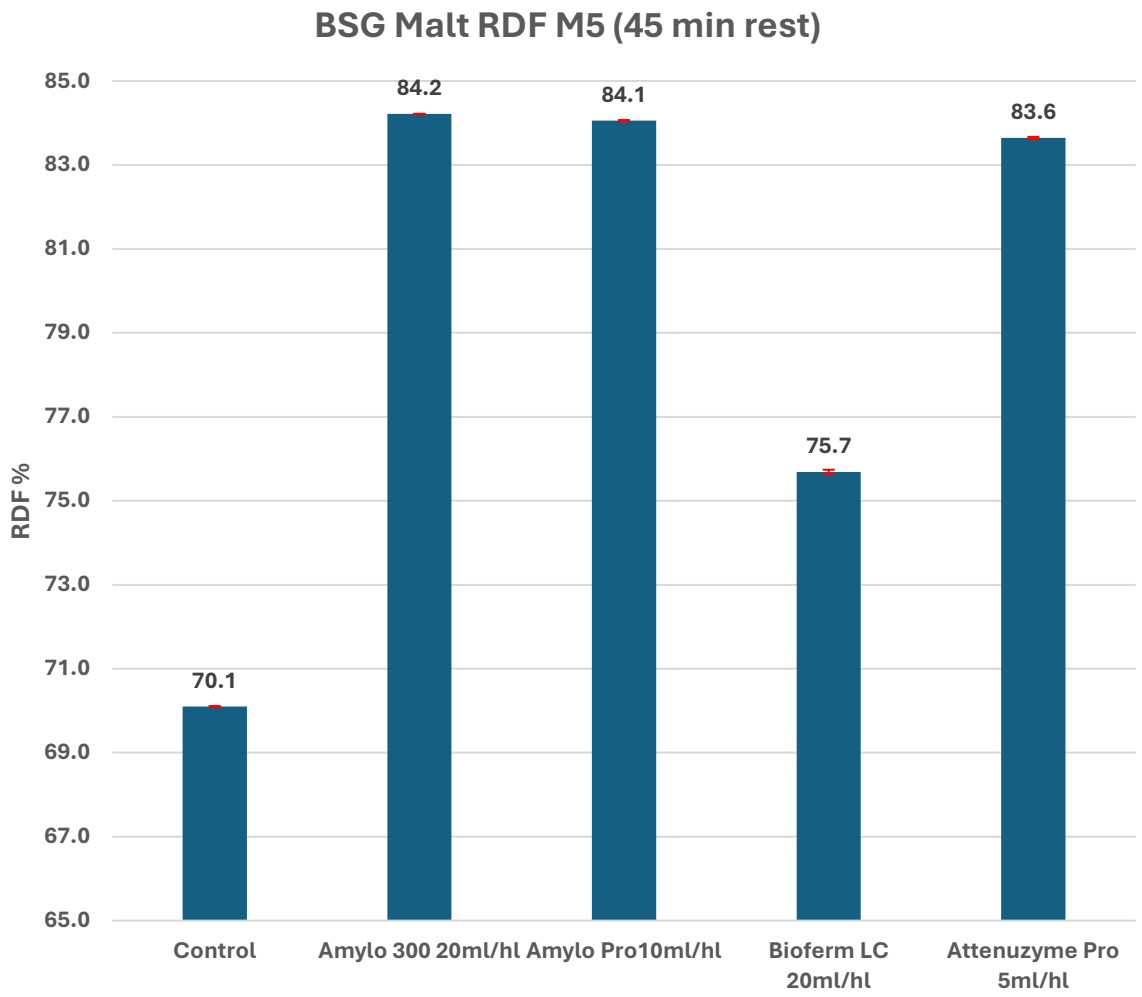
Amylo 300

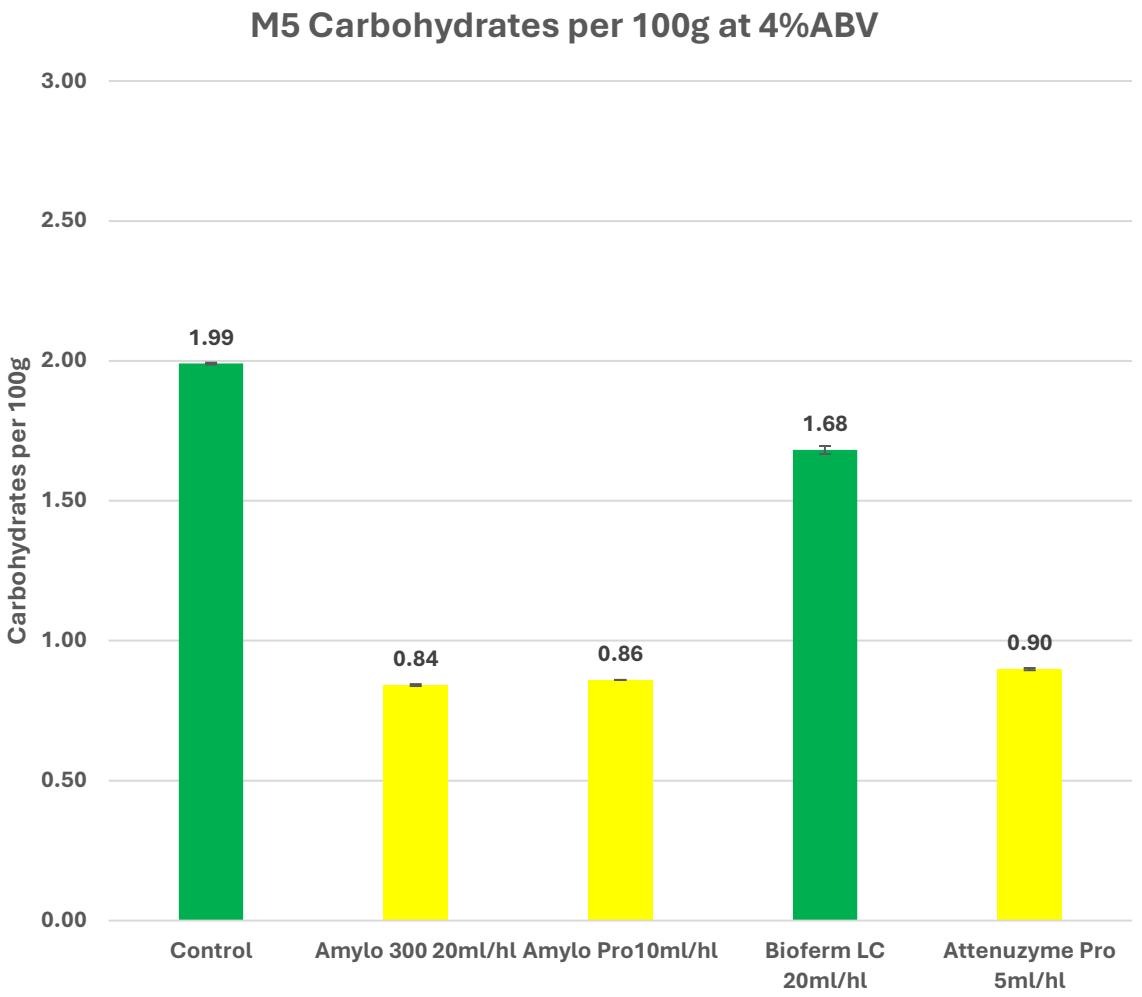
Amylo Pro

Time	Temp (Degrees C)
5	50
45	65
10	78
10	85



Mash 4:
Amylo 300, Amylo Pro, Bioferm LC & Attenuzyme Pro in Fermentation





Conclusions

- A 4% increase in RDF can be achieved with ‘modest’ Amylo 300 doses of 6-9kg/tonne in the mash
- A 9.5% RDF increase can be achieved when Hitempase 2XL is combined with Amylo 300 in the mash
- More significant RDF increases of 16%, which is close to the ultra-low carb threshold of 1g/100g, can be achieved when the enzyme dose rate is increased and the 65C step is extended
- Addition of high dosages of enzymes into the fermenter is the most effective way to increase RDF and get below the ultra-low threshold of 1g/100g carbohydrates, but there are key factors to consider

Pros and cons, mash Vs fermenter additions

Mash Addition

Pro
- De-activated in boiling step
- No real change to the process

Con
- High dose rates
- Mash times can be longer – reduced capacity
- Long mash times can also impact flavour – oxidation prone

Fermenter Addition

Pro
- Higher RDF lower carbohydrate possible
- Lower dose rates

Con
- Enzymes can hydrolyse any remaining dextrin
- If dextrin is hydrolysed after packaging – can cause increased sweetness
- If any live yeast present – can cause over carbonation

NO & LOW ALCOHOL BEVERAGES

Methods for Producing Non-Alcoholic Beers

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ALCOHOL REMOVAL (POST-FERMENTATION)

Vacuum distillation, membrane filtration, spinning cone

PROS: Starts with a fully fermented, quality beer, and then removes alcohol, largely leaving the flavor compounds intact.

CONS: Expensive, requires significant capital investment and equipment.

LOW ALCOHOL YEAST & MALTOSE-NEGATIVE YEAST

Alcohol naturally stays low due to the strain of yeast

PROS: Predictable results, limited capital investment for equipment.

CONS: Limited flavor development during fermentation. Can be overly sweet and worty.

ARRESTED/COLD FERMENTATION

Yeast activity halted to limit alcohol production

PROS: Inexpensive, limited capital investment.

CONS: Flavor compounds do not fully mature, Beer is overly sweet and worty.

Non-Alcoholic Cocktails (Mocktails) & Spirits

- Global Market Size: $6.5B - $9B
- CAGR of 6-9%
  - Growth is ahead of soft drinks
  - Growth is ahead of most alcoholic RTD segments

- **<u>Product Development:</u>**
  - Made similarly to a carbonated soft drink
  - **Typical Ingredients:** Sugar, acid, buffer, flavors, cloud, potentially juice
  - **Example:** Mojito – sucrose, citric acid, sodium citrate, lime juice, natural flavors
  - **Preservation:** chemical preservative or pasteurization
  - **Desire & Challenge:** To have the same appearance, aroma, and taste experience as an elevated, alcoholic cocktail or spirit
    - Tends to lead to an over reliance on capsaicin as a method of getting an alcoholic 'burn' in the product

Taste Challenges with No & Low Alcohol Beverages

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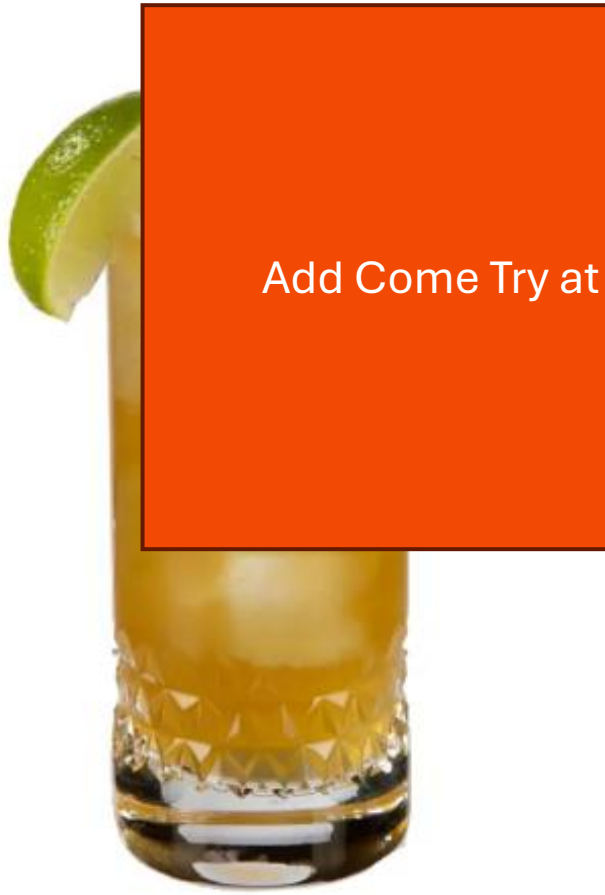
- **<u>NA BEER</u>**
- Challenges can be specific to the methods implemented
  - **Potential Solutions:** Taste Technology
    - **Thin, watery product:** Kerry Tastesense Mouthfeel
    - **Lack of alcoholic bite:** Kerry Tastesense Sensations
    - **Sour taste:** Kerry Tastesense Maskers
    - **Lack of aroma:** Kerry flavors & extracts, addition of hops and hop extracts
    - **Lack of bitterness:** Kerry bitter flavors or hop/alpha acid addition
- **<u>NA Cocktails</u>**
- Challenges tend to center around recreating alcohol burn, mouthfeel, and authentic aroma/taste
  - **Potential Solutions:** Taste Technology
    - **Thin, watery product:** Kerry Tastesense Mouthfeel
    - **Lack of alcoholic bite:** Kerry Tastesense Sensations
    - **Sweet enhancing w/o added calories:** Kerry Tastesense Sweet
    - **Lack of authentic spirit aroma/taste:** Kerry flavors & extracts

Experience it for Yourself!

- **Non-Alcoholic Dark & Stormy at Kerry/BSG booth**

  - **Option #1** – Sugar, citric acid, sodium citrate, lime juice concentrate, ginger extract, lime extract (BSG), Tastesense Sweet (BSG), neutral cloud emulsion, colors

  - **Option #2** - Sugar, citric acid, sodium citrate, lime juice concentrate, ginger extract, lime extract(BSG), Tastesense Sweet (BSG), ***Tastesense Sensations, Tastesense Mouthfeel, Natural Rum Flavor***, neutral cloud emulsion, colors



Hazy IPAs

Hazy IPAs

Adjuncts used in Hazy IPAs

Wheat – soft creamy mouthfeel, foam stability
Barley – good for body, silky mouthfeel and stable haze
Oats – creamy thick body and juicy haze

These adjuncts all add viscosity and increase mouthfeel

Bioglucanase can help your brew day go smoothly, keep your juicy big body hazy IPA and make sure you don't get a stuck mash!

Hazy IPAs

Pentosan (%)	B-glucan (%)	Lipid (%)	Protein (%)	Extract dry (%)	Gelatinization Temperature (°C)	Starch (%)	Cereal
3-7	0.1-2.8	1.7-3.1	9-12	88-92	61-62	50-65	Malt
3-15	3-6	1.8-3.5	7.5-12	75-80	50-74	50-70	Barley
5-8	0.2-0.5	1.5-3.5	8-17	75-80	52-66	60-70	Wheat
1-10	3-8	3-11	8-18	45-50	55-62	40-63	Oats

- When using adjuncts that have high β-glucan and pentosan content even small amounts in the grist bill can have large effects on brewhouse performance
- Bioglucanase helps to increase extract, improve mash filtration and processing avoiding stuck mash problems
- Bioglucanase can help to optimise rice hull requirements with filtration improvements

QUESTIONS?