KU LEUVEN GENT

# Adapted mashing to reduce sugar production for NABLAB

Dr. ing. Gert De Rouck

More awareness of alcohol and health – healthier lifestyle
Stronger regulation on zero-tolerance when driving



GUINNESS
DRAUGHT
0.0
Corona Cero
PERONI
0.0%
BECK'S
HEALTHY LIFESTYLE
DROP BEAR
BEER CO.
FLAT TIRE
BIG DROP BREWING CO.
REEF POINT CRAFT LAGER
ALCOHOL-FREE
0% Radler
AMSTEL
0,0%

# How to produce NABLAB beers

# Different options for NABLAB production

**Brewhouse**

- **STANDARD MASH** — standard mashing scheme
- **HIGH TEMP MASH** — adapted mashing scheme for low fermentable sugars wort

**Fermentation**

- **STANDARD FERMENTATION** — high ABV
- **COLD CONTACT / ARRESTED FERM.** — 1-3 days at 1-4 °C OR fast crash cooling
- **MALTOSE NEGATIVE YEAST**

**Post treatment**

- **DISTILLATION**

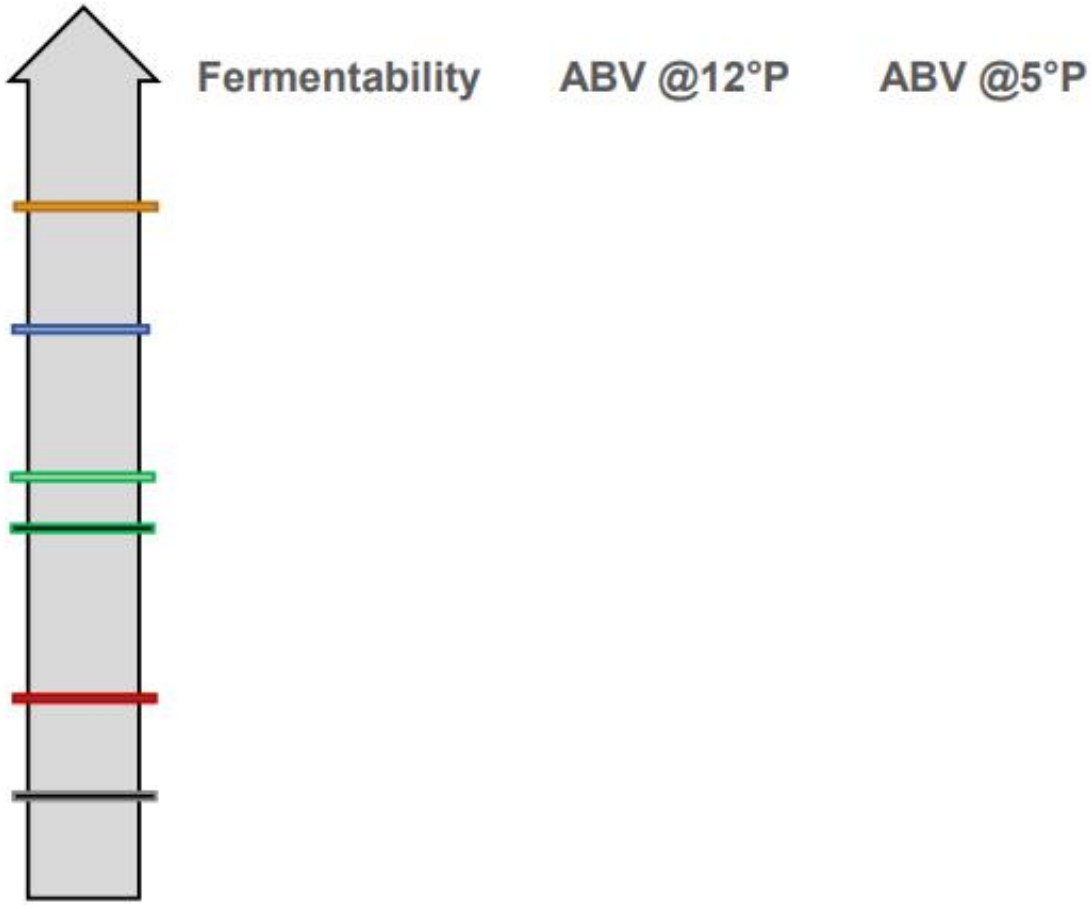
- **MEMBRANES**

- **NONE**
- **DILUTION**

**0.0 % ABV**

**< 0.5 % ABV**
only pasteurizer required

# Method comparison



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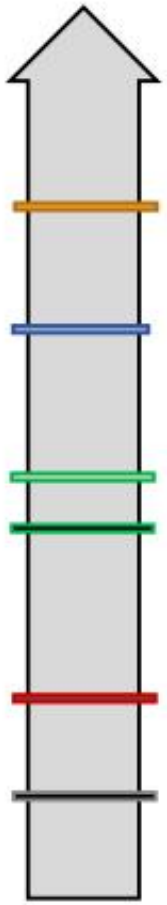


| | Fermentability | ABV @12°P | ABV @5°P |
|---|---|---|---|
| Regular wort | 70 % | 5 % | 2 % |
| Ultra-fast ramping | 60 % | 4.2 % | 1.6 % |
| Low temp mash | 45 % | 3.2 % | 1.3 % |
| High temp mash | 40 % | 2.8 % | 1.1 % |
| Maltose negative yeast | 15 % | 1 % | 0.4 % |
| Cold contact | 1-10 % | 0.5 % | 0.2 % |

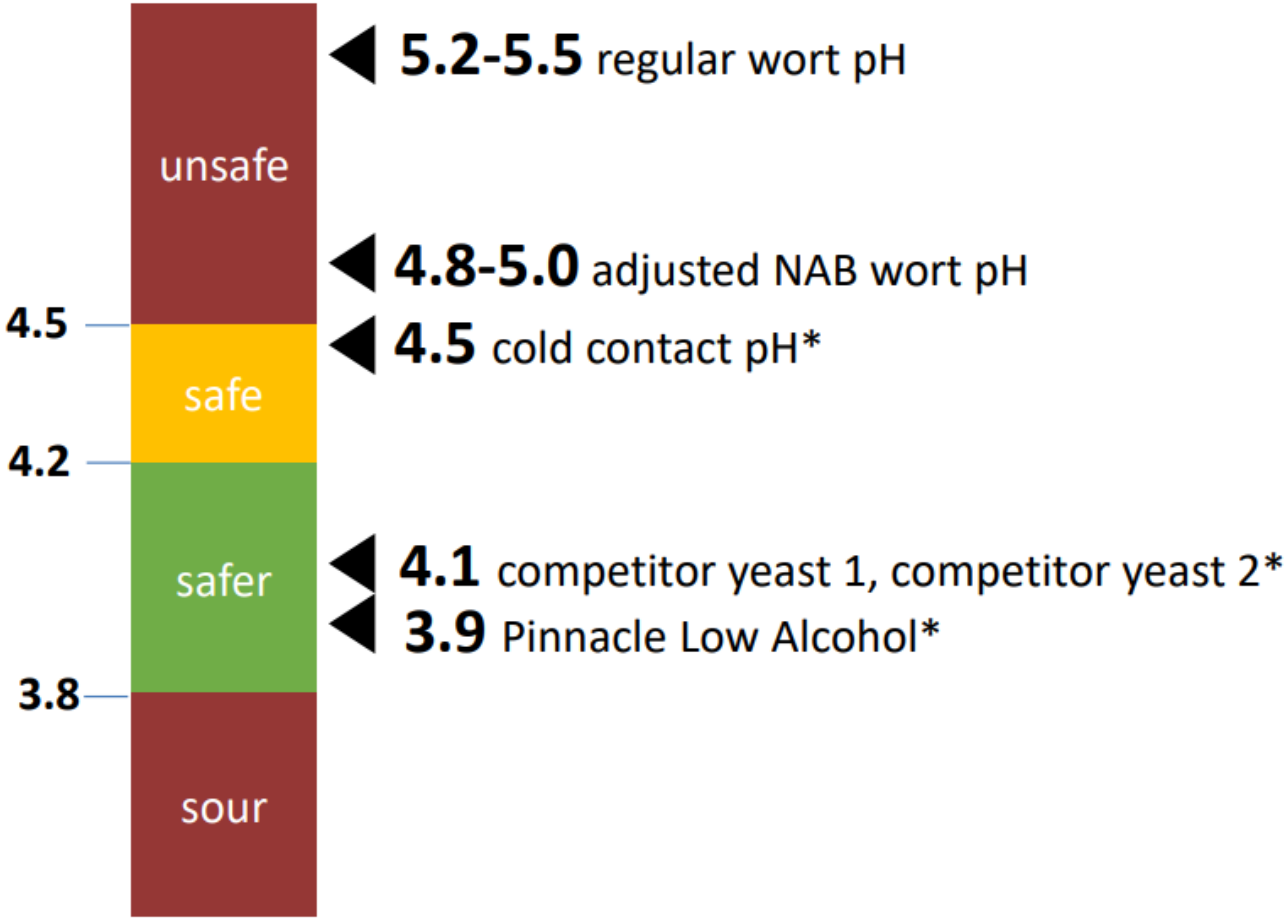
Still needs dilution
=> very watery !

remove worty-grainy
drop pH • no off-flavours

Very worty • low pH drop

# Low pH is crucial for microbial stability

Pasteurization ≠ sterilization
Low pH and pasteurization work hand in hand




Recommendation is to pre-acidify the wort
The yeast will do ( a bit) the rest

* from wort with pH 4.8

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# Maltose negative yeasts


POF + => slightly phenolic


POF - => neurtal


For IPA


POF - => neutral
Bigger pH-drop

## Ferments only glucose

⇒Residual maltose / triose => SWEET

⇒Limited to °8 P to be <0.5%ABV => WATERY

# Adapted mashing to reduce sugar content

Aiming at 12°P Original Extract
But lower in glucose & maltose

- Effect of mashing-in temperature
- Effect of milling (differences between lautertun and thinbed filter operations)
- Effect of malt:water ratio (differences between lautertun and thinbed filter operations)

- Mashing-in at 63°C for 20 min – 1°C/min to 80°C – 1 min or to $I_2$-normal
- Mashing-in at 72°C for 20 min – 1°C/min to 80°C – 1 min or to $I_2$-normal
- Mashing-in at 80°C for 20 min – 1 min or to $I_2$-normal

  20 min mashing-in to mimick the industrial reality of mixing malt & water

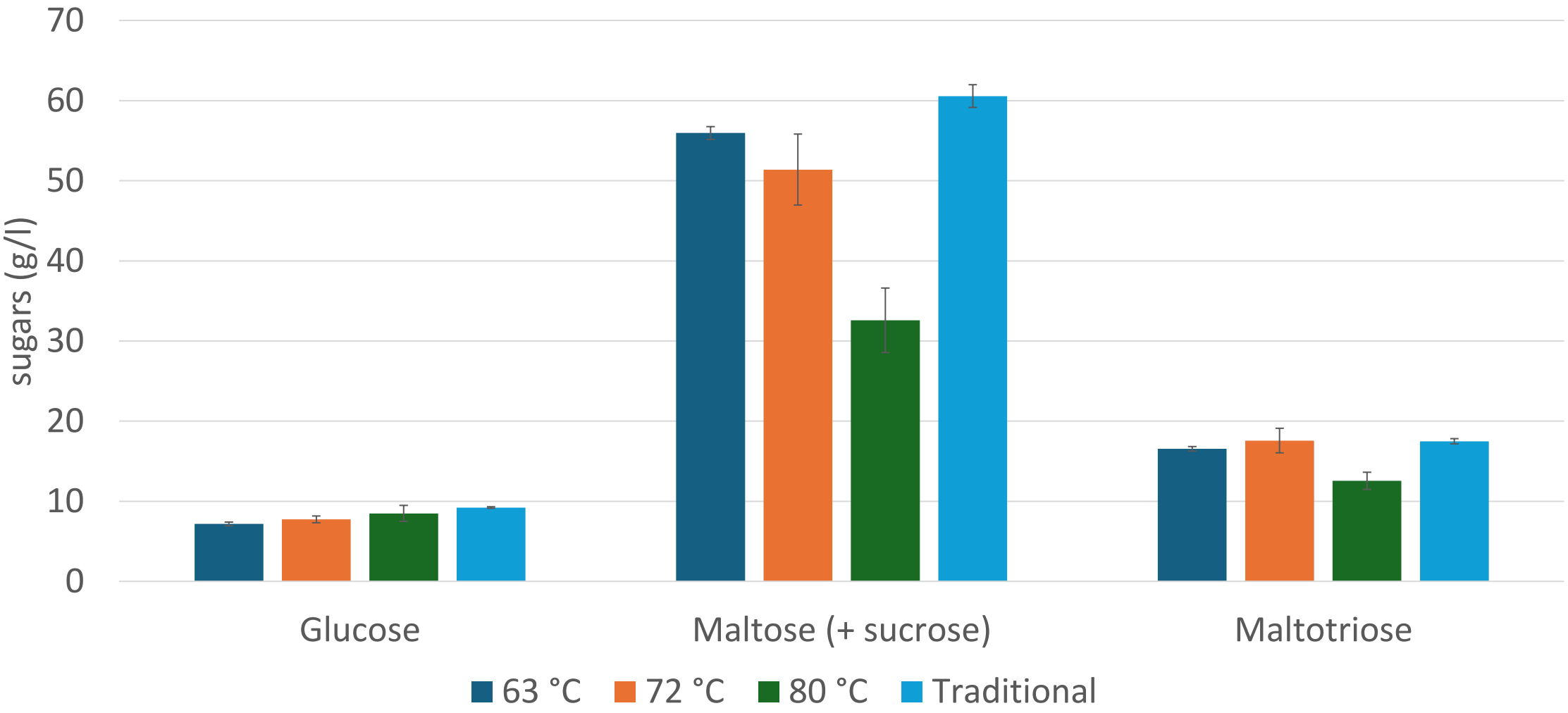
- Mashing-in at 63°C for 20 min – 63°C for 30 min – 1°C/min to 72°C – 72°C for 20 min – 1°C/min to 78°C – 78°C for 1 min (= reference mashing)

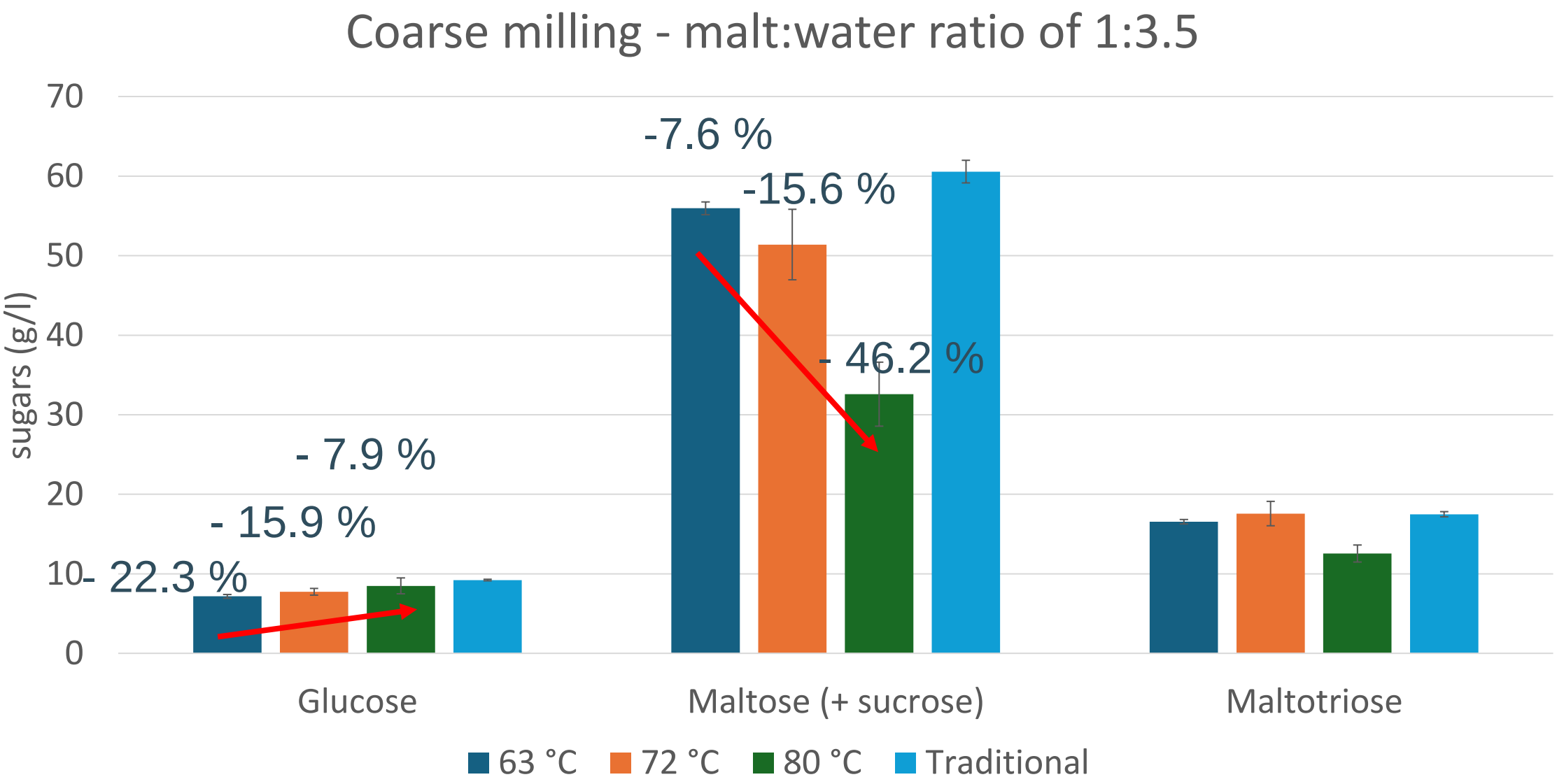
# Sugar analyses (via HPLC-RI)

Brewing trials in triplicate

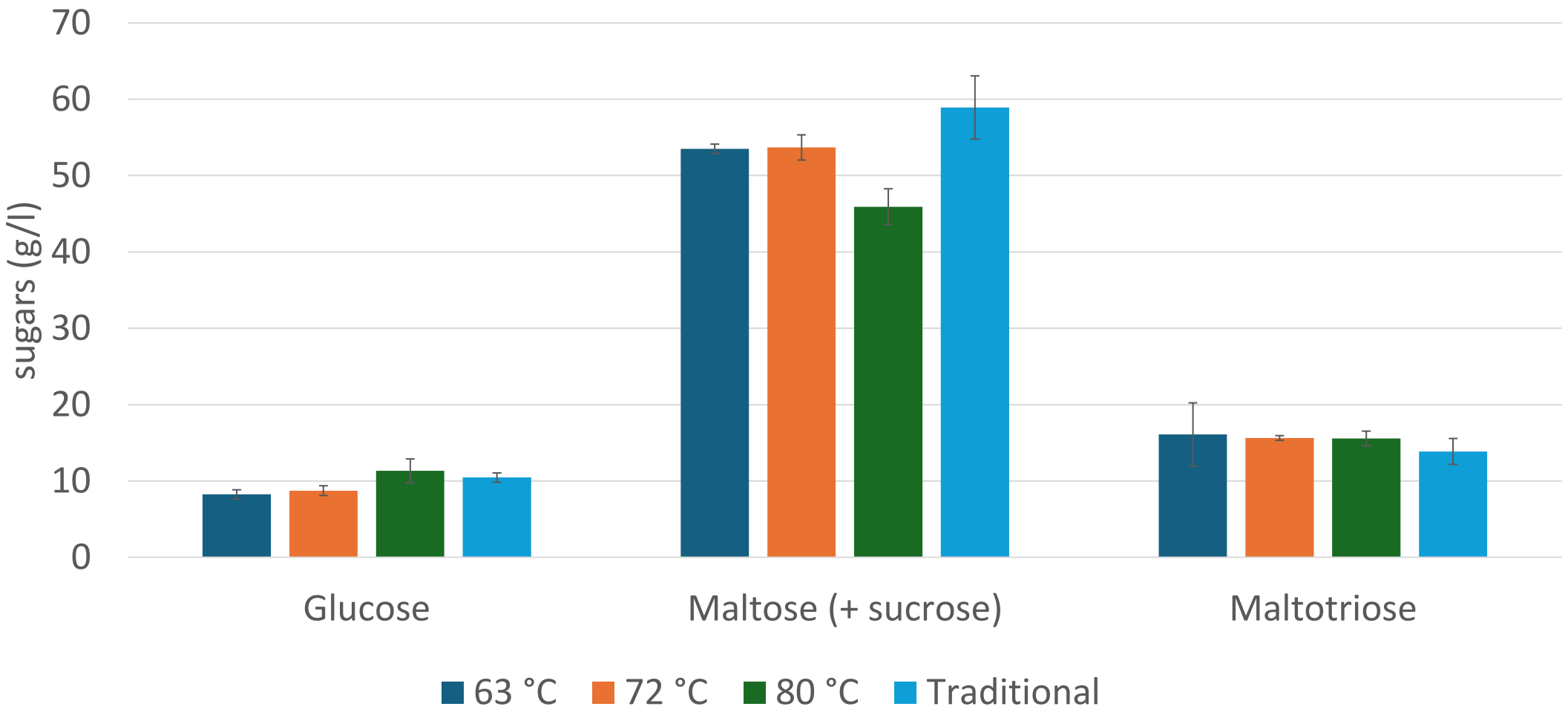
| Wort | Malt:water ratio | Extract (°P) | Sugar Content (g/l) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Glucose | | Maltose (+ sucrose) | | Maltotriose | | Σsugars | |
| | | | average | st dev | average | st dev | average | st dev | average | st dev |
| **63 °C** | 2.5 | 12 | 8.24 | 0.22 | 53.51 | 1.13 | 16.10 | 0.69 | 77.85 | 1.53 |
| | 3.5 | 12 | 7.16 | 0.24 | 55.96 | 0.81 | 16.54 | 0.28 | 79.67 | 1.22 |
| **72 °C** | 2.5 | 12 | 8.73 | 0.63 | 53.69 | 1.64 | 15.63 | 0.32 | 78.05 | 2.21 |
| | 3.5 | 12 | 7.74 | 0.42 | 51.39 | 4.43 | 17.57 | 1.54 | 76.70 | 6.36 |
| **80 °C** | 2.5 | 12 | 11.32 | 1.58 | 45.91 | 2.35 | 15.57 | 0.96 | 72.80 | 3.65 |
| | 3.5 | 12 | 8.48 | 0.99 | 32.59 | 4.03 | 12.55 | 1.08 | 53.62 | 6.06 |
| **Traditional** | 2.5 | 12 | 10.45 | 0.62 | 58.91 | 4.14 | 13.87 | 1.71 | 83.23 | 4.18 |
| | 3.5 | 12 | 9.21 | 0.09 | 60.57 | 1.42 | 17.48 | 0.32 | 87.27 | 1.72 |

# Coarse milling - malt:water ratio of 1:3.5




Coarse milling - malt:water ratio of 1:3.5
sugars (g/l)
70
60
50
40
30
20
10
0
- 22.3 %
- 15.9 %
- 7.9 %
-7.6 %
-15.6 %
- 46.2 %
Glucose
Maltose (+ sucrose)
Maltotriose
63 °C
72 °C
80 °C
Traditional

# Fine milling - malt:water ratio of 1:2.5



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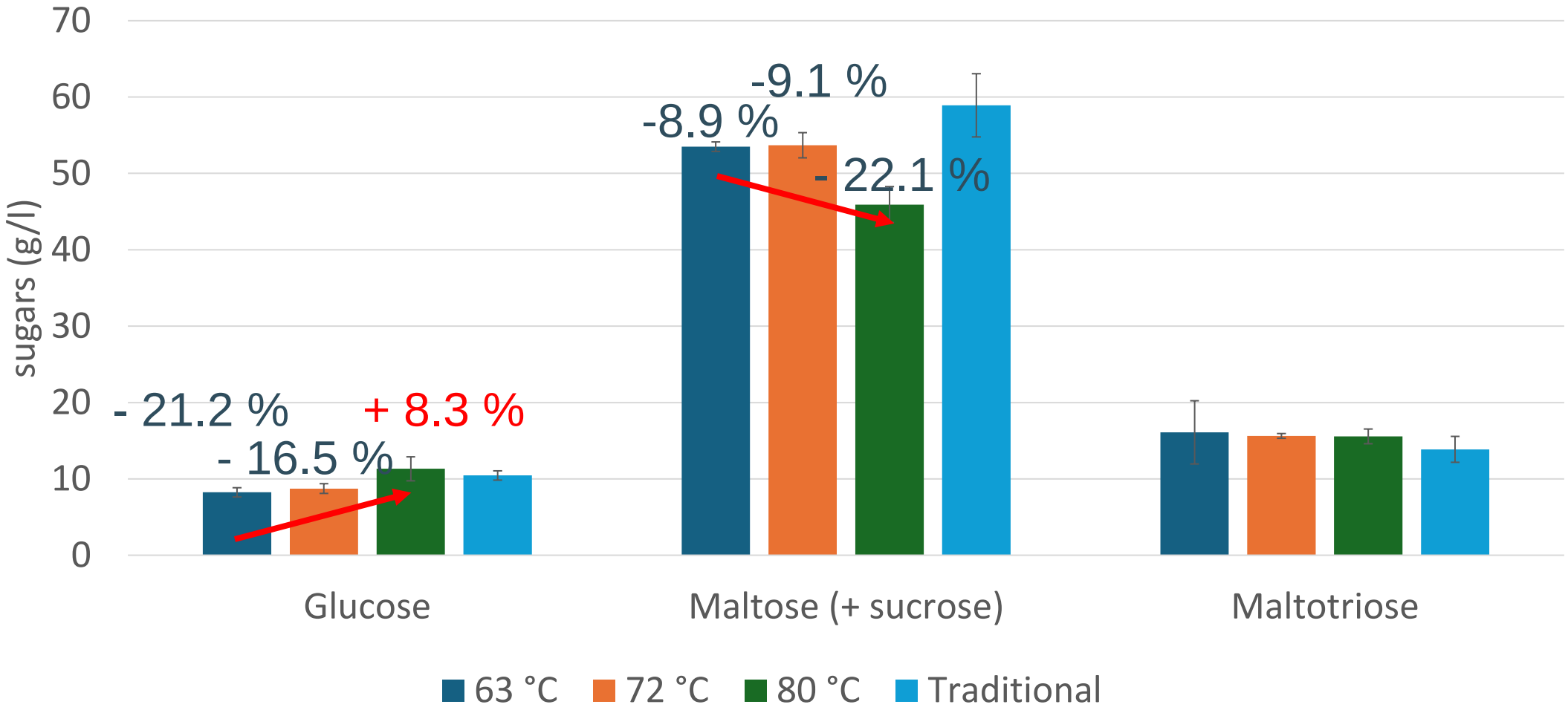

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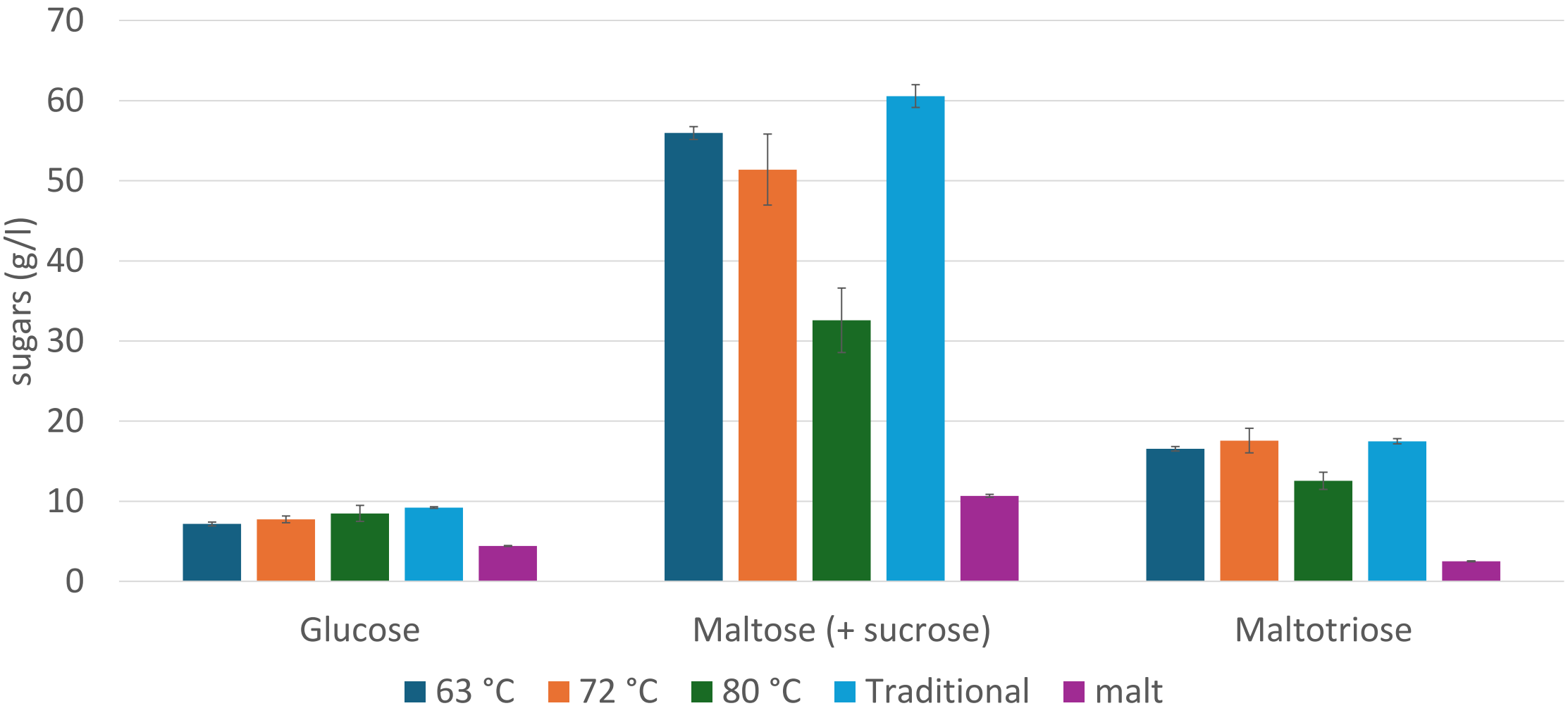

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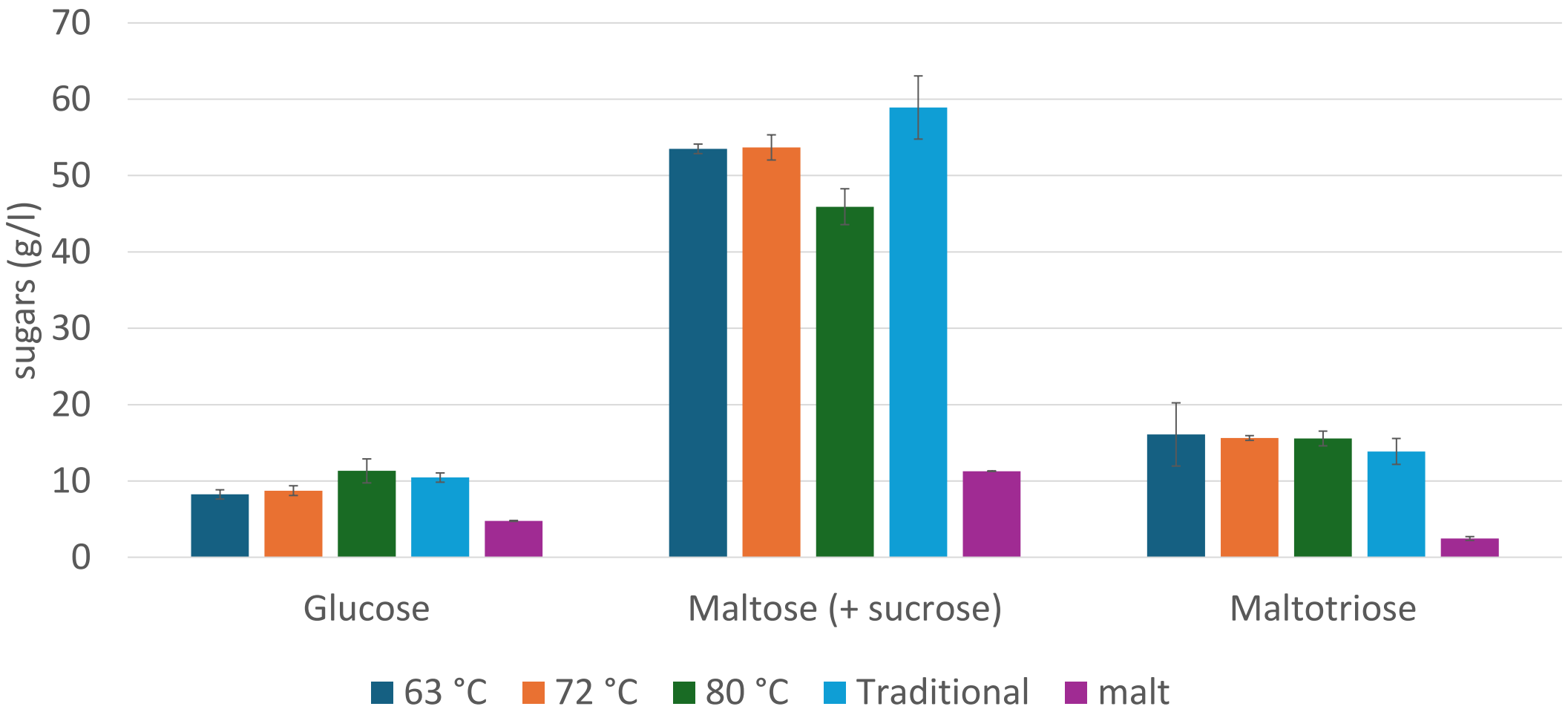

# Alcohol potential

Aiming at 4.5 %ABV

| Wort | Malt:water ratio | Extract | Glucose | Alcohol | Extract | Maltose |
|---|---|---|---|---|---|---|
| | | °P | g/l | %ABV | °P | g/l |
| 63 °C | 2.5 | 12 | 8.24 | 0.53 | 10.1 | 45.11 |
| | 3.5 | 12 | 7.16 | 0.46 | 11.6 | 54.29 |
| 72 °C | 2.5 | 12 | 8.73 | 0.57 | 9.5 | 42.72 |
| | 3.5 | 12 | 7.74 | 0.50 | 10.8 | 46.12 |
| 80 °C | 2.5 | 12 | 11.32 | 0.73 | 7.4 | 28.17 |
| | 3.5 | 12 | 8.48 | 0.55 | 9.8 | 26.70 |
| Traditional | 2.5 | 12 | 10.45 | 0.68 | 8.0 | 39.16 |
| | 3.5 | 12 | 9.21 | 0.60 | 9.1 | 45.68 |

# In conclusion

- Malt already contributes for 10 g/l maltose and 4.5 g/l glucose (12°P wort)
- Higher mashing-in temperatures results in decreased maltose production
- This is really the case for coarse milling – thin mashes (- 46%)
- Only 22% reduction of maltose whit fine milling – thick mash => better protection of enzymes against temperature in thick mashes
- Higher mashing-in temperatures results in decreased glucose production compared to reference mashing, but only in case of coarse milling – thin mashes.
- However, the higher the mashing-in temperature, the more glucose is produced
- With fine milling – thick mash: more glucose with higher mashing-in temperatures.
- Even higher glucose levels than reference mashing (under the same conditions)

# Next steps

- Adapted malting regimes
  - Lower kilning temperatures ?
  - Less germination to reduce a & b-amylase activity
  - Other grains or # barley/malt ratio’s

- Different pH’s during mashing
- Lowering $Ca^{2+}$ during mashing