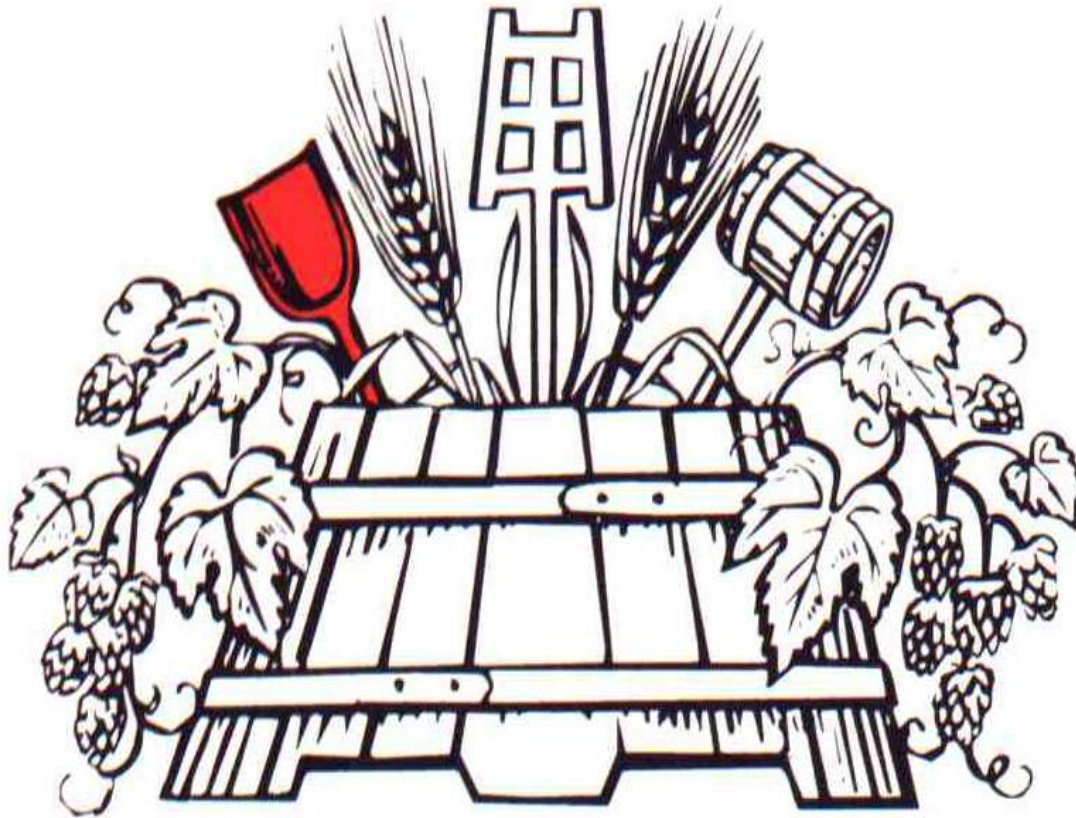


Mashing!!



What is it, exactly?

- A continuation of the starch conversion process that began in the malt house.
- Ground malt mixed with water.
- The most critical process in brewing good beer.

Milling



Water

- * Should be potable.
- * Free from iron.
- * Neutral pH.
- * Alkalinity below 100 ppm (or 50).
- * Calcium helps mash pH.
- * Chlorine free.

Mixing

- * Proper mixing ensures no clumps or dough balls.
- * Mash thickness can vary, from 2.5:1 up to 5:1 liquor to grist ratio.
- * Gentle mixing is important.
- * Avoid aeration when mixing.

Starch

- * Chains of glucose molecules.
- * Linear chains are called amylose.
- * Branched chains are called amylopectin.
- * Germination during malting breaks down proteins and exposes the starch.
- * Mashing breaks the starch into sugars, via enzymes.
- * Three steps...

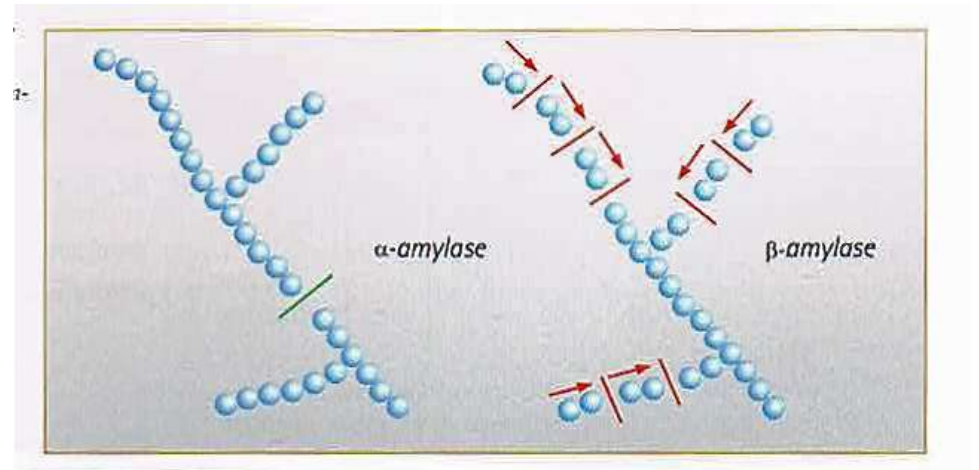
Gelatinization

Starch granules are hydrated (absorb water) and become a gel.

Enzymes cannot break down the starch until this happens.

Liquefaction

- * Reducing the viscosity of the gelatinized starch by alpha-amylase action.



Saccharification

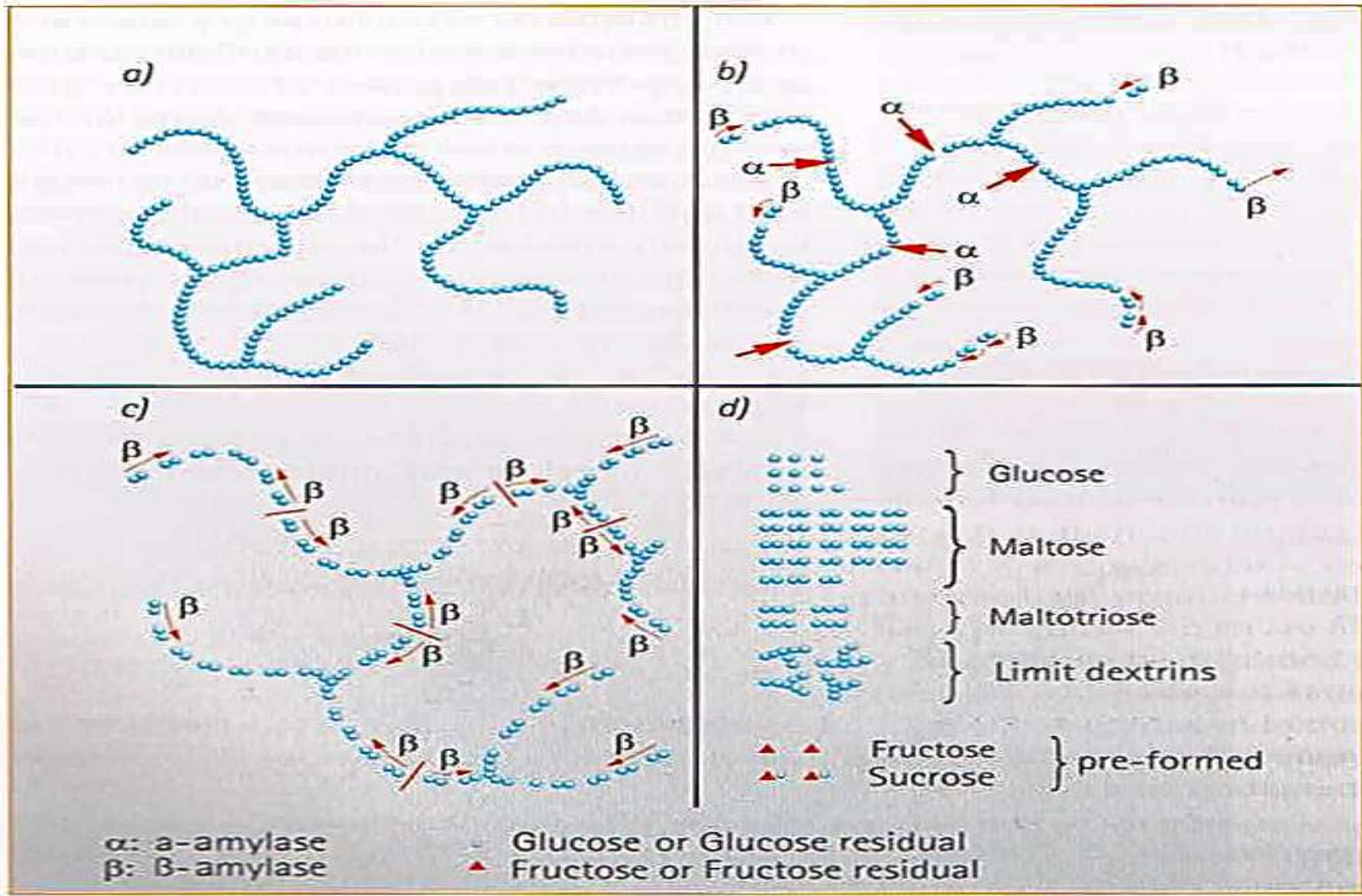


Fig. Star-duri

Alpha-amylase

- * Optimum temperature is 158-165 F.
- * Denatured at 176 F.
- * Randomly breaks complex starches.
- * Creates dextrans.

Beta-amylase

- * The main fermentable sugar maker.
- * Works from the nonreducing end of the starch chain to make maltose.
- * Optimum temperature range is 136 to 144 F.
- * Denatured above 149 F.

Infusion mashing

- * English tradition.
- * Fully modified malt required.
- * Temperatures of 148 to 156 F typical.
- * Enzymatic activity continues into the kettle.

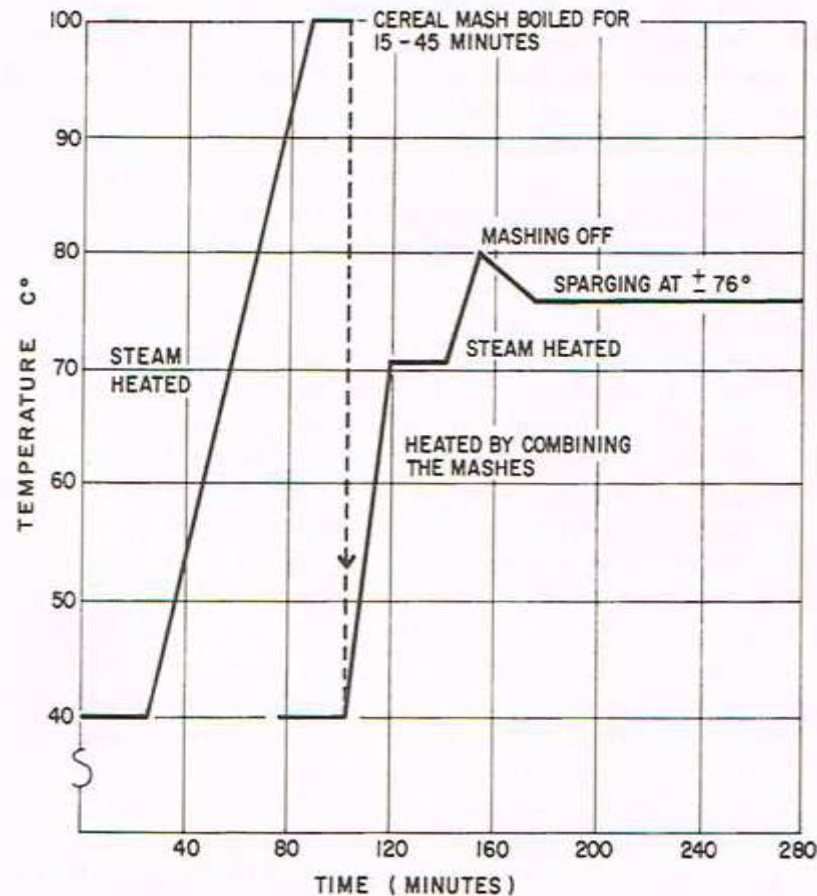
Step mashing

- * Adding heat while mixing, to control enzyme activity.
- * Example:
 - * 131 F for 15 minutes
 - * 145 F for 30 minutes
 - * 158 F for 15 minutes
 - * 170 F for 5 minutes

Decoction mashing

- * Traditionally used for undermodified malt in continental Europe.
- * 1,2 or 3 decoctions can be pulled.
- * Mash is drawn off, boiled, then added back to raise temperature.
- * Energy and time intensive.
- * Darkens wort, can add astringency.
- * Still done, especially for Bock beers.

Double (adjunct) mashing



Time-temperature curve of double mash upward infusion system.

Time-Temperature relationships of a cereal mash, malt mash and combined mash in an upward infusion system. Times and temperatures are approximate and would differ with ingredients and individual brewery practices.

Troubleshooting

Hazy beer.

Astringency.

Over or under-attenuated beer.