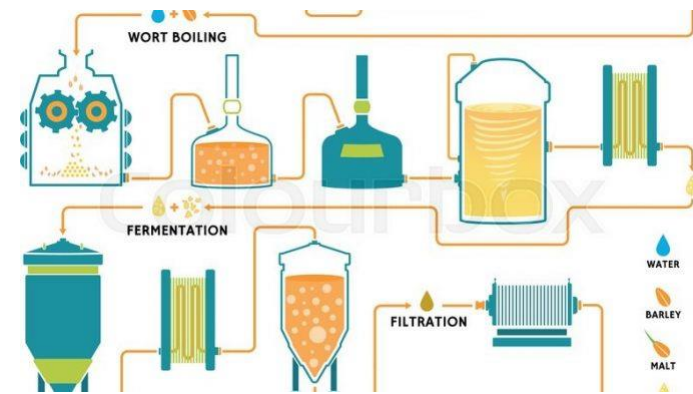


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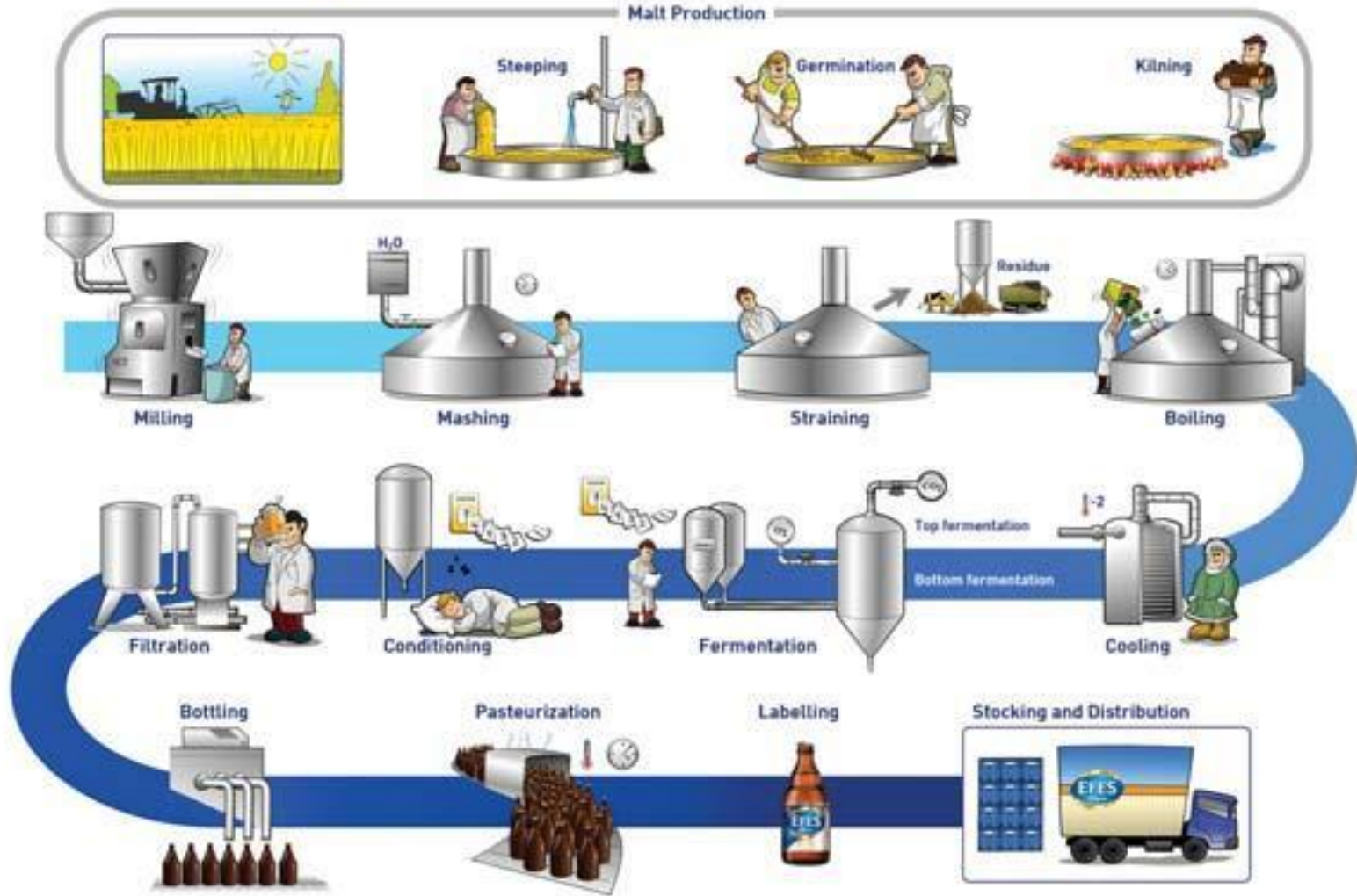
FERMENTATION TECHNOLOGY

Production of Beer-Part III





BEER PRODUCTION PROCESS



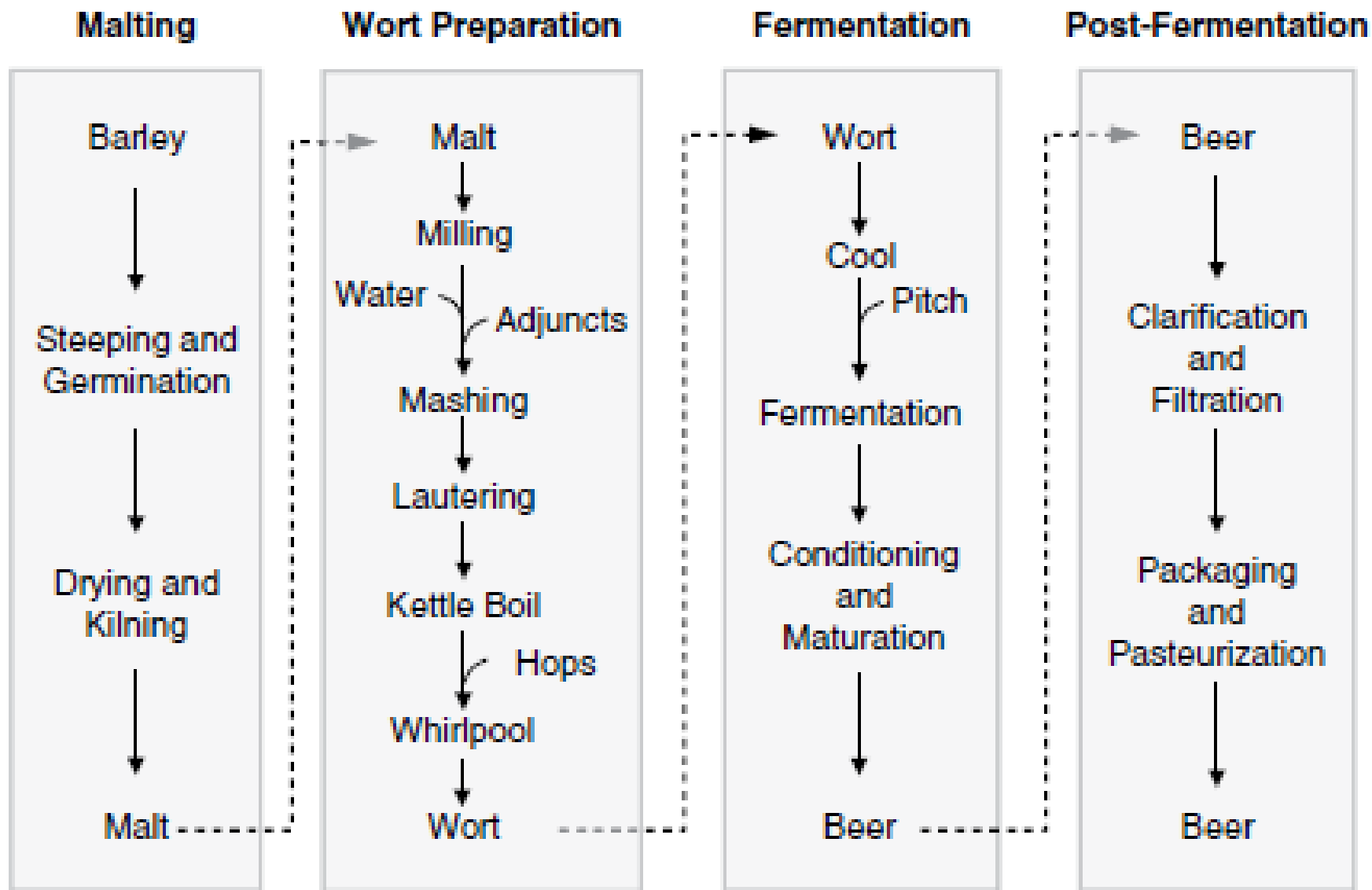
Steps in the brewing process

MALT

Steeping, Germination, Kilning

BEER

Milling, Mashing, Straining/Lautering, Boiling, Addition of hops, Cooling, Fermentation, Conditioning, Filtration, Bottling, Pasteurization



Mashing and Wort Preparation

- 1. Milling of Malt**
- 2. Mashing**
- 3. Lautering**
- 4. Boiling of wort with hops**
- 5. Separating out the hot trub (Whirlpooling)**

Mash Separation Step (Straining/Lautering)

- ▶ At the end of mashing, husks and other insoluble materials are removed from the wort in two steps.
 1. First, the wort is separated from the solids.
 2. Second, the solids themselves are freed of any further extractable material by washing or sparging with hot water.
- ▶ **Lautering** is a process in brewing beer in which the mash is separated into two forms; **the residual grain and the sugary clear liquid known as wort.**
- ▶ After the mashing step, the insoluble material in the mash liquid is then separated by one of several means. This is an important step because the mash still contains grain solids and insoluble proteins, carbohydrates, and other materials. In addition, trapped within the mash solids is a reasonable amount of soluble materials, including fermentable sugars that would otherwise be discarded with the spent grains.

Mash Separation Step

- ▶ The sparging (or washing with hot water) of the mash solids is done with water at about 80° C and is continued till the extraction is deemed complete.
- ▶ The material which is left after sparging is known as «spent grain» and is used as animal feed.

Wort

- ▶ Ultimately, the liquid material or filtrate that is collected at the end of the mash separation step is called “**wort**”.
- ▶ Since it is the wort that will be the growth medium for the yeast and which will ultimately become beer, its composition is very important.

Composition of Wort

Carbohydrate fraction:

- ▶ The main component of wort (other than water) is the carbohydrate fraction (90%).
- ▶ Most (75%) of the carbohydrates are in the form of small, **fermentable sugars**, including maltose, glucose, and maltotriose. If adjuncts were added, fructose and sucrose may also be present.
- ▶ The rest, about 25% of the total carbohydrate fraction, are longer, **non-fermentable oligosaccharides** that include dextrins (α -1,4 linked glucose molecules) and limit dextrins (α -1,4 and α -1,6 glucose molecules). A small amount of **β -glucans** (β -1,4 and β -1,6 linked glucose molecules), derived from the cell walls of the barley, may also be present.

Wort Boiling

- ▶ In the final step prior to fermentation, the wort is pumped into a special heating tank called **the brew kettle**. It is here that the wort is boiled and other important reactions occur. One more essential beer ingredient, **hops**, are also added to the wort during the boil step.
 - (Note that exactly when hop addition occurs will depend on brewer preferences and the desired level of bitterness or aroma properties).
 - (When corn syrup or sucrose is used as an adjunct it is added at the beginning of the boiling. Hops are also added, some before and some at the end of the boiling).
- ▶ Wort mixtures are usually boiled for 1-1½ hours in a **brew kettle (or copper)** which used to be made of copper (hence the name) but which, in many modern breweries, is now made of stainless steel.

Separating out the hot trub (Whirlpooling)

- ▶ The hot wort is not sent directly to the fermentation tanks.
- ▶ A **trub** or **precipitate** forms during the kettle boil step.
- ▶ In addition, the wort may also contain insoluble hop debris, especially if whole hops had been used.
- ▶ If dried hops are used then they are usually removed via strainers or screen-type devices.
- ▶ For hot trub removal, several separation systems can be used.
 - The simplest method is sedimentation, but this is not a very efficient process.
 - A much more efficient method is to centrifuge the hot wort using continuous centrifuges. Such units, however, are expensive and require frequent maintenance.
 - Therefore, the most common means of separating out the hot trub is the **whirlpool separator**, which is typically a low-height, conical-shaped (cone pointing downward) tank whose geometry promotes whirlpool-type movement of the wort. The trub or precipitate collects in the center of the tank.

Fermentation

Inoculation

- ▶ After the wort is cooled and aerated, the yeast culture is, at last, added to the wort, in a step called **pitching**.
- ▶ The cooled wort is pumped or allowed to flow by gravity into fermentation tanks and yeast is inoculated or '**pitched in**' at a rate of 7-15 x 10⁶ yeast cells/ml, usually collected from a previous brew.

Fermentation

- ▶ Brewing yeast is *Saccharomyces cerevisiae* (ale yeast) or *Saccharomyces pastorianus* (lager yeast).
- ▶ Two types of yeasts are used in brewing.
 1. **Ale style beers** are made using selected strains of *Saccharomyces cerevisiae*, otherwise known as the “ale” or “top-fermenting” yeast.
 2. **Lager beers** are fermented by *Saccharomyces pastorianus* (formerly called *Saccharomyces carlsbergensis*), also known as the “lager” or “bottom-fermenting” yeast.

Post-Fermentation Steps

- ▶ Conditioning
- ▶ Clarification and Filtration
- ▶ Carbonation
- ▶ Packaging and Pasteurization