Unit IV - Topic 5
Beer defects and spoilage

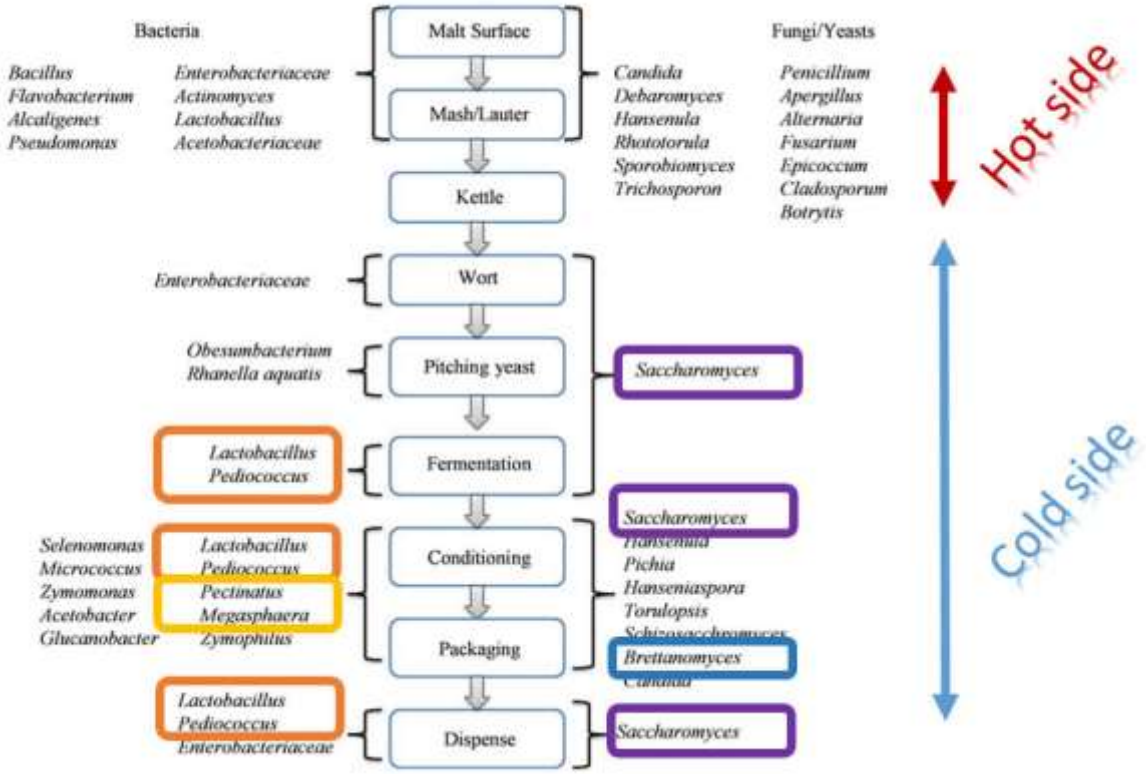
BEER SPOILERS: WHAT ARE THE MAJOR BEER SPOILERS TO BE CONCERNED ABOUT?

From a human safety aspect, historically beer was always considered a safe drink (compared to water) in that pathogens were not found in beer. This is in part thanks not only because the wort is boiled in the kettle but also due to the level of alcohol, hop resins and a low pH. That said, certain microbial contaminants, the so called "beer spoilers" can propagate in beer and be responsible for off-flavours, acids and non-desirable aromas as well as hazy beers.

From a fermentation stand point, they can also interfere and compete for essential nutrients with the introduced "brewer's yeast strain"; with the outcome of a beer "stuck in fermentation" or "over-attenuated".
There are two major groups of microorganisms responsible for contaminating wort and beer:

- Bacteria
- Wild Yeast

Below is an overview of published spoilers (Bokulich 2013). The most commonly encountered beer spoilers have been highlighted in colour with the lactic acid bacteria (orange) reported to be responsible for 60-90% of contaminations.



Bokulich, N.A. and Bamforth, C.W. (2013) The Microbiology of Malting and Brewing. Microbiology and Molecular Biology Reviews, 77, 157-172

BACTERIAL SPOILAGE

While beer wort can be considered as a microbiological broth media, beer itself should be looked upon as a microbiologically stable beverage thanks to the presence of ethanol (0,5-10%), the hop bitter compounds notably the iso alpha acids (present generally at a concentration of 17-55ppm), a high C02 level (0,5% w/v), an extremely low oxygen content (<0.1 ppm) which renders beer a near to anaerobic medium, a prohibitively low pH (often ranging from 3,7-4,8) and not to mention the fact that the nutritive profile has been depleted following fermentation with a brewer's yeast.

From a classification angle, gram positive bacteria are most commonly encountered, some gram negative can occasionally be also responsible for beer spoilage.

Gram positive bacteria (cell wall retains the purple dye from the gram stain [giving a blue appearance under the microscope]) do not in general, survive in beer (these include potential pathogens), however certain species of the common genera Lactobacillus and Pediococcus often referred to as the lactic acid bacteria (LAB) can survive and are by far the most commonly encountered beer spoilers.

Lactic Acid Bacteria – Friend or foe?

Friend: As their generic name suggests, they produce lactic acid which is a gentler, cleaner-tasting acid than acetic acid. The **sour German wheat beers**, like **Berliner Weisse** and **Gose** are soured with this type of bacteria, and of course they also occur in lambic fermentations.

Foe: Considered to be responsible for 60-90% of contaminations making them by far the most common contamination problem (Back 2003). These beer spoiling species exhibit strong resistance to hop iso alpha acids [denoted by the presence of hop resistance genes horA and horC] (Suzuki et al 2005).

Why is it important to determine if the LAB possess the hop resistance genes?

The ability to differentiate between lactic acid bacteria possessing the horA and horC genes from those without is important to the brewer and quality control manager as it enables them to estimate the level of risk involved on spoiling the final product (e.g. gene resistant containing bacteria are a real threat to the quality whereas bacteria without the genes are more of a sanitiser indicator). Currently and practically this is only possible with PCR (Polymerase Chain Reaction) based tests in a brewery laboratory.

How easy is it grow beer-spoilage LAB on a petri dish?

The ease and speed of LAB growth has often been observed as variable on Quality Control detection media and this is especially true for the primary isolation of beer-spoilage LAB strains which leads to the failure in the detection of beer spoilage LAB by QC tests in breweries (Suzuki 2012). One principal reason for this is due to the adaptation of these organisms to the brewing environments which means the culture media environment is not optimal (e.g. nutritional profile, pH).

What is beer spoilage?

A notable group of microorganisms now becoming more common in breweries are Zymomonas, Pectinatus, and Megasphaera. These gram-negative bacteria can interfere with the brewing process by producing undesired, beer-spoiling byproducts. These bacteria oxidize ethanol into acetic acid which results in vinegary off-flavors.

Beer Spoilage Organisms

Despite beer's inherent stability, a limited number of microbes can grow that are collectively known as "beer spoilers" which include bacteria, yeasts, and molds. Beer-spoilage microbes include bacteria belonging to genera of Lactobacillus, Pediococcus, Megasphaera, and Pectinatus. In addition, the most common genera of yeast that can spoil beer include Saccharomyces and Brettanomyces species. Microbial contamination can originate from a variety of sources in the brewing process. Raw materials, air, brewing water, additives, and even pitching yeast can act as a constant supply of contaminants. Residues remaining in brewhouse tanks, pipelines, valves, heat exchangers, and packaging equipment harbor microorganisms too that represent a potential source of recontamination. Some of the effects of contamination range from comparatively minor changes in beer flavor and fermentation performance to gross flavor and aroma defects, turbidity problems, abnormal attenuation rates, excessive acidity, gushing, and reduced yeast crops. Aspergillus niger, also called "black mold," is a fungus common in breweries.