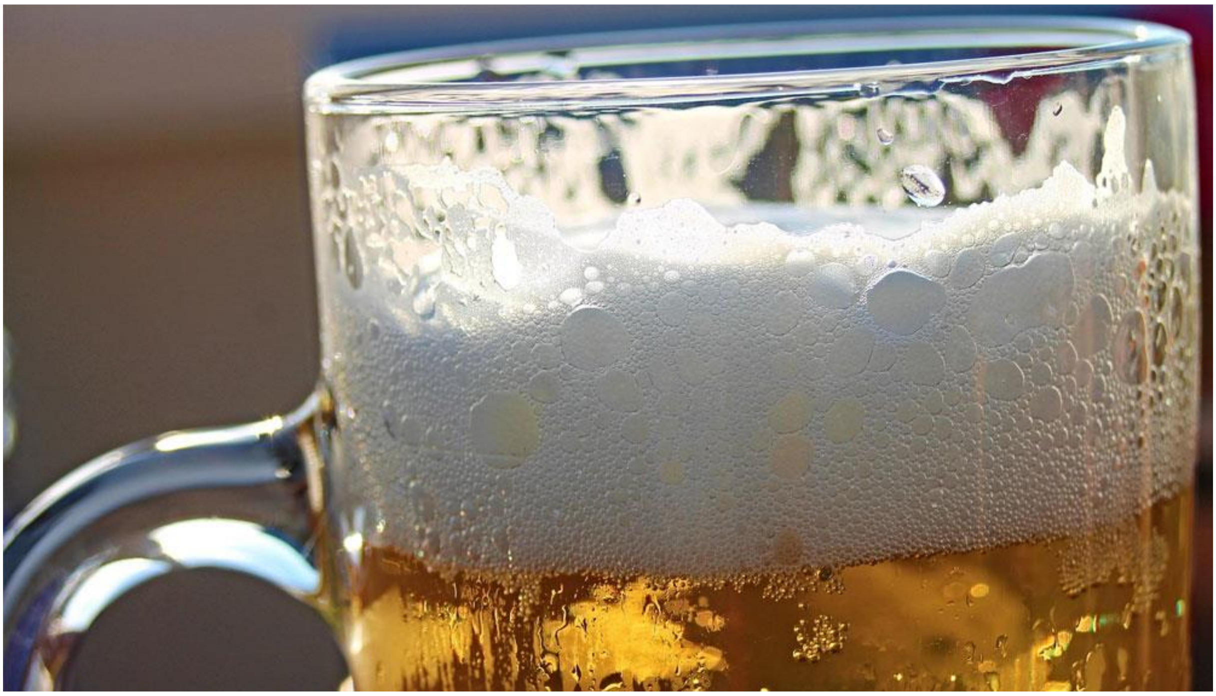
Brewing Helles – the technological challenges

Brewed to perfection | For most consumers, it would seem logical that beer could simply be brewed by following a recipe. However, a glance at the typical characteristics of a Helles-style beer reveals very narrow limits on the variability regarding original gravity, bittering units, color and aroma. Similarly, the possibilities for creativity in recipe design also appear somewhat limited. Yet this is precisely what makes this beer style so fascinating, the quality of which is largely determined by the brewing technology – or rather the art of brewing.



The visual impression of a “perfect” Helles ranges from a light straw yellow color to a deep golden. The beer should be topped with a stable, finely filigreed head of foam. The key to enjoying Helles lies in its drinkability which is due to a number of factors. On the one hand, it is important to minimize the difference between the final degree of attenuation of the beer leaving the maturation cellar and the limit of attenuation measured in the laboratory. Leaving a small amount of residual extract in the beer does not enhance its full-bodied nature, as is often incorrectly assumed, but rather imparts an undesirable fatty or oleaginous impression to the beer.

The sweetness of the unfermentable dextrins, on the other hand, positively influences the full-bodied character; however, they must be properly balanced with the bitterness. The bitterness itself should never be harsh or lingering. Polyphenols also impart fullness and structure to the beer but can lead to an astringent note if oxidized, which can serve to counter the pleasant mouthfeel. Another factor central to the mouthfeel is the amount of CO_2 dissolved in the beer. Freshness, and thus flavor stability, is one of the most essential attributes contributing to the quality of a Helles. Of course, no off-flavors, such as diacetyl, should spoil the drinking experience.

Many different factors in the brewhouse determine the quality of a Helles (Photo: cerdadebbie on Pixabay)

All these factors impact the quality of a Helles and are a direct result of a distinct set of brewing techniques, from the brewhouse work and yeast management to managing fermentation, maturation and lagering through to oxygen-free filtration and bottling.

Key factors in the brewhouse

The milling process, with the corresponding malt fractions and their possible oxidation, has an impact on several quality characteristics, such as tannins and the resistance of the beer to aging. Water treatment is particularly important for pale bottom-fermented styles, like Helles, as the water influences both the color and the quality of the tannins. The mashing process, including the mash-in temperature and the subsequent rests, must be adapted to the malt quality. Avoiding any oxygen uptake is essential for the subsequent flavor stability and the quality of the tannins.

Lautering for the shortest time possible prevents leaching of the undesirable compounds in the husks. A properly coordinated boiling process influences the foam and colloidal stability. Ideally, wort intended for Helles production should have a FAN content of 180–200 mg/l to provide sufficient yeast nutrition, minimize the formation of higher alcohols and avoid any subsequent oxidative degradation of the amino acids in the filtered beer. Finally, the target pH value of the wort should be 5.0–5.2 for a lean character and improved flavor stability.

Yeast management and fermentation technology

Achieving a decent level of foam and flavor stability lies in proper yeast management practices and careful monitoring of the fermentation process. The goal of optimal yeast management is to avoid the release of substances from the yeast cells which compromise quality. Brewers refer to these as the products of autolysis – which include fatty acids and amino acids as well as proteinase A. This enzyme degrades foam-positive protein fractions. The release of these substances by the yeast into the beer takes place through autolysis (rather seldom). This occurs when the yeast dissolves its own cell walls or excretes undesirable compounds due to stress. The latter is plainly the more decisive factor.

Helles should be drunk soon after packaging, otherwise the flavor suffers (Photo: Surprise on Pixabay)

The condition and age of the yeast cells determine the potential for the release of the unwelcome products of autolysis. As the yeast cell ages, more of these products accumulate in the vacuoles. Furthermore, the tendency for yeast to react poorly to stress and to undergo autolysis, thus excreting these undesirable substances, increases with the age of the yeast cells. In addition to the potential for the yeast to secrete fatty acids, amino acids and proteinase A, the size, weight and tendency to flocculate also increases with the age of the cells. Young yeast cells remain in suspension for much longer and therefore exhibit a greater fermentative capacity. The tools for rejuvenating the yeast population lie in aerobic yeast propagation, sufficient aeration of the wort (8 mg O_2/l), in avoiding repitching cropped yeast too frequently and in purging the yeast generously from the cone or tank bottom when harvesting yeast.

Harvesting and storing bottom-fermenting yeast

When harvesting bottom-fermenting yeast, one should keep in mind that the only yeast cells one can harvest are those that have flocculated and sedimented out, i.e., the older, heavier and less active cells. The most active (small, lightweight) yeast cells, on the other hand, remain in suspension. Their activity therefore decreases with each harvest cycle and the tendency to release autolysis products increases. When storing cropped yeast, one should note that yeast cell activity level decreases drastically with the storage duration, while at the same time, the tendency for autolysis increases significantly.

For this reason, the rule of thumb for storing yeast is similar to that for storing fresh fish: the conditions under which yeast should be stored are as follows: for as short a duration as possible (1–3 days) and as cold as possible (0–2 °C). One should also bear in mind that a thick slurry of yeast in a tank cannot be cooled like normal liquids, due to its viscosity and insulating properties. Cooling in the tank can only be achieved through agitation, pumping or by chilling during the transfer of the yeast from the fermentation tank to the yeast storage tank.

Pitching the yeast into the wort

Pitching literally means "adding the yeast to the wort" – but it's not that simple and there are a few details to consider.

Since new, young and therefore active yeast cells are only formed under aerobic conditions, sufficient aeration of the wort is crucial for the quality of the beer produced with this yeast. Depending upon the temperature of the wort, the value for oxygen saturation is 7–9 mg of oxygen per liter. Given the fact that yeast cells can only be active in suspension, the yeast must be entirely in suspension. Yeast at the bottom of the tank after pitching will never go back into suspension; rather, it will start excreting substances resulting from stress or even undergo autolysis.

With regard to the pitching temperature, 80 percent of higher alcohols are formed during the aerobic phase. Since higher alcohols are direct precursors of the carbonyls responsible for aging in beer, a low pitching temperature is crucial for flavor stability. For this reason, a consistent temperature during pitching is an important factor for the quality of the beer.

In addition, one must pay attention to the number of yeast cells and their uniformity during pitching, because both the formation of esters and SO2, which are of great importance for flavor stability, depend upon it. Fewer yeast cells mean greater ester formation and a better ratio of esters to higher alcohols, as well as an increase in the SO_2 content. The fermentative capacity of the yeast determines, in part, the target yeast cell count, which is generally 8–12 million cells/ml. It goes without saying that the pitching yeast should have very high levels of viability (> 95 %) and vitality in order to minimize the tendency for autolysis.

Maturation of the beer

After the rapid onset of fermentation and a satisfactory fermentation, one characterized by a pH drop to around 4.4, the focus then turns to the maturation of the lager beer. Due to the traditionally low fermentation temperatures common in bottom fermentation, the beer must undergo a maturation phase after fermentation, as many processes important for beer quality have not yet been completed. The substances responsible for the green beer bouquet, as it is known, must be converted by the yeast.

The concentration of diacetyl in the beer serves as an indicator of the progress of maturation by the yeast. However, before the yeast can reduce the diacetyl, which has a very low olfactory threshold, into the 2,3-butanediol, which has a high threshold, the precursor 2-acetolactate formed by the yeast must be converted into diacetyl through chemical decarboxylation. This chemical reaction and the reduction by the yeast are contingent upon the temperature. A minimum temperature of 5 °C is thus necessary for maturation. Insufficient maturation caused by cooling the green beer too quickly to lager temperatures is one of the most frequent errors encountered in lager beer production.

In addition to refining the beer flavor through the transformation of green beer aromas and the elimination of volatile (sulfur) compounds by means of scrubbing with CO_2, the comprehensive elimination through fermentation of the residual extract still in the beer is important. This means that to produce a beer with a decent level of drinkability and thus a high quality, the final degree of attenuation should be as close as possible to the theoretical limit of attenuation. Since all the processes involved in maturation are carried out by the yeast cells, the yeast activity in this phase is critical. This is the stage of the process in which the inherent advantages of the technique known as kräusening become evident.

Cold lagering

After maturation, a period of cold lagering commences, a phase which is not directly reliant upon the yeast. On the contrary, a high yeast cell count at this stage in the process would be counterproductive. A small number of active yeast cells in suspension without yeast cells present in the lees would be ideal, as the yeast in suspension continues to reduce substances in the beer, thus optimizing its freshness without the negative influence of autolysis. To the greatest extent possible, the yeast should be regularly purged from the bottoms of tanks. Likewise, the yeast sediment should be removed when transferring between tanks, or a green beer centrifuge can be employed. The optimum temperature during this phase is 0 °C to –1.5 °C. If the conditions mentioned above are met, a long or even an extended cold storage phase is an absolute advantage for the quality of the lager, as the CO_2 continues to become progressively more dissolved in the beer, further improving both the foam stability and the mouthfeel.

Filtration and filling

The last two stages of the production process are critical for the freshness and flavor stability of Helles. The most important factor impacting quality during filtration and bottling is the avoidance of any oxygen uptake. This begins by replacing the volume of beer leaving the lager tank with CO_2 as the beer flows out, followed by pumping the beer to the filter (mechanical seals!), venting and purging the filter of air as well as dosing diatomaceous earth under oxygen-free conditions. Acid cleaning of the bright beer tanks in a CO_2 atmosphere without opening the tank is now accepted as best practice. This is followed by oxygen-free transfer of the beer to the filler (mechanical seals!) and the filling process itself. At the very end of the filling process, a correctly adjusted and flawlessly functioning high-pressure injection system is necessary to bottle the perfect Helles.

Freshness is of the essence

Despite all of the attention on the brewing techniques and the state-of-the-art equipment, the most important point in this process for the quality of a Helles is after it has been bottled. Due to the separation of the yeast from the beer during filtration and the resulting lack of reducing capacity, hardly any protection against oxidation is present in the beer. Oxidation and therefore a decline in freshness inevitably occurs.

This is dependent upon the concentration of the precursors for aging compounds and the concentration of residual oxygen in the bottled beer. The quality of the beer is dependent specifically on these factors. Unfortunately, this loss in quality is unavoidable. Depending upon the temperature, the loss in quality is not measured in months, as is indicated by the best before date, but in mere weeks.

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