

Chmielenie piwa na zimno – wybrane aspekty technologiczne i jakościowe

Dry hopping of beer – some technological and quality aspects

Summary

The last decade was a time of dynamic development for the brewing industry in Poland. The "beer revolution" manifesting itself by the creation of dozens of new breweries every year, brewing of various beer styles, numerous beer festivals and increasingly popular beer competitions has come to our country. At the center of these changes is the brewery, modern techniques and technologies, and a focus on high-quality raw materials and repeatable product quality. It is also about improving brewing techniques, which, despite the centuries-old brewing tradition and perfected brewing technology, must keep up with the changing expectations and preferences of consumers.

Hops are the most expensive and at the same time least stable raw material used in beer brewing. It is of great importance for the beer revolution, because new beer styles are often based on changes in the varieties of this raw material or its dosing techniques. Dry hopping is a technique that has gained on popularity in the last decade. It involves the addition of hops to beer at the fermentation stage or after fermentation is completed, giving the finished product a unique hop aroma, difficult to achieve when hopping is done using traditional methods at the brewhouse stage. The dry hopping technique has many benefits, but also risks - the addition of hop granules to beer may change its quality. The key aspect of dry hopping is the ability to predict quality changes in beer, both in terms of aromatics and in terms of the physicochemical parameters of the product.

The aim of the experiments presented in this doctoral thesis was, among other things, to examine qualitative changes in hops during storage in various conditions. Moreover, the study attempted to explain how dry hopping affects the oxidative stability of beer and what impact the polyphenols and metal ions released from hops have on this parameter. One of the important goals of the work was also to expand the available knowledge related to secondary fermentation occurring during dry hopping called "hop creep".

The obtained results indicate that an increase in the HSI coefficient (indicating the degree of oxidation of bitter hop compounds), is observed after 21 days of storing hops both, with the extent of the increase being dependent on the temperature of storage and air access.

Studies performed using ESR spectroscopy clearly indicate the positive effect of dry hopping on the oxidative stability of beer. This stability is strongly related to the concentration of polyphenols and iron content in the beer after dry hopping. The results of experiments related to the hop creep phenomenon suggest that a high dose of hops for dry hopping (15 g/l) causes deeper attenuation of the beer compared to a dose of 5 g/l, and also causes a significant increase in pH compared to a lower dose of hops. Additionally, it has been shown that hop creep is continuous - separating hops from beer stops this secondary fermentation and no further decrease in apparent extract is observed. The degree of extract decline due to the hop creep phenomenon in the pilot scale (20 l) and commercial scale (10 hl) is the same. The course of secondary fermentation differs significantly in its duration (longer time on a smaller scale of production). The experiment also verified the influence of the tank pressure on the extent of the hop creep process. The duration of secondary fermentation is longer in the case of fermentation under pressure, but the final degree of attenuation does not depend on this process parameter.

Keywords: hop quality, dry hopping, beer oxidative stability, hop creep, secondary beer fermentation

