Dry Hopping and Its Effect on Beer Foam

IMPACT ANALYSIS | Dry hopping is a very popular method to bring hop aroma to beer. But how can it influence the brewing process and the final beer? The first part of this paper (BRAUWELT International No. 1, 2018, pp. 25-29) discussed the impact it can have on bitterness, the IBU, and pH. This contribution focuses on foam, as many craft brewers who dry hop experience poor foam stability while others do not. To better understand the impact dry hopping can have on beer foam, a series of dry hopping experiments were performed and foam measurements were made to see what factors effect beer foam stability.

CRAFT BREWERS who dry hop use a wide range of dry hopping techniques with some adding very little hops, 0.5 lbs/bbl or less, while others add as much as two lbs/bbl or more. In addition, contact times can vary from a few hours up to a week or more. Dry hopping can significantly alter the hop acid composition of beer [1] which might affect beer foam stability. Also a wide range of hop varieties are used for dry hopping so there could be varietal effects. Dry hopped beers were made looking at all these variables and had their foam stability tested using the Nibem foam stability tester.

Test Methods Used and Sample Preparation

Pilot scale beers were brewed in a 15 gallon Sabco pilot brewery for the dry hopping experiments. Hop pellets were typically dumped on top of the beer, at 16 °C, for three days unless otherwise mentioned.

Small-scale dry hopping of commercial beer was accomplished by the addition of ground-up hop pellets to twelve oz of beer, fobbing to top of bottle, and capping using an oxygen-absorbing cap. After three days of storage at 16 °C, the bottles were placed in a 20-21 °C water bath before Nibem foam stability testing.

Foam stability testing was conducted on beers at 20 °C and 10 °C using the Nibem-30 foam stability method of EBC 9.42 [2]. The 10 °C results were obtained by placing the beer in a 10 °C water bath. Iso-Extract 30 %, Alpha Extract 20 %, and Tetra-Iso-Extract 10 % were obtained from Hopsteiner for the beer spiking experiments. Humulinones were prepared in-house and used for beer spiking experiments [3].

Dry Hopping and Beer Foam

To investigate why some craft brewers experience poor foam stability in their dry hopped beers while others experience very good foam stability, a commercial ale assaying 44 ppm isoalpha acids by HPLC was dry hopped with 0, 0.5, 1.0, and 2.0 lbs/bbl Cascade hop pellets for three days at 16 °C. The effect on the beer's foam stability was dose dependent and nearly linear, causing a 50 second and 80 second loss in foam stability with the one lb and two lb hop dosage respectively when tested with the Nibem foam stability tester at 20 °C (Fig. 1); thus the larger the dose rate the worst the foam stability. To see if contact time effects beer foam stability, a beer was dry hopped at one lb/bbl with Cascade hop pellets and had its foam stability measured over eight days (Fig. 2). The Nibem foam stability results clearly showed the longer the contact times the worse the foam stability. To investigate if this reduction in foam stability was due to the change in the hop acid composition that occurs with dry hopping, a beer containing 48 ppm isoalpha acid (HPLC) had its Nibem foam tested before and after dry hopping with one lb Cascade hop pellets per barrel

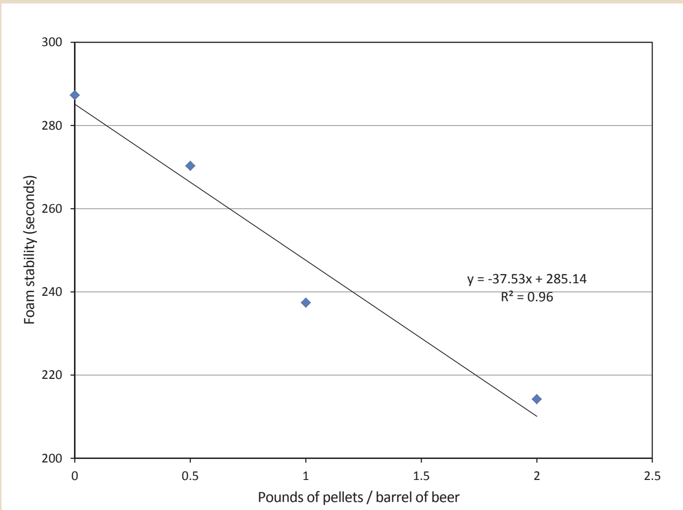

Fig. 1 Nibem foam results vs. lbs/bbl Cascade pellets dry hopped

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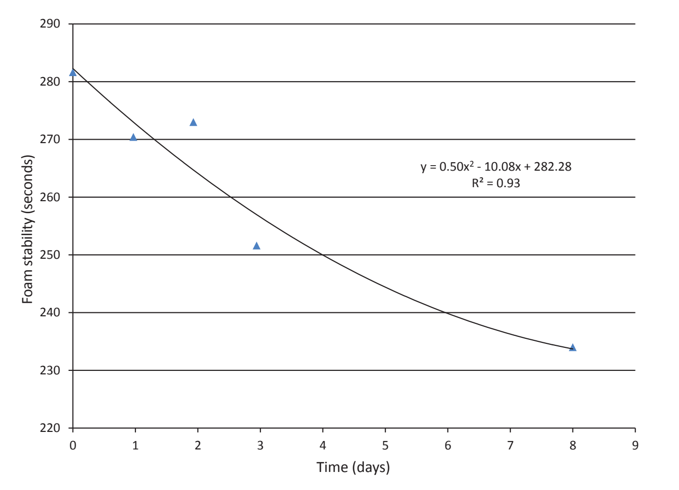

Fig. 2 Nibem foam results vs. dry hopping contact time with 1 lb/bbl Cascade hop pellets

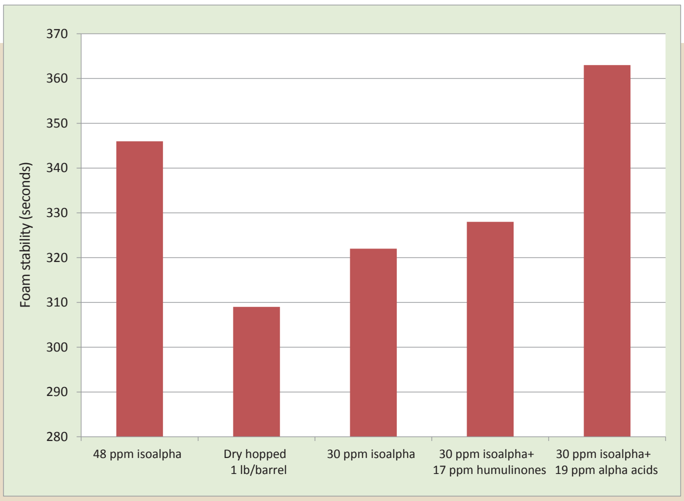

Fig. 3 Effect of dry hopping and hop acid composition on beer foam

beer for three days. Dry hopping caused a 37 second reduction in beer foam stability and HPLC analysis of the dry hopped beer showed it contained 30 ppm of isoalpha acid, 17 ppm of humulinones, and 19 ppm of alpha acid. To see what effect this change in hop acid composition had on foam stability, a 30 ppm isoalpha acid beer, a 30 ppm isoalpha acid + 17 ppm of humulinone beer, and a 30 ppm isoalpha acids + 19 ppm alpha acid beer were prepared. Each beer was tested using the Nibem foam stability tester and the results listed in Fig. 3 show that a loss in isoalpha acid concentration results in a reduction in beer foam stability but the decrease was not as bad as the dry hopped beer. The addition of 17 ppm humulinone to the 30 ppm isoalpha acid beer did little to improve the foam stability demonstrating the poor foam enhancing properties of humulinones. When 19 ppm of alpha acids were added to the 30 ppm isoalpha acid beer, the foam stability was better than the pre-dry hopped beer. Alpha acids added to beer post-fermentation are known to enhance beer foam [4]. Therefore the change in hop acid composition was not responsible for the reduction in beer foam stability and in fact should have improved the foam stability. To overcome this reduction in beer foam stability, it's possible to add a foam enhancing hop acid like tetrahydro-isoalpha acids (Tetra) to a dry hopped beer to restore the foam stability to pre-dry hopped levels or more (see Fig. 4). The Cascade hop variety was used in these dry hopping experiments because it is currently the largest (aroma) hop variety being grown in the USA with over 7100 acres planted and is widely used by craft brewers for dry hopping. To see what effect other hop varieties have on beer foam three varieties, Centennial, Apollo, and Eureka! were compared to Cascade. Three days of dry hopping, at 16 °C, with the Centennial hop variety also caused a decrease in Nibem foam stability when tested at 20 °C, however two varieties, Apollo and Eureka! actually improved the foam stability of the beer (Fig. 5). Because beer is consumed cold and poured cold these beers had their foam stability tested cold, 10 °C, even though the temperature conditions for using the Nibem foam stability tester was 20 °C. Better foam stability test results are generally obtained when beer is tested cold [4] and that was indeed the case with Centennial, Apollo, and Eureka!, however that was not the case with Cascade, which still gave poor foam stability results when tested cold (Fig 5). It appears Cascade may be an outlier when it comes to reducing beer foam stability, although more varieties need to be evaluated. To retest contact time versus foam stability, the foam enhancing hop variety Eureka! was used to dry hop a beer at one lb/bbl at 16 °C over seven days (Fig. 6). Under the conditions tested, one can obtain maximum foam enhancing effects after just two days of dry hopping, however, at three days the

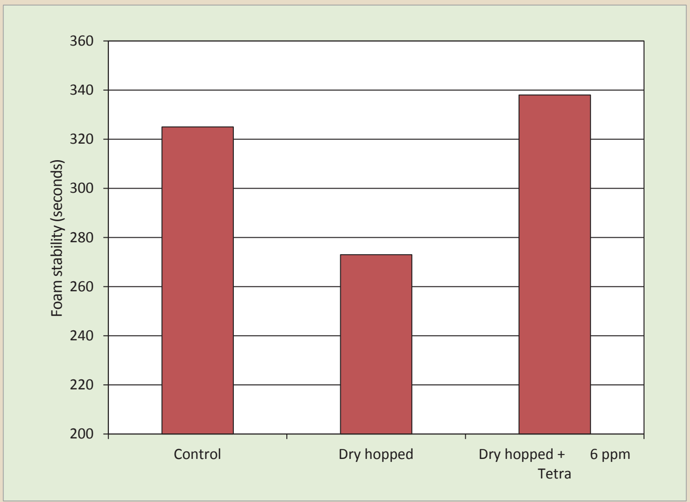

Fig. 4 Improving the foam of a dry hopped beer with Tetra

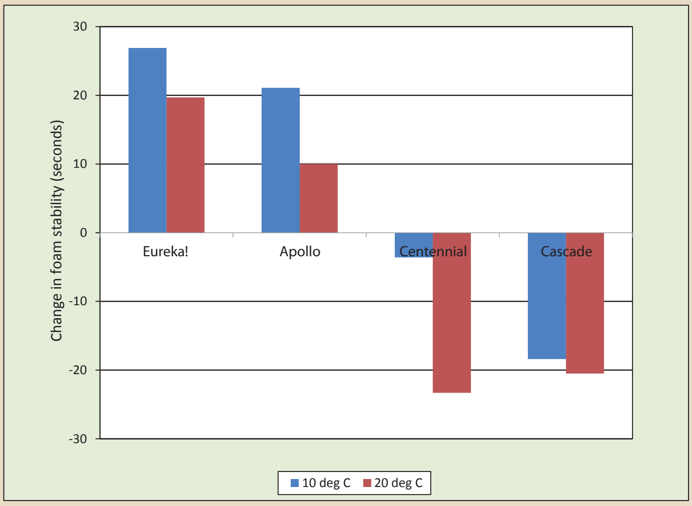

Fig. 5 Nibem foam results for beer dry hopped for three days with different hop varieties

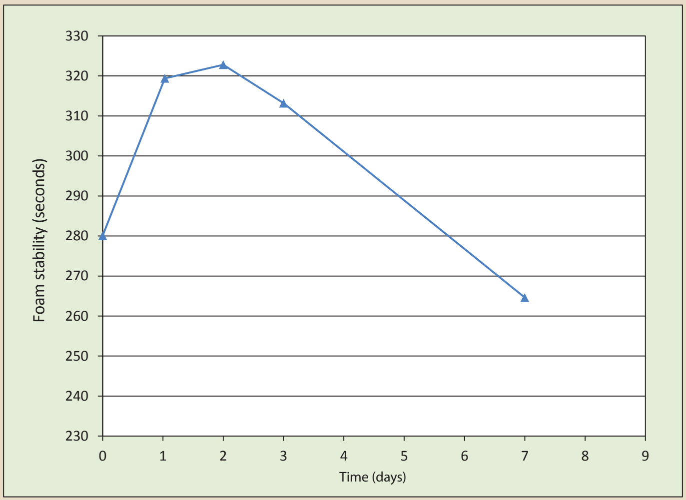

Fig. 6 Nibem foam results for beer dry hopped with Eureka! hop pellets 1 lb/bbl vs. time

foam stability starts to slowly decrease and by day six the foam stability is similar to the non-dry hopped beer. Dry hopping with Eureka! for more than seven days will cause the foam stability to be worse than the control. It appears the foam negative compounds, most likely fatty acids, slowly dissolve into the beer over time reducing the beer's foam stability over time confirming our previous test, that long dry hopping times can negatively affect beer foam stability with some varieties reducing the foam faster than others.

Conclusion/Summary

Under the conditions tested, dry hopping can affect the foam stability of beer but it appears to be variety dependent with some varieties improving beer foam stability and others potentially reducing it. Increasing the dry hopping dose rate or extended contact times can also reduce beer foam stability with some varieties reducing the foam faster than others. Brewers seeking to improve the foam stability of their dry hopped beers can experiment with reduced dose rates, shorten contact times, or use a foam enhancing hop acid like tetrahydro-isoalpha acids. ■

References:

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