Evaluating the Utilization of Hop Pellets vs. Hop Extract during the Beer Brewing Process

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Introduction

Hops play a crucial role in imparting both flavor and aroma to beer. Traditionally, the brewing industry has relied on dried and pelletized hop flowers, but hop extracts, which contain the essential bittering and aromatic compounds, are gaining popularity. In this study, we brewed two batches of beer, comparing pelletized Citra® hops with an iso-butane Citra® hop extract. Samples of wort, beer, and spent hops were collected throughout the brewing process. Using HPLC-DAD analysis, we measured the quantity of alpha, beta and iso-alpha acids at defined steps of the brewing process. Both beer batches used an equal amounts of alpha acids for boil, whirlpool and dry hopping additions. The utilization from pellets versus extracts is presented.

Objective

The objective of this study is to determine the alpha acid utilization rate between hop pellets vs hop extracts and quantify the utilization during different brewing stages.

Methods

Two identical 2hL batches of beer, with only Citra hop pellet or extract addition differences, were brewed at the KPU Brew Lab. Equal amounts of alpha acids were added at different brewing stages to the two baches of beer. The amount of alpha acid (AA) and beta acid (BA) in pellets and the extract were calculated based on HPLC-DAD analysis via the ASBC Hops 14 method using the specified standards (ASBC, 2011). Iso-alpha acids (IAAs) from wort and beer samples were quantified using a HPLC-DAD via the ASBC Beer 23 method and the specified standards (ASBC, 2011). The pellets were put in stainless-steel mesh containers and added to defined brewing stages (Fig. 1). Wort, spent hops, and beer were sampled as indicated in Fig 1. All samples were collected in triplicate and the average and standard deviation for each collection are reported in the results.

Figure 1. Flow Chart of the Utilization of Hop Pellets vs Hop Extract Analysis During Different Brewing Stages

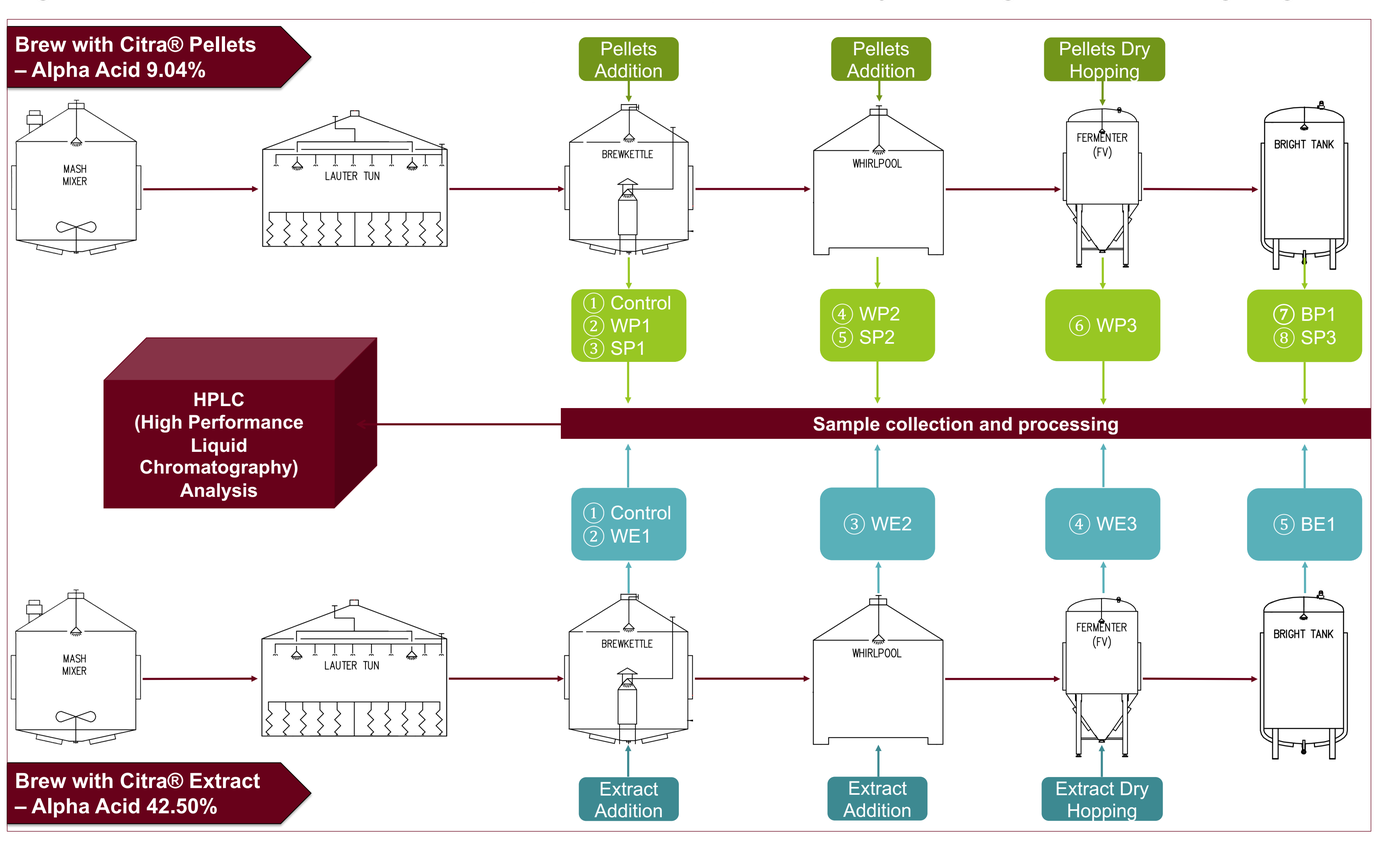


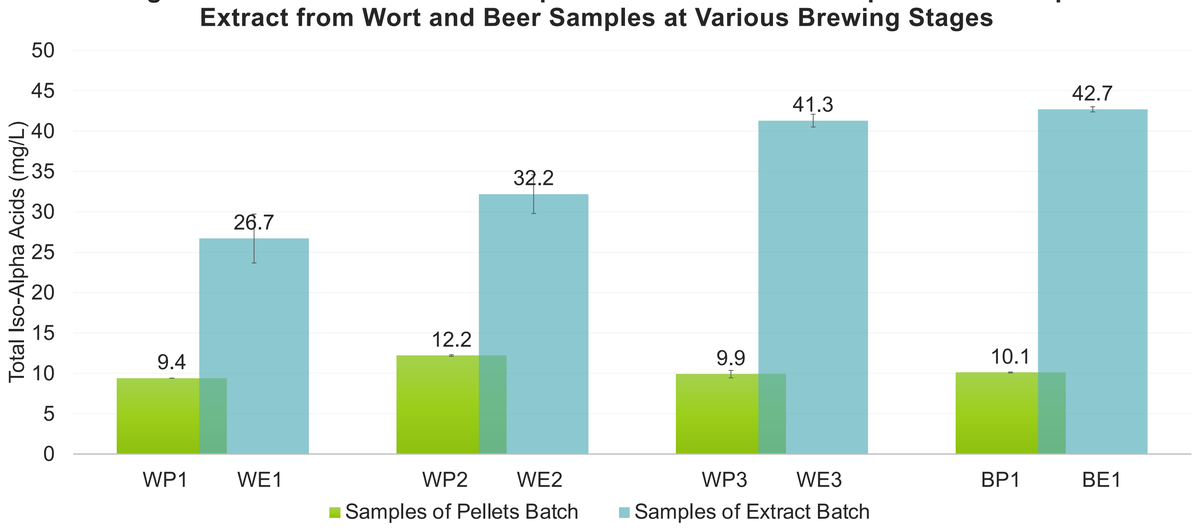
Figure 1. Legend:

① **Control**: Wort was sampled before adding hops
② **WP1**: Wort sampled at end of boil (60 min)
③ **SP1**: Spent hops sampled at end of boil (60 min)
④ **WP2**: Wort sampled at end of whirlpool (15 min)
⑤ **SP2**: Spent hops sampled at end of whirlpool (15 min)
⑥ **WP3**: Wort sampled after crash cool (168 hours in fermenter)
⑦ **BP1**: Beer sampled after being transferred to BBT (288 hours in fermenter)
⑧ **SP3**: Spent hops sampled just prior to being transferred to BBT (288 hours in fermenter)

① **Control**: Wort sampled before adding hops
② **WE1**: Wort sampled at end of the boil (60 min)
③ **WE2**: Wort sampled at end of whirlpool (15 min)
④ **WE3**: Wort sampled after crash cool (168 hours in fermenter)
⑤ **BE1**: Beer sampled after transferred to BBT (288 hours in fermenter)

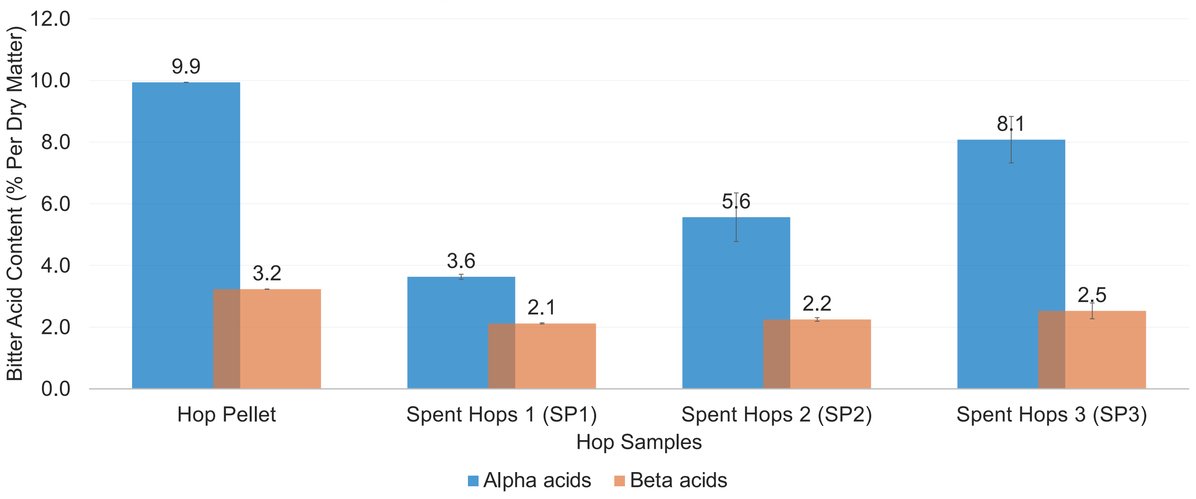
Results & Discussion

Figure 2. Concentration of Iso-Alpha Acids Detected for Hop Pellets vs Hop Extract from Wort and Beer Samples at Various Brewing Stages



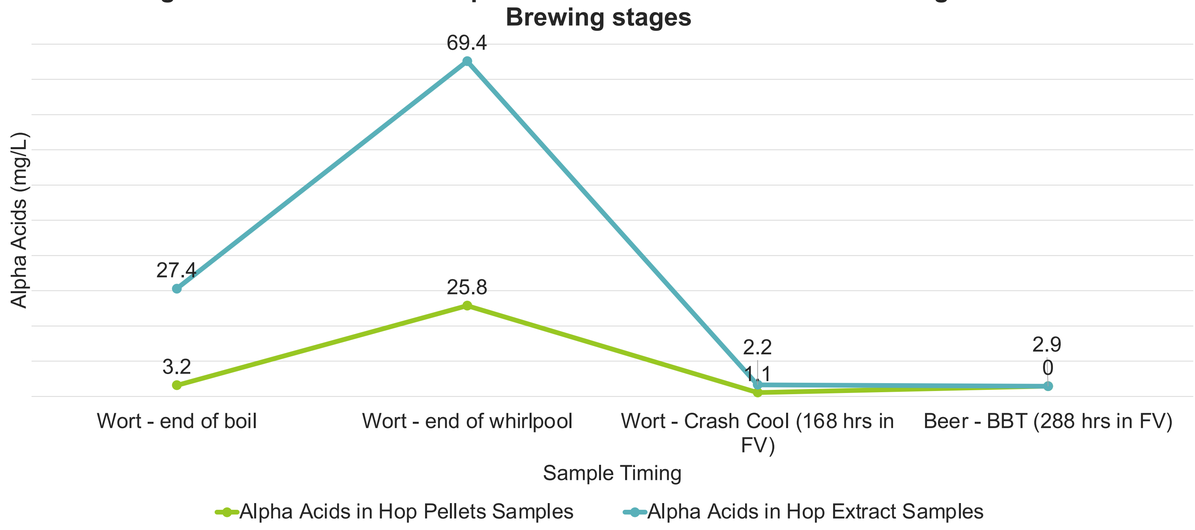
- Four times more IAA accumulated in the final beer product in hop extract brewed beer compared to hop pellet brewed beer although the same amounts of alpha acids were added during both brews.
- The 4x increase in alpha acid utilization in hop extracts provides an opportunity to use 4x less extract to achieve the same IBU target from pellet based brewing recipes.

Figure 3. Hop Pellet and Spent Hop Alpha/Beta Acids% Sampled at Different Stages of the Pellet Based Brew



- Approximately 2/3 of the pellet-based AA added in kettle were removed from hop pellets during the 60 min boil (SP1), whereas only a small reduction of AA was observed after 288 hours in the fermenter (SP3).
- BAs were not extracted from hop pellets at any brewing stages, which is consistent with their poor water solubility.

Figure 4. Non-Isomerized Alpha Acids Detected in Wort/Beer During Different Brewing stages



- Increased levels of non-isomerized AA were detected in extract-based wort compared to pellet-based wort during the boil and whirlpool stages.
- The amount of remaining AA increased after the whirlpool stage additions as less AA were isomerized at the relatively lower temperature and shorter heating time compared to the boil stage.
- Nearly all AA 'crashed out' of the beer/wort post fermentation in both batches likely due to their association with yeast cells and removal due to yeast flocculation.
- No BA were detected in any of the wort/beer samples collected.

Conclusions and Future Studies

Alpha acid utilization in hop extracts is four times more efficient compared to AAs derived from hop pellets at all different brewing stages.

Hop pellets used for dry hopping utilize almost no AA and thus present and opportunity to reuse spent dry hops during boil brewing stages.

Considering that AA utilization is 4x more efficient in hop extracts as compared to pellets, a sensory focused study for determining flavor compound utilization between hop extracts and hop pellets could be performed. If you have interest in this or other R&D projects, please reach out to the KPU brew lab or the KPU Applied Genomics Center (hops@kpu.ca).

Acknowledgements

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