Investigating the effects of oak spiral aging on Beer ABV and IBU

Dr. Nick Flynn[12]

[1]Department of Chemistry and Physics, [2]Advanced Bio Genetics & Life Sciences

Abstract

Prior studies have identified a decrease in ABV and increase in IBU associated with oak spiral aging in beers. Initial results indicated that the ABV decrease was because of oxidation of ethanol to acetic acid due to resealing of bottles, while the IBU increase was proposed to be due to oak components that dissolved in aged beer. In this study, commercial beer samples were opened, allowed to sit for 30 seconds and resealed. Additionally, an oak spiral was added to a 5.00% aqueous solution of ethanol. After three weeks, there was no difference in ABV or acetic acid content in the opened bottles when compared to bottles that remained sealed. The oak spiral ethanol solution exhibited a decrease in ABV similar to that found in our prior studies. Both UV-Visible spectra and A_{275} absorbance of this same solution indicate that oak spirals contribute a significant amount of absorbance at 275 nm thus confirming that oak components contributed to the IBU increase. In conclusion, oak spirals do appear to decrease beer ABV in an oxidation-independent fashion while concomitantly increasing IBU values using the A275 IBU method.

Introduction

This study was an extension of prior work using oak spirals and beer. Oak spirals are now being used to generate oak-based flavors in commercial beer due to the cost of intact barrels and the time associated with aging. Oak spirals can, for example, generate the desired flavor in approximately two weeks in individual bottles. In the prior study we determined that oak spiral aging of beer led to an increase in measured International Bitterness Units (IBU) units and a decrease in alcohol by volume (ABV). We proposed that the increase in IBU units was due primarily to extraction of compounds that absorb at the same wavelength that isomerized alpha acids are measured using an ASBC method (275 nm). We also believed that the reduction in ABV was primarily due to oxidation of ethanol to acetic acid. Studies reported here are intended to test these two separate hypotheses.

$CH_3\text{-}CH_2\text{-}OH$ ----------> $CH_3\text{-}COOH$

Hypothesis

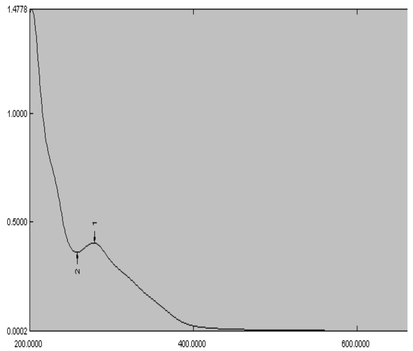
- ABV decrease associated with oak spiral aging is due to an increase in acetic acid content
- IBU increase is due to an increase in oak derived compounds that absorb at 275 nm

Methods

- Commercial beer bottle samples were split into two separate groups. One group remained sealed while the other group was opened, allowed to sit for 30 seconds and resealed.
- After three weeks, both sets of bottles were examined for ABV and Acetic Acid content.
- A 5.00% ethanol solution was generated using HPLC Ethanol and Water; Ethanol Amax 270-400 = 0.01

Results

Treatment	Alcohol By Volume	Acetic Acid (g/L)
Opened, then resealed	4.80 ± 0.06 %	0.091 ± 0.002
Unopened	4.83 ± 0.02 %	0.890 ± 0.002



Wavelength (nm)
Figure One- UV-Vis Spectra of 5% ethanol solution containing oak sprial

Treatment	IBU	SRM	ABV
Unopened	15.3 ± 0.4[b]	5.68 ± 0.01[b]	4.95 ± 0.01[a]
Resealed	15.7 ± 0.2[b]	5.58 ± 0.01[b]	4.81 ± 0.01[b]
Oak Spiral, Resealed	19.9 ± 1.0[a]	5.90 ± 0.06[a]	4.76 ± 0.03[b]

Prior Study Results
Column figures with different letters are statistically different as analyzed by ANOVA, Tukey Post Hoc.
IBU measured at 275 nm and SRM measured at 430 nm

Results & Discussion

• There was no difference in ABV concentration between open/resealed and unopened bottles opened after three weeks

• There was no difference in acetic acid concentration between open/resealed and unopened bottles opened after three weeks

• The 5.00% ethanol solution that had an oak spiral added to it did exhibit significant absorbance at 275 nm. There was a decrease in ABV that was similar to that observed in prior study.

In the first experiment, we were primarily interested in determining whether the process of simply opening the commercial beer bottles led to an oxidation of ethanol and subsequent production of acetic acid. This did not occur.

The second study demonstrated that the addition of oak spirals to an ethanol based solution resulted in an elevated absorbance which can only be attributed to oak spiral components. The reduction in ABV demonstrates that the oak spiral itself was the culprit for ABV reduction in beer bottles exhibited previously.

Future Study

Repeat the study using the oak spiral addition to several 5.00% ethanol solution and compare acetic acid concentrations.

References

1. UV-Visible Analysis of Bitterness and Total Carbohydrates in Beer. Thermo Scientific, Application Note 52467. 2013.
2. Effect of Oak Spiral Aging on Beer IBU, Dissolved Oxygen, SRM and ABV. ACS- National Meeting, San Diego, CA, 2019.
3. Prediction of Flavor Differences between Beers from Their Chemical Composition. J Agric. Food Chem. 1982, 30, 1009-1017.
4. Chalconoids and Bitter Acids in Beer by HPLC with UV and Electrochemical Detection. Application Note 1020. 2012.
5. Determination of α-acids in Hops and Beers. Perkin Elmer, Application note. 2012.
6. Chemistry and Analysis of Hop and Beer Bitter Acids. M. Verzele and D. De Keukeleire. pp 132-135. Elsevier. 1991.

Acknowledgements

We wish to thank the Chemistry and Physics Department for their help with conducting this research. We would also like to thank the Welch Foundation (Grant # AE-025) for support of this research.