Quality control and analysis for small breweries

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Introduction

Small breweries have become a growing trend in the Pacific Northwest, as well as nation wide. Small breweries lack the advantages large breweries have when it comes to quality control and analysis. It is important to promote quality beer to consumers because good beer leads to happy customers.

The objectives of this study were to modify and develop QA/QC protocols from the American Society of Brewing Chemists Methods for Craft Brewers (ASBC) for use in classrooms and small breweries.

This work focused on adapting methods for use in teaching labs for international bitterness units (IBU), standard research method for color (SRM) and alcohol by volume (ABV) for beer.

Methods: IBU, SRM, and ABV

Each analysis contained an instrument performance check consisting of Keystone Light Beer for all measurements. All beer was decarbonated by hand, pouring back and forth around thirty times prior to analysis.

IBU: Five ml of beer were transferred and 0.5 ml of 3M HCl added with 10 ml 2,2,4-trimethyl pentatne (iso-octane) and shook (320 cycles/min) for 10 minutes.
UV-Vis parameters:
Hitachi U-3000 UV-Vis spectrophotometer
Photometry method (fixed wavelength)
Tungsten and Deuterium lamps used
PMT: Auto
Wavelength: 275nm

SRM: Each sample consisted only of beer. Samples were analyzed using the same UV-Vis parameters above with the exception of wavelength. Two were used, 430nm and 700nm. Any absorbance over 1 was diluted and re measured.

ABV: A solution of 5% n-propanol was used for the internal standard in all assays.
Calibration curve: A range of ethanol solutions from 3%-8% were used. Five ml of internal standard was mixed with 5ml of each ethanol concentration. Peak heights of ethanol to n-propanol was graphed verses ethanol concentration to produce a linear relationship.
GC w/FID parameters:
Column: 20M Carbowax, 6 ft x 1/8 in.
Oven Temp: 70°C to 150°C at 4°C/min
Carrier Gas: Helium about 20 ml/min
Injector: 200°C
Detector: 250°C
Sampling: 5ml of beer was mixed with 5ml of internal standard. A volume of around 1µl was injected.

Results

A sample of the data is shown in Table 1. This was based on the instrument performance check: Keystone Light and three samples of beer from a local brewery. Anton Paar was present for an Alcolyzer demo and compared the GC method of ABV analysis to the Alcolyzer ABV analysis for a select sample of beer. Figure 2 shows the two layers, organic and aqueous, from the IBU evaluation. The calibration curve used to determine the alcohol in beer is shown in Figure 2. An example of the gas chromatography read-out is shown in Figure 3.

Table 1. Sample analysis of instrument performance check and beer samples.

Sample	IBU	SRM	ABV: GC	ABV: Alcolyzer Demo
1: Keystone Light (KL)	8.53	2.84	4.22	4.08
2: KL	8.73	2.89	4.14	-
3: KL	8.87	3.25	4.22	-
4: KL	8.65	3.18	4.58	-
Mean	8.70	3.04	4.29	-
STD	0.143	0.205	0.197	-
Known	7-8	3	4.2	-
Beer 1[1]	19.6	4.5	4.45	4.59
Beer 2[1]	32.14	5.7	6.71	6.63
Beer 3[1]	44.38	23.5	4.97	4.82

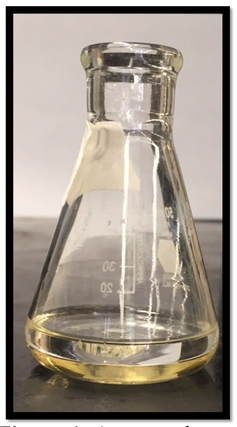

Figure 1. Aqueous layer is shown above the beer/water layer for IBU analysis.

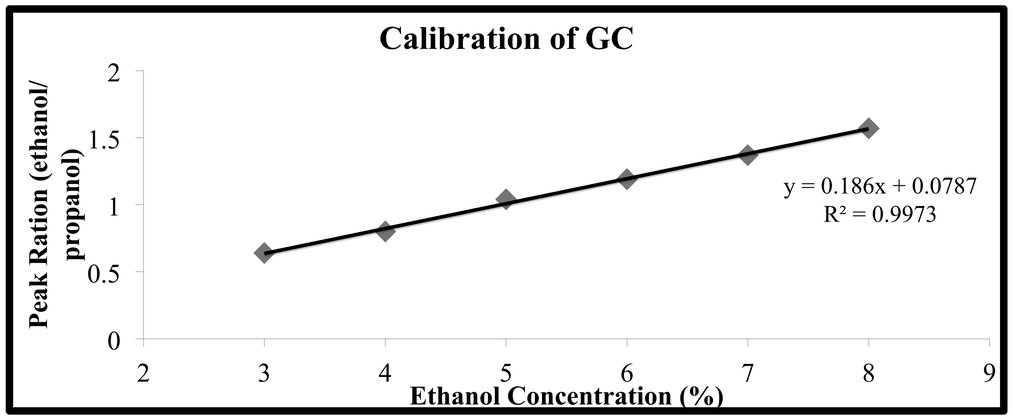

Figure 2. Calibration curve used to determine the ethanol concentration in each beer sample for ABV.

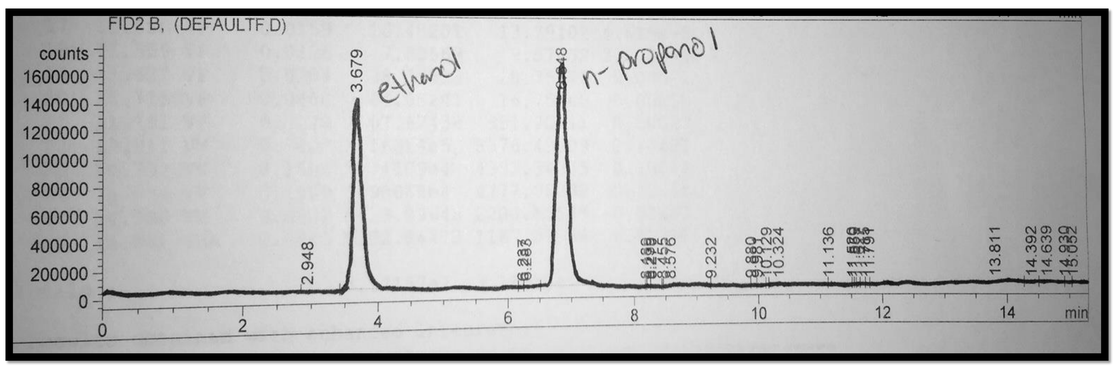

Figure 3. Peak analysis read-out from the gas chromatography ABV determination. The ratio is used to determine the alcohol by volume in each sample.

Conclusions

All samples analyzed from the three different breweries, as well as the instrument performance check, showed consistent results after each protocol was adjusted for the equipment and technique differences.

IBU required that each sample be carefully mixed otherwise an emulsion formed. Additionally, blanking with iso-octane was crucial to prevent instrumental drift.

SRM was fairly straightforward. All beer had to be decarbonated or else the absorbance reading would be off. The 700nm absorbance was used as a way of checking for this.

ABV proved the most challenging. The distillation method was time consuming and produced very inconsistent results. Once the parameters of the GC were determined it provided efficient, consistent results. Although our lab does not have a Alcolyzer, the demo showed that the GC method produces accurate results, and verified the data and method.

Significance

- A protocol for each analysis type was developed and will be tested in the spring with the Instrumental Methods of Analysis Class.
- Our lab is now able to work with local breweries to provide accurate results for beer analysis.
- Working on this research allowed our lab to use the GC w/ FID which had not been used for a number of years. A protocol is now provided for students to use with this instrument.
- Accurate beer analysis allows breweries to adjust their recipes which leads to happy consumers and consistent results.
- Future research includes purchasing an Alcolyzer and preparing methods for instrument use. Additionally, exploring the wine QA/QC industry.

Acknowledgments

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Literature cited

ASBC Methods of Analysis, CD-ROM. Method 4,23,10. Beer Alcohol, Color, Bitterness. Second Ed. American Society of Brewing Chemists, St. Paul, MN, U.S. A.

Restek: Scotch on CarboBlack B. Searchable Chromatogram Library.

Local Breweries:
[1]Grain Station Brew Works
Heater Allen
Golden Valley Brewery
Other Resources:
Oregon Brewlab
Anton Paar Alcolyzer w/ near Infrared demo

Further information

Please contact Dr. Brian Gilbert, Linfield College, at bgilber@linfield.edu for more information.