

Comparison of Perceived Sourness, pH, and Titratable Acidity of Sour Beers



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Introduction & Background:

The rise of sour beers in the craft beer industry has necessitated a standard method to analytically measure the sourness of a given beer. Although brewers use pH as a measure of acidity in beers, pH often does not reflect the perceived sourness of a beer during sensory evaluation. Lack of an accurate measure for sour taste can hinder brewers' ability to establish quality standards for both sour and non-sour beers. Developments in the production of sour beers suggest that titratable acidity (TA) may be the preferred method of measuring sour taste. TA is defined as the sum of titratable acids by neutralization titration with an alkali solution to a targeted end point determined by a colored indicator or target pH, whereas pH is a measure of hydrogen ions in a solution (Zhang, Lin, Chai, Li, & Barnes, 2014). TA is presumed to be a better indicator of sourness because pH only measures dissociated hydrogen ions in solution even though the organic acids produced in fermentation are weak acids that do not dissociate easily (Hieronymus, 2017). Therefore, it is critical to consider the impact of organic acids when analyzing sourness because they are the key flavoring agents in sour beers (Li & Liu, 2015). This experiment seeks to bridge the gap in the application of analytical data and the corresponding consumer perception of sour beers.

We compared perceived sourness in beer via sensory evaluation to current methods of testing sourness using a simple pH meter, TA methods via American Society of Brewing Chemists (ASBC), and RedCheck Acidity Kit, a newly marketed item that aims to provide a simpler and quicker method of TA measurement. Furthermore, the average time per test was recorded to evaluate the time commitment of each test. We assessed RedCheck kits for ease of use and accuracy compared to the ASBC procedures for measuring TA. The kits, designed by Beyers Analytical Brewing Sciences, measure TA using the addition of phenolsulfophthalein (PSP) rather than phenolphthalein, leading to a more brilliant red color change. Beyers Analytical designed the kits to be easier and more reliable than a typical phenolphthalein test for TA due to a more rapid and obvious color change.

Methods:

Three sour brands and a non-sour control provided by Gilded Goat Brewing Company were analyzed in triplicate by each of the following methods, then compared to findings reported by a trained sensory panel. The beers consisted of a non-sour control, Citra Sour (Brand 1), Sour Purple Dream (Brand 2), and Flanders Red Sour (Brand 3). The pH of each undiluted sample was tested using a calibrated pH meter. For each method, the average value of each triplicate testing was recorded in the results table, as well as the average time needed to complete testing of each sample.

- Sensory Panel:** A sensory panel assessed the sourness of each of the sour beers, including the non-sour control beer. The sensory evaluation consisted of 26 panelists, each ranking the four beers according to a sourness scale of 0 (non-sour) to 5 (intensely sour).
- TA w/ pH meter via ASBC Beer-8:** 50 mL of decarbonated sample was dispensed via pipet into a 100 mL beaker. Decarbonation was performed by pouring the sample between two beakers 10 times, followed by shaking the sample in a capped 50 mL conical for 30 seconds. A calibrated pH meter was inserted into the solution the sample was stirred on a magnetic stirrer. While stirring, the sample was titrated with 0.1M NaOH to pH 8.2. The volume of NaOH added to reach equilibrium was recorded. We calculated TA as % lactic acid using equations provided by the ASBC Beer-8 method. Although beer contains additional acids than just lactic acid, it is standard to use % lactic acid as an approximation for all present organic acids.

Methods continued:

- TA w/ phenolphthalein via ASBC Beer-8:** 250 mL of distilled water was brought to a boil in a 500 mL beaker. The sample was boiled for 2 minutes, then 25 mL of decarbonated beer was added via a pipet and heated for an additional minute. The sample was removed from the hot plate and cooled rapidly to room temperature using a cold water bath. 0.5 mL of 0.5% phenolphthalein was added and the sample was titrated with 0.1 M NaOH until a faint pink color change was observed. The sample was then titrated with 0.2 mL more NaOH to make the color change permanent. The first reading was recorded and TA as % lactic acid was subsequently calculated using the same equations as before, per the ASBC method.
- RedCheck Acidity Kit:** 1 mL of sample was measured into a flask and diluted with 100 mL distilled water. A capsule of pre-measured, powdered PSP was added to the solution and swirled to dissolve. NaOH was added dropwise while swirling the solution until the sample turned red, indicating the end of titration. The number of drops was recorded and used to calculate TA as % lactic acid.



Photo by Charlie Hoxmeier



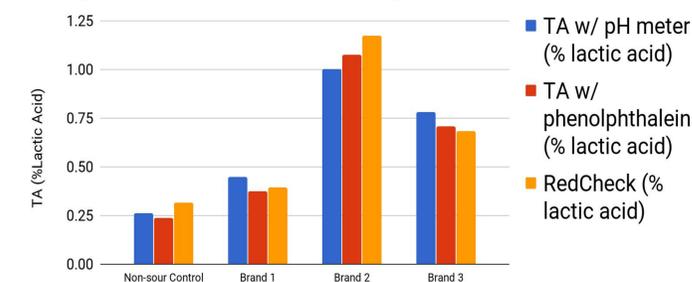
Photo by Abigail Reecer

Results:

	Non-sour Control	Brand 1	Brand 2	Brand 3	Average Standard Deviation	Average Time Per Test
pH (1-14)	4.26	3.59	3.38	3.63	0.0134	0:00:43
TA w/ pH meter (% lactic acid)	0.26	0.45	1.00	0.78	0.0181	0:12:45
TA w/ phenolphthalein (% lactic acid)	0.24	0.37	1.08	0.71	0.0134	0:25:20
RedCheck (% lactic acid)	0.32	0.40	1.17	0.68	0.0289	0:04:09
Sensory Average	0.52	2.52	4.71	3.88	0.52	n/a

Results:

Comparison of Titratable Acidity Measurement



Conclusions:

Our data demonstrated that higher TA values were more indicative of higher levels of perceived sourness by the sensory panel. Brand 2 was rated as the sourest sample by the sensory panel and similarly returned the highest TA values. Brand 1 had lower TA values across all three methods and a lower perceived sourness ranking, however, its pH was higher than Brand 3. Thus, a lower pH value did not always accurately predict sourness. Comparing TA with sensory perception resulted in a R^2 value of 0.944 whereas comparing pH with sensory perception had an R^2 of 0.871. The RedCheck Acidity Kit took considerably less time per test on average than the other two methods of TA measurement. One of the downfalls we discovered during experimentation was subjectivity in determining what consisted of an adequate color change when using phenolphthalein titration. In contrast, RedCheck yielded a dramatic color change once equilibrium was reached. This gave us more confidence in the endpoint of titration via the Redcheck kit as opposed to the ASBC method with phenolphthalein.

The understanding of TA and thus organic acid content is best utilized by the brewer because it bridges the gap between analytical data and sensory perception, and provides an additional control point for the monitoring of out of specification beer. However, measuring TA can be time consuming, especially when using the phenolphthalein method. RedCheck Kits provide a good alternative to more labor intensive TA measurement methods by allowing brewers to test for TA with minimal equipment and time needed. RedCheck can be used in conjunction with other TA methods for critical control of finished beer, providing TA values within $\pm 15\%$ of values obtained by other TA measurement methods (Beyers Analytical, 2018).

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