

VDK Test Strip Validation and Sensory Detection Threshold of VDK in Gilded Goat Brewing Company Beers

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Introduction

Vicinal diketones (VDKs) are associated with off-flavors and aromas that render most beer styles substandard. Therefore, it is advantageous for a brewer to accurately quantify the various VDK compounds that are present during and after fermentation.

- Main VDKs in beer: 2,3-butanedione (diacetyl, contributes buttery off-flavors) and 2,3-pentanedione (contributes honey-like off-flavors)
 - Diacetyl: Detection threshold of ~ 20 - 60 ppb in light lagers⁴, ~ 40 - 80 ppb in darker beers⁴
 - Pentanedione: Threshold is up to ten times higher than diacetyl, but can be an important marker for yeast health
 - Ratio of diacetyl to pentanedione has been shown to be an indicator of microbiological contamination¹
- It's important for brewers to monitor the VDK levels in their beers, especially at the end of fermentation
- Beyers VDK test strips would provide a cost effective and simple way for breweries to measure VDK concentrations in beer
- Two main purposes of this study:
 - Validate Beyers VDK test strip efficacy compared to ASBC distillation method and GCMS using four different Gilded Goat Brewing Co. beers
 - Determine average consumer absolute and recognition threshold levels for diacetyl in four different Gilded Goat Brewing Co. beers

Relevance and Innovation in the Brewing Industry

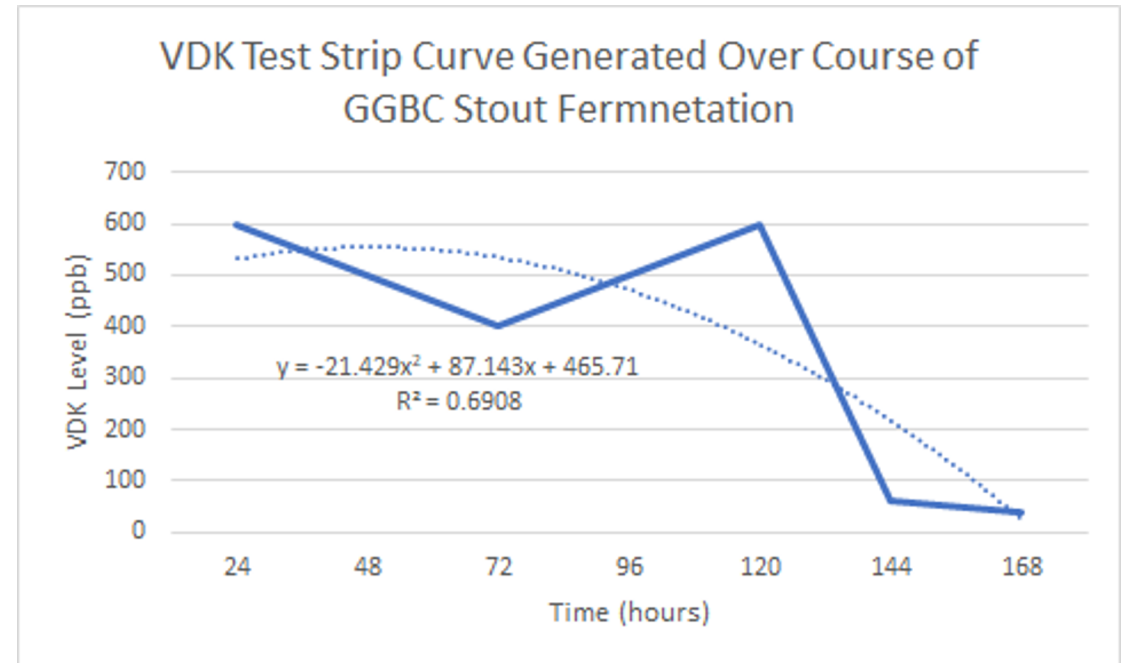
- Affordable. Uses less equipment and resources
- Private lab analysis can take days. Beyers VDK strips can produce results in ~15 minutes
- End-of-Fermentation Diacetyl Check

Experimental / Descriptive Methods

- Experiment intended to validate the accuracy of Beyers VDK test strips compared to other VDK detection methods
 - Compared to Gas Chromatography (AB) and Distillation (MSU) methods done by third parties
- 4 Samples of Gilded Goat beer were tested
 - Double IPA, Bock, Cream Ale, and Stout
 - Samples were drawn at the same time to ensure consistency
- Results of GC and Distillation were compared to the test strips.
 - Numbers within 5% of distillation are validated.
- A VDK curve was generated during fermentation of Frumpy MooMoo using the strips.
 - Over the course of 7 days samples were taken at approximately the same time day to day
 - Samples were centrifuged for 1 min to remove yeast that would cause interference
 - The results were recorded, and the data was used to generate a graph

Experimental Data

Beer	Strip Result (ppb)	Distillation Result (ppb)	GC Result (ppb)
Frumpy Moo Moo (Stout)	< 50	1726*	97.11
Downpour Petrichor (DIPA)	< 50	650.9	62.26
Cashmere (Cream Ale)	< 50	241.2	18.622
Guten Bock (Bock)	< 50	146	6.823



Conclusion (experimental)

Graphing the Curve:

- Lack of precision
 - colorimeter will help with comparison
- Demonstrated the excretion and reuptake of VDK's

VDK Strip Validation:

- Strips performed well vs. distillation
- Strips are good for go/no-go application
- Less expensive alternative to other methods
- Frumpy Moo Moo Outlier
 - Adjunct related
 - Distillation may not perform well with high adjunct use

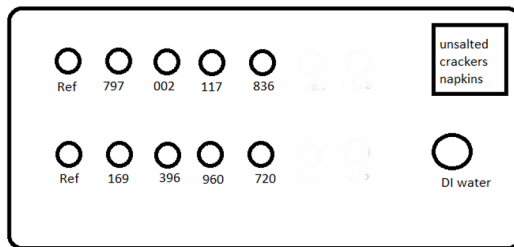
Sensory Methods

Group A			Group B		
Sample / Dosing	Cashmere Cream Ale	Frumpy MooMoo Stout	Sample / Dosing	Guten Bock Bock	Downpour Double IPA
Control	REF	REF	Control	REF	REF
50ppb Diacetyl	797	169	50ppb Diacetyl	519	887
100ppb Diacetyl	002	316	100ppb Diacetyl	067	782
300ppb Diacetyl	117	960	300ppb Diacetyl	537	854
500ppb Diacetyl	836	720	500ppb Diacetyl	238	630

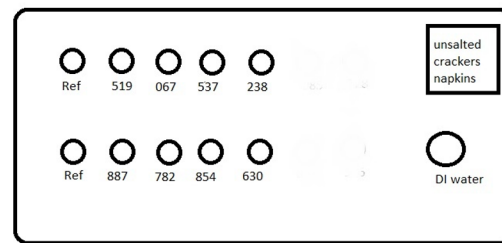
- Three Separate data collection sessions ($n_A=9$, $n_B=9$, and $n_{A+B}=5$, respectively)
- Combined data for analysis

Sample setup for Group A

Sample setup for Group A

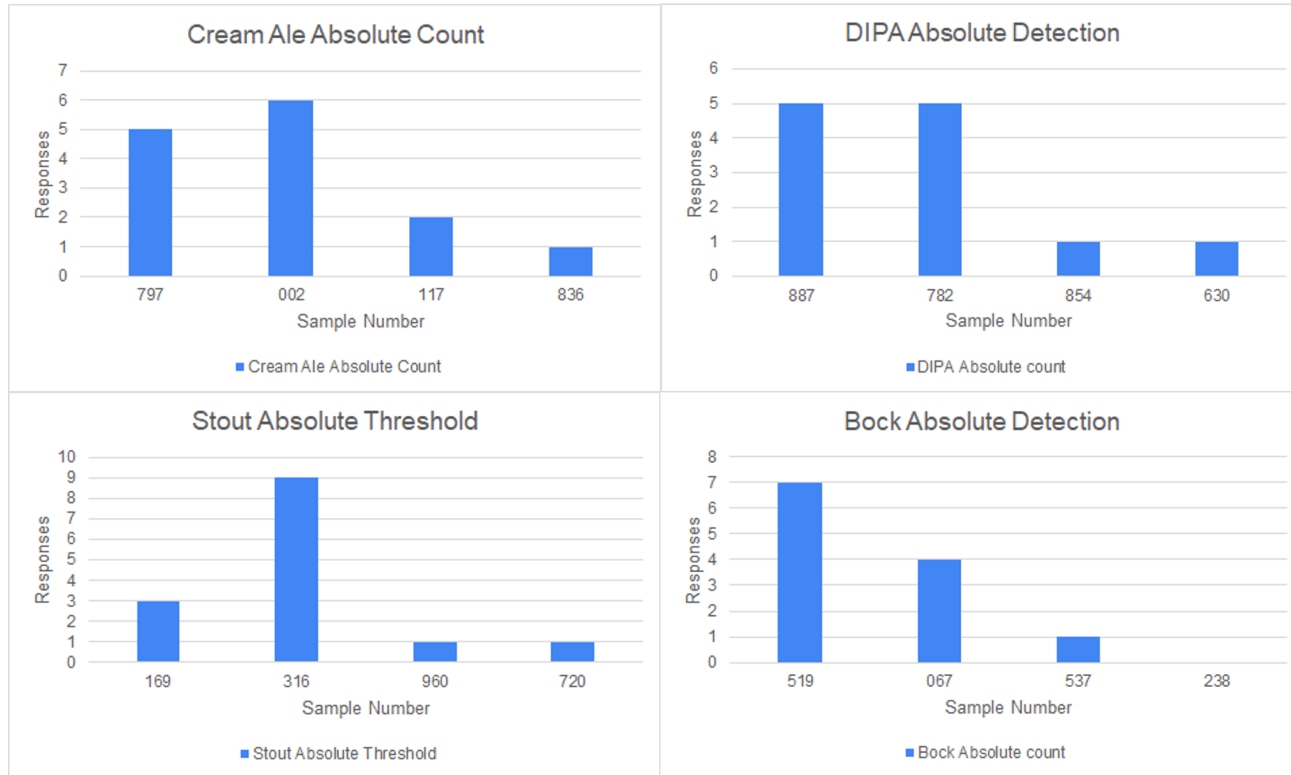


Tray



Tray

Sensory Results



Absolute threshold for the cream ale, bock, and DIPA: ~50 - 100 ppb

Absolute threshold for the stout: ~100 ppb.

Conclusion of Sensory Evaluation Results

- Stout - Higher absolute and recognition thresholds than the Cream Ale, Bock and DIPAs
- Several panelists noted that the stout exhibited flavors that contrasted with diacetyl, causing it to stand out more. However, the overall data trend did not support that conclusion.

While the overall data trend did not support the idea that diacetyl stood out more in the stout due to contrasting flavor compounds, the idea should not be completely discounted. Further research could be done on what specific flavor compounds in different beer styles will hide diacetyl presence or make it stand out.

Successes:

- Data collection method and schedule
- All data points were within reasonable expectations. No outliers or unexplained points
- Confirmed changes in diacetyl concentration detectable in low concentrations
- Some noted diacetyl complimented the cream ale flavor profile

Deficiencies:

- Unable to quantify diacetyl in each sample
 - Sample creation
 - Redesign threshold test with verified diacetyl concentrations.
- Potential for inconsistency between samples made on different dates

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- Katie Fromuth, CSU FST Laboratory

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