SmartNotes

As breweries continue to grow, the importance of the quality of their beer becomes increasingly more significant, and basic microbiological testing is no longer enough to guarantee adequate consistency. Larger breweries that already test for beer quality are always looking for ways to simplify their testing efforts by utilizing different technology to limit the time and expense of quality testing. UV-Visible spectrophotometers are a perfect solution to help breweries meet their quality standards by offering quick, simple, and affordable testing as well as the versatility to utilize a large variety of methods compared to more limited instrumentation like a colorimeter.

Diacetyl

Diacetyl (2,3-butanedione) is naturally present in beer as a by-product of the fermentation process. A similar compound 2,3-pentanedione is also produced, and they are collectively known as vicinal diketones (VDKs). Increased 2,3-butanedione content can negatively alter the flavor of beer giving a butter or butterscotch flavor while 2,3-pentanedione tends to impart a honey flavor to the beer. Monitoring the production and consumption of VDKs is important as they are easily detectable in beer with generally reported flavor thresholds of 0.1 mg/L for 2,3-butanedione and 0.9 mg/L for 2,3-pentanedione. As VDKs are a natural part of fermentation, they cannot be completely eliminated from beer, however healthy yeast also serves to reabsorb VDKs over time. The reabsorption of VDKs occurs over multiple days, so the ability to measure the concentration of VDKs in beer is advantageous as it can increase brewing productivity saving time and money. An organoleptic test is often done to detect VDKs consisting of a panel of testers tasting and smelling the sample. While this test is useful to report the presence or absence of VDKs, it is limited by the specific sensory perception of each person and is not sufficient to monitor yeast performance over time to determine if it is finished reducing the VDKs in the beer.

Question: How do I measure beer Vicinal Diketones using UV-Vis spectrophotometry?

Answer:

The concentration of vicinal diketones in beer can be determined by distillation of a beer sample followed by color development of the distillate. The absorbance of the sample is then measured at 530 nm and the result is compared to a previously generated standard curve to obtain the concentration of VDKs.

Materials needed

Thermo Scientific™ GENESYS™ UV-Visible Spectrophotometer with BeerCraft™ Software, beer, α-naphthol, isopropanol, vegetable carbon, creatine, potassium hydroxide, diacetyl, distillation apparatus, volumetric flasks, pipettes, graduated cylinders, 10 mm cuvettes.

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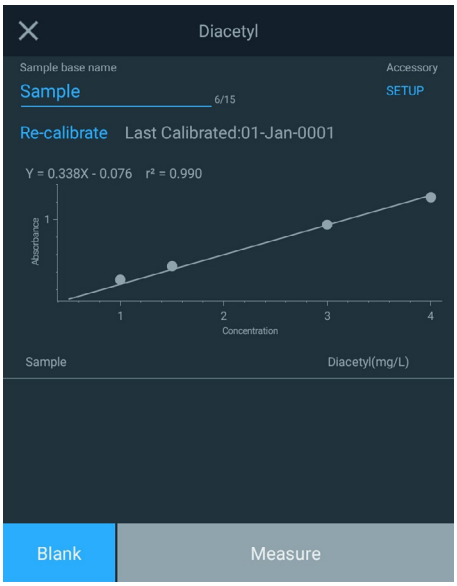
Procedure

1. Prepare a α-naphthol solution by dissolving 4.0 g of α-naphthol in 100 mL isopropanol. Then add 0.5 g of vegetable carbon. The solution is stirred for 0.5 h and filtered.
2. A KOH-creatine solution is made by dissolving 0.3 g creatine in 80 mL of 40% KOH and filtering.
3. The diacetyl standard curve is made by pipetting 0.5, 1.0, 1.5, 3.0, and 4.0 mL of a 20 mg/L diacetyl solution into 10 mL volumetric flasks followed by adding water to bring the volume to 5 mL. Since the upcoming beer distillation step concentrates the VDKs in the sample by 4, the standard solutions are prepared at 4 times the normal concentration to eliminate the need for additional calculations. These 5 mL solutions represent concentrations of 0.5, 1.0, 1.5, 3.0, and 4.0 mg/L.
4. Distill 100 mL of decarbonated beer into a graduated cylinder containing 5 mL water. Collect ~15 mL of distillate and fill to 25 mL with water. Pipette 5 mL of this solution into a 10 mL volumetric flask.
5. Pipet 5 mL of water into a 10 mL volumetric flask to serve as a blank.
6. To each standard, sample, and blank volumetric flask add 1 mL of the α-naphthol solution and 0.5 mL of the KOH-creatine solution and fill with water to the mark. Then shake for 1 min.
7. Select the Diacetyl method on your GENESYS UV-Vis spectrophotometer.
8. Select Re-calibrate and then select Calibrate to enter the concentration values of your prepared standards.
9. Blank the instrument and measure the standard solutions.
10. Return to the method home screen and measure the sample to obtain the concentration of diacetyl in beer in mg/L.

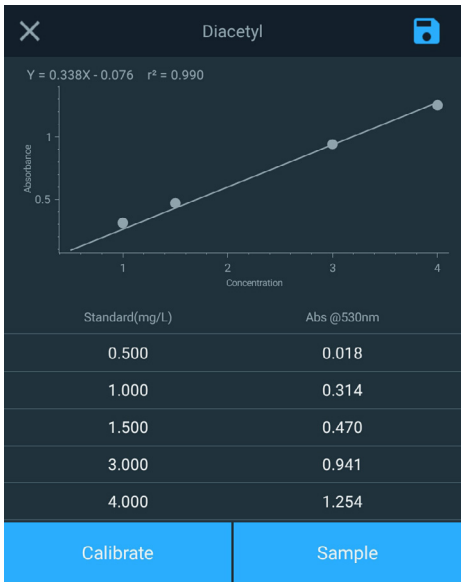
Thermo Scientific™ GENESYS™ 150 UV-Vis Spectrophotometer

Easily measure beer diacetyl:



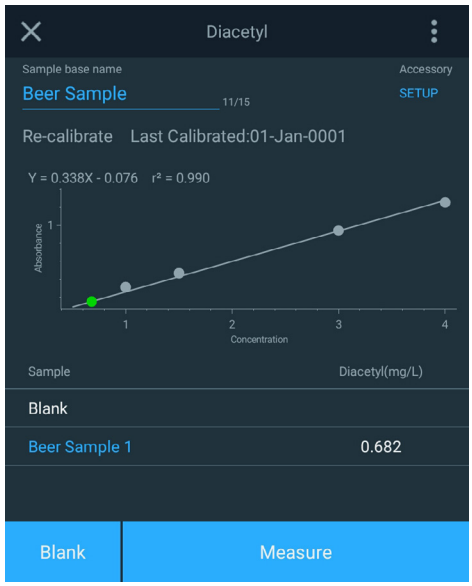
1

Open the GENESYS BeerCraft Software and select Diacetyl. Select Re-calibrate



2

Select Calibrate to enter the concentration of the standards and measure the absorbance



3

Blank the instrument and measure the sample to determine the diacetyl concentration

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Results

The calculations determined that the VDK concentration in this beer sample was 0.682 mg/L. This high VDK concentration could indicate the need for additional time during fermentation for the yeast to properly break down the VDKs. The spectroscopic test for VDKs is advantageous over the organoleptic test in that it can save the brewer days of production with a certainty they can move to the next step by giving quantifiable numbers in a shorter time. At a relatively low cost, the GENESYS UV-Vis Spectrophotometer is a worthwhile investment that will provide significant payback over time. A GC method is often used for measuring VDKs, but this method has a number of limitations compared to the spectroscopic method including a large cost investment on equipment, the need for a skilled operator, various testing and safety factors, the need to purchase gas tanks, and extended run times for each analysis. The spectroscopic method of VDK analysis offers brewers the ability to obtain analytical data on the quality of their beer sample at an affordable price.

References

1. *ASBC Methods of Analysis, online. Beer 25. Broad Spectrum Method for VDK Approved 1964. American Society of Brewing Chemists, St. Paul, MN, U.S.A: 10.1094/ASBCMOA-Beer-25*

Related chemicals ordering information

Description	CAS number
α-naphthol	90-15-3
isopropanol	67-63-0
vegetable carbon black	7440-44-0
creatine	57-00-1
potassium hydroxide	1310-58-3
diacetyl	431-03-8