Predicting colloidal stability in beer

Beer stability can be judged by the degree to which a beer tastes and looks as good at the end of its shelf life as it did when it was first packaged. Most customers "drink with their eyes". They are often more willing to accept a glass of beer which does not taste quite right, over a glass of beer which is hazy. Hence colloidal stabilisation is often considered a more important attribute than flavour stability.

Technical Summary 4

The fourth in this series of technical summaries for the Institute & Guild's AME candidates. By Tim O'Rourke.

In the first article of this series (January 2002) stability was related to both the flavour and colloidal instability which can occur in beer as a result of oxidation reactions principally during and after packaging. Through the use of modern colloidal stabilisers it is possible to produce beer which shows improved colloidal stability. This article will cover the measurement and prediction of colloidal stability.

When it comes to assessing colloidal stability of a beer for the duration of its shelf life there are three principal methods:

• ABSOLUTE ACCURACY: - keeping the beer at ambient and measuring haze at the end of its stated shelf life (best before date – e.g. 12 months)

• RELIABLE INDICATOR – using some form of accelerated ageing (forcing test) on the packaged beer (e.g. 4 weeks at 37°C is equivalent to 1 months storage at ambient) and relating the date to absolute results.

• PREDICTIVE TEST – using a measurement usually related to the proteins or polyphenol content of the beer to predict the probable rate of production of haze and hence the shelf life.

Typically bright beer is packaged with an EBC haze of less than 0.8 units. The critical haze for stored beer is usually less than 2 or 3 EBC units for beer at 0°C.

Keeping beer to the end of its shelf life to evaluate its colloidal stability is pointless except as an assurance exercise but it is essential to calibrate rapid prediction methods.

Accelerated ageing tests

These tests are aimed at stressing the beer usually by subjecting the beer to either hot or cold conditions to produce "accelerated" aging. Almost every brewing company has its preferred method. A few are listed below:

European Brewery Convention (1963 method).
The beer is held at 60°C for 7 days then cooled to 0°C for 24 hours and the haze measured.

Harp method
The beer is stored for 4 weeks at 37°C followed by 8 hours at 0°C and the haze measured. In this method forced haze development is equated to normal storage time. One member of the consortium related 1 weeks forced aging to 1 month of storage under normal conditions, while another equated 4 weeks of forced storage to 6 months of storage under normal conditions.

The forcing tests have to be correlated to normal storage conditions as shown in Figure 1.

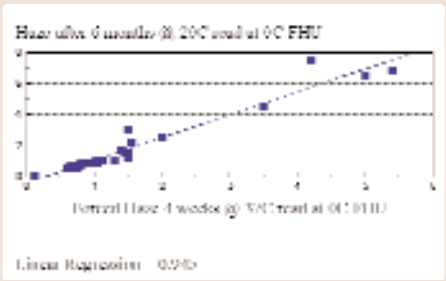

Fig 1: Correlation between forced haze and absolute haze development.

Cycle tests – European Brewery Convention (1975 method)
The beer is kept overnight at 0°C and the haze read to establish the base line. The beer is placed in a heated water bath at 60°C and then kept overnight at 0°C and the haze checked again. This shows the rate of haze development and can be repeated over number of cycles.

Although these methods are faster than the absolute test, they still take a number of days to several weeks to complete, by which time the beer has been released and found its way in trade. It is a reactive rather than a proactive test.

Predictive tests

What every brewer would like is a test, which can predict the colloidal stability and therefore the expected shelf life of the beer.

There are a number of factors which influence colloidal stability (see Technical Summary, January 2002), however given similar beer brands and brewery equipment, the principal variables will come from the protein and polyphenol content of the beer. These are usually measured when predicting colloidal stability.

Looking at the protein (polypeptide) content

Chilling test
A sample of the beer is chilled below 0°C to as low as -8°C without freezing (often alcohol has to be added) and left for 8 hours and chill haze measured. The lower the chill haze the greater the stability. The chill haze is principally the protein fraction.

Sensitive Protein – Titration with tannic acid
Tannic acid is a "super" polyphenol which readily forms insoluble complexes with protein. A given amount of tannic acid is titrated against a given volume of beer to give a haze measurement which relates to its stability

Ammonium Sulphate Precipitation (SASPL)
Saturated ammonium sulphate is titrated against a sample of beer where it forms an insoluble precipitate with larger molecular weight polypeptides (m.w. 210,000). The precipitate drops out and once all the proteins have been removed, the haze starts to increase giving an measurement of the amount of high molecular polypeptides in the beer.

Looking at the polyphenol content.

Titrating with PVP
This is a nephelometric titration of soluble PVP (polyvinyl pyrollidone) solution. PVP has a similar structure to a protein molecule and readily forms an insoluble precipitate with polyphenols, particularly medium size molecular weight polyphenols often called tannoids, which are know to be haze active. When the PVP is titrated in beer a haze is formed. This increases to a maximum and then decreases by a dilution effect as PVP addition continues. The peak value gives a measure of the "tannoids" which can be correlated with chill-stability.

High Performance Liquid Chromatography
Polyphenols can be adsorbed on Sephadex LH 20 and can be identified using 4-dimethylaminocinnamaldehyde as a chromogen. The individual polyphenols can then be measured directly.

These predictive tests can be used to →

produce rapid results for beer prior to packaging, but the results have to be correlated with actual storage data.

For best results the data should be set up per brand (product quality) and per brewery to reduce the amount of outside influences distorting the stabilisation results.

As well as predicting the potential shelf life of a beer, these methods are useful in determining the optimum dosage rate of a beer stabilisation treatment. See figure 2.

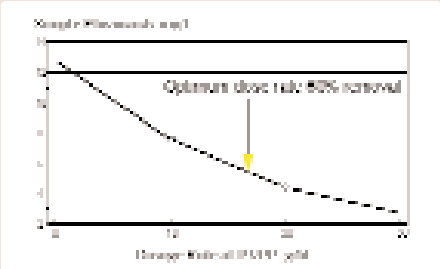

Figure 2: Determining the optimum dose rate for a beer stabilisation treatment.

Automated measurements

To help the brewer, some of the methods described above have been automated.

Tannometer

This instrument measures the turbidity of a liquid sample in the range of 0 to 300 EBC in units of 0.01 EBC. It works on transmitted light at 510nm and the instrument can control the sample temperature including cooling it down to -8°C. The Tannometer can produce automated results for:

- Tannoid content
- Chill haze
- Sensitive Protein
- SASPL

PT Standard

Uses a series of specially developed reagents to the measure the protein and polyphenol content of a beer through titration and the results can be simply displayed on a computer allowing the brewer to see immediately the relative stability of his beer and decide what further treatment – protein or polyphenol, could be used to achieve the required stability. See figure 3.

Summary

There are a number of methods which can be used to predict colloidal stability and hence the shelf life of a beer. The principle reactions occur between the protein and polyphenol fractions and hence the most consistent results come by looking at the levels of both fraction.

The test and storage data are usually collected under ideal (laboratory) conditions.

Packaged beer faces a much greater extreme of conditions in the real world, particularly those in the export trade, and it is export beers which are usually those consumed near or at the end of their shelf life.

For those brewers anxious to deliver their beer to the consumer in prime quality they must not only look at the predicted stability of the beer in the brewery, but consider the hazards the beer may be subjected to during storage and in the supply chain and take appropriate remedial action.

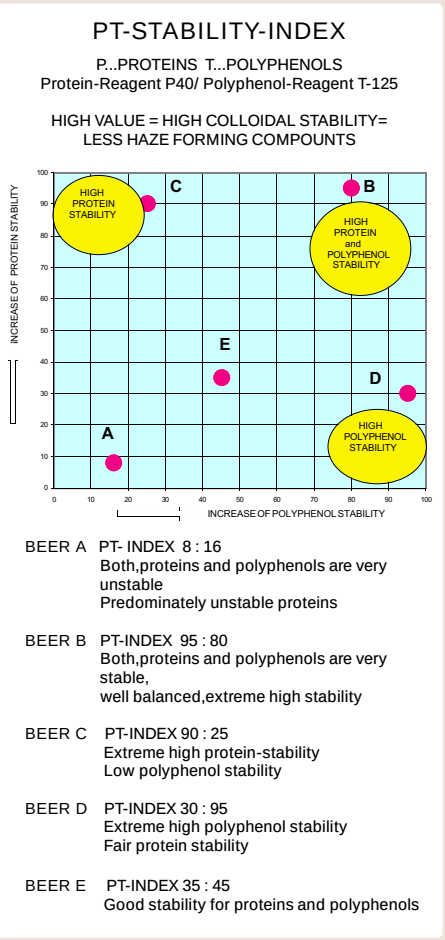

Figure 3: Predicting beer stability using PT standard.

Further Reading

Tim O'Rourke: Beer Stabilisation *Brewer International* – January 2002.

Tim O' Rourke *et al*: from poster presented at Perth Convention - Ferment June 1998 - p189.

Tim O' Rourke: Back to Basics, *Brewers Guardian* February 2000 - p29.

Jurgen Schneider: Opto-electronic regulations of stabilisation inputs – *Brewers Guardian* July 2000.

M Moll: Colloidal Stability of Beer – *Brewing Science Vol 3* ed Pollock.

I. McMurrough I *et al*: Effect of PVPP dosage on the flavanoid content of beer and consequences for beer quality – *Brew Digest* 59 (10) 1984.