A Simple, Quantitative Approach to Beer Freshness

Michael Koppelman, Head Brewer, Badger Hill Brewing, LLC, Shakopee, MN USA

Beer is a perishable product and brewers spend a considerable amount of effort managing freshness and setting freshness expectations for their customers. Here we present a simple, quantitative approach to freshness in a unitless ratio, which we refer to as the “freshness ratio”, which is the total amount of heat experienced by the beer, in units of degree-days, with respect to the maximum amount of heat allowed according to the specification of the brewer. A brewer may determine that a given beer expires after 120 days at 3˚C. The freshness ratio implies that the same beer would expire after just 18 days at room temperature. This allows quantitative analysis of processes and even, perhaps, detection of heat exposure in the form of a “freshness badge” on the product itself.

THE PROBLEM

Brewers of craft beer and their consumers want to be confident that the beer they are drinking tastes as intended. Craft beer is generally unpasteurized and thus highly sensitive to temperature. Brewers set freshness expectations with “best by” coding on their packaging. The problem is this information doesn’t convey anything about the conditions the beer was subject to between packaging and consumption. As is well known, the age of beer is a function of its chronological age and the temperatures it has been subject to during its lifetime. It would be ideal if brewers could measure the amount of heat their product was subjected to in the distribution chain.

THE CONCEPT

The most simple way of looking at heat exposure is to look at the temperature as a function of time. A rule of thumb for many brewers is that beer kept at a constant 3–4˚C (38˚F) will retain its intended flavor for 90 days. Thus they beer can be exposed to 300 degree-days of heat exposure (3.33˚C*90days=300˚C-days). We are ignoring any scale factor and encapsulating all microbiological processes of aging into this single variable. We are only looking at the first-order (linear) situation where twice as much time or twice the temperature equates to half the freshness. This can be expressed as a unit-less ratio of the actual degree-days the product is exposed to versus that specified by the brewer for the product in question.

A LITTLE MATH

“It can be safely said that all beers are susceptible to flavor degradation due to aging…Oxygen, time and increased temperatures are the three basic elements for causing oxidation in packaged beer.” (McCabe 1999)

From a biological perspective, aging is process that is a function of temperature (need reference), with aging essentially non-existent at freezing and reaching a maximum at around 100˚F (38˚C). We can think of the age of the beer as the integral of the temperature (T) as a function of time.

$$\Omega = \int T dt$$

Which in actuality is generally discrete events at a certain temperature for a certain time.

$$\Omega = \sum_{x=0}^{n} T_x t_x$$

The freshness ratio is just the ratio of the actual conditions versus those specified by the brewery:

$$f = \frac{(\Omega)_{avg}}{\Omega_{spec}}$$

…where Ω_{spec} is specified by the brewer.

Using units of Celsius degrees and days, the product of the temperature of the beer and the time spent at that temperature represents a crude measure of the amount of heat the beer was exposed to. A beer that expires after 90 days at 3˚C, for example, can be exposed to 270 degree-days of heat. If stored at 9˚C the beer will expire in 30 days (i.e. have a freshness ratio of 1).

Beer that is exposed to less than maximum conditions have a freshness ratio less than 1. For example, beer kept at 3˚C for 7 days has a freshness ratio of 8%, meaning it is at 8% of its maximum age and is thus very fresh. Freshness ratios greater than 1 are situations where the beer is older, in this theoretical sense, than is specified. A beer stored at room temperature for a month has a freshness ratio of 2.3, indicating more than twice the heat exposure than 90 days at 3˚C mentioned.

Figure 1

IMPLEMENTATION

In theory it would be possible to create a small badge or patch that is placed directly on packaging to measure and indicate the amount of heat exposure experienced by the package and hence the beer. Brewers could place the badges on certain pallets and later read off the data to gain insight on the delivery chain handling of the product. Some might choose to bring that information to the consumer so they can see for themselves the “freshness age” of the product at the time of purchase or consumption. See Figure 1. In this case the manufacturer would activate the badge by exposing it to the air when the package is filled. This would provide consumers with scientific, accurate, timely and convenient information about the freshness of their beer. This is a subject of paramount importance to brewers.

REFERENCES

McCabe (ed.), Schmidt, Kluba, 1999, Master Brewers Association of the Americas, *The Practical Brewer*, p. 390