

A Comparison of Three Methods for the Assessment of Foam Stability of Beer

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ABSTRACT

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Three methods for measuring foam stability were assessed using nine different beers. The methods were the NIBEM instrument of Haffmans, the device marketed by Steinfurth and the manual procedure developed by Constant. There were reasonable-to-good correlations when the foam stability of all the beers, as determined by the individual methods, were compared one with another. However when individual beers were studied, it appeared that different techniques rank them in somewhat different sequences. All of the methods demonstrated the superior foam stability of examined ales over lagers, however there were some differences in ranking of beer foam quality, in particular with the beers bittered with reduced iso- α -acids, which performed better when assessed by methods that quantified the foam itself, rather than drainage.

Key words: comparison, foam, instrument, manual method, ranking.

INTRODUCTION

Over the years a substantial number of methods have been proposed for assessing the foam stability of beers³. In part this speaks to the complexity of the foam phenomenon, with aspects of foam formation, appearance, retention, lacing and robustness meaning that a single assay is unlikely to address all of these issues.

Perhaps the most important of these parameters is foam stability (head retention), for it can fairly be argued that it will not be achieved without foam having been formed in the first place and, in turn, lacing and resistance to damage (aka robustness) will not occur without an inherent perseverance to the head.

Recently we have performed research using three methods for assessing foam stability and have described that each correlates well with the perception of foam quality and also each has inherent reproducibility^{1,5,7}. The NIBEM procedure depends on the conductimetric assessment of the collapse of foam, i.e., it fundamentally assesses collapse of the foam per se. The Steinfurth technique relies on the optic assessment of the movement of the foam-liquid beer interface, i.e., it primarily gauges drainage.

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There are adherents, however, to methods that do not demand investment in such relatively sophisticated equipment. One such method is that of Constant², that involves the monitoring of total height (foam plus beer) and liquid height (beer beneath foam) over a 5 minute period and computing the stability of the foam from the changes in these measurements. Various parameters can be calculated, of which perhaps the most significant is foam half-life.

In the present paper we compare the performance of three procedures: the instrumental methods of NIBEM and Steinfurth and the Constant procedure.

MATERIALS AND METHODS

The NIBEM foam measurement system

The NIBEM-T(PH) foam stability instrument was supplied by Haffmans B.V. (Venlo Holland) and operated according to manufacturer's instructions. The instrument measures the time taken for the surface of a reproducibly-dispensed foam to collapse by 10 mm, 20 mm and 30 mm as assessed using conductivity. A movable plate with three electrodes is lowered to make contact with the surface of the foam. As the foam collapses, contact between the electrodes and the foam is lost, leading to the instrument moving the plate down to restore contact. The measured rate at which the plate is lowered quantifies the rate of collapse of the foam.

Operation of the Steinfurth foam measurement system

The Steinfurth Foam Stability tester was supplied by Steinfurth (Fayetteville, GA) and operated according to their manual. Beer is foamed by injection through a nozzle into the glass cylinder of the apparatus. The foam slowly decays to beer, which collects at the bottom of the cylinder. Two optoelectronic sensors detect the passing of the boundary between remaining foam and beer. The foam stability figure is then calculated from the time necessary for the third quarter (50% to 75%) of beer foam to decay.

The constant method

The method as delineated by Constant² was followed, with measurement of liquid height (L) and total height (T) (in duplicate) after elapsed times (t) in the range 0-5 min. Foam height (F) is calculated according to (T - L) and the rate of foam collapse calculated according to

$$\ln(F) = a + bt$$

In turn, foam half-life (min) was determined as $\ln(0.5) / b$.

Table I. Beers studied.

Beer	Description
A	American amber ale (34 Bitterness Units, BU)
B	All malt American pale ale (37 BU)
C	American lager, corn syrup adjunct (10 BU)
D	American lager, corn syrup adjunct, reduced hop preparation (12 BU)
E	American lager, rice adjunct (11 BU)
F	American light lager, corn syrup adjunct, reduced hop preparation (10 BU)
G	American light lager, corn syrup adjunct (9 BU)
H	Low carbohydrate American lager (4 BU)
I	American light lager, rice adjunct (10 BU)

This is a pour method, to contrast with the NIBEM and Steinfurth procedures, which rely on instrumental measurement of foam generated by forcing beer under pressure through an orifice.

Beers

Beers were purchased locally and are described in Table I. Six different bottles of each beer were assessed for foam by each of the three methods.

RESULTS AND DISCUSSION

Reproducibility of the methods

For the Constant method, T values showed a Coefficient of Variance (CV) value of 7.0% or better, while the CV value for L was equal to or better than 5.0%. In each case, mean values were used to calculate foam half life. The Steinfurth procedure had CV values of 4.2% or better and the NIBEM procedure gave CV values of 1.5% or better.

Comparison of foam methods

Correlations between the three methods have been drawn (Fig. 1.) A reasonable proportionality was found between the procedures for their ability to measure foam stability. The correlation between the NIBEM and Constant procedures was the strongest ($R^2 = 0.756$), followed by that between NIBEM and Steinfurth ($R^2 = 0.722$) and Steinfurth and Constant ($R^2 = 0.629$). As such, adherents to each method can be confident that their preferred method is affording the opportunity to assess foam stability.

Ranking of beer for foam stability by the three methods

The mean foam stability values (mean of six samples) for the nine beers studied are shown in Table II. The methods differ somewhat in their ranking of the beers. Thus whilst one of the ales was ranked first by the instrumental methods, the Constant procedure rated the other ale as superior.

The other product that gave divergent performance was the regular beer bittered with reduced pre-isomerized extract (Beer D). The Steinfurth procedure scored it rather low, whereas the other two methods ranked it more highly. We presume this relates to the fact that the Steinfurth method is weighted towards assessment of liquid drainage, which may be relatively rapid from a foam that is stiffened by the presence of reduced iso- α -acids,

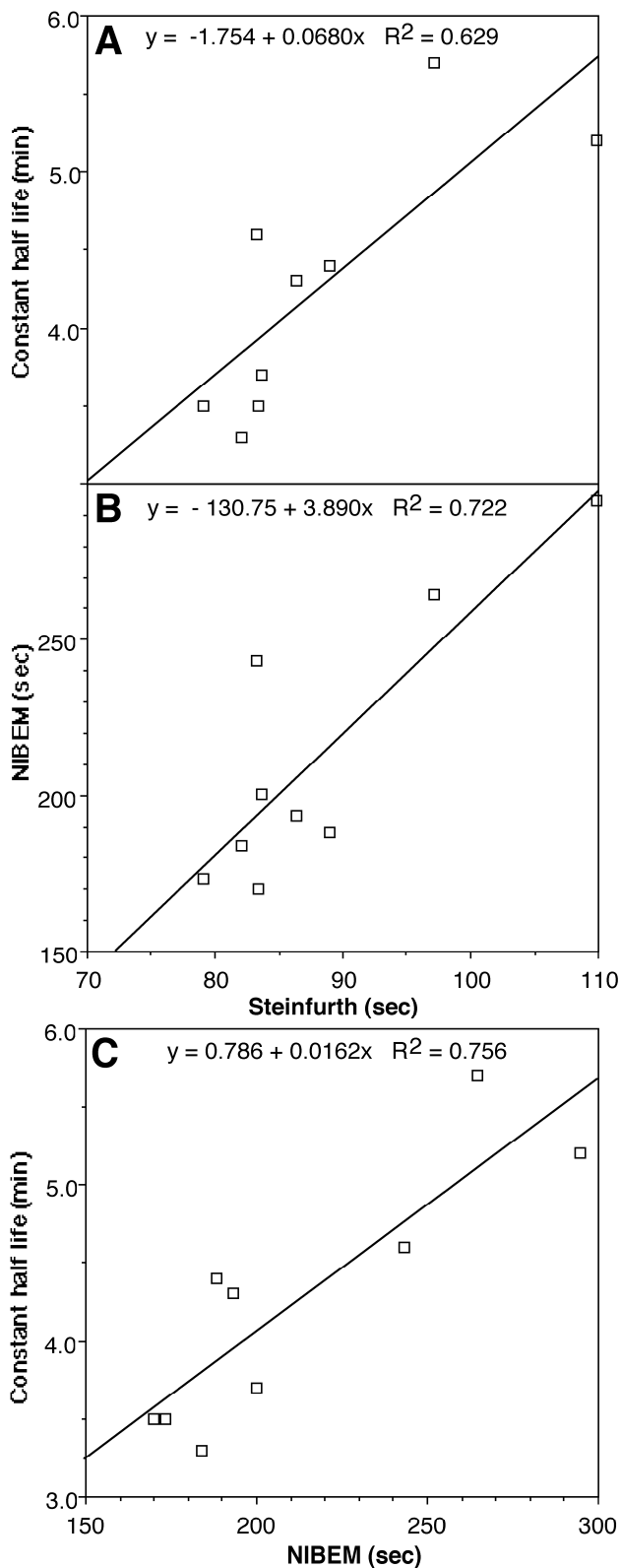


Fig. 1. (A) Comparison of foam stability as assessed by the methods of Constant and Steinfurth. (B) Comparison of foam stability as assessed by the methods of NIBEM and Steinfurth. (C) Comparison of foam stability as assessed by the methods of Constant and NIBEM.

Table II. Comparison of foam methods for the assessment of individual beers.

Beer	Steinfurth (mean reading(s), standard deviation and ranking)	NIBEM (mean reading(s), standard deviation and ranking)	Constant (mean reading(s) (min), standard deviation and ranking)
A	109.9 (1.08) [1]	294.5 (8.6) [1]	5.2 (0.42) [2]
B	97.2 (0.84) [2]	264.5 (5.0) [2]	5.7 (0.42) [1]
C	89.0 (0.48) [3]	188.2 (1.2) [6]	4.4 (0.23) [4]
D	83.2 (0.87) [7]	243.3 (3.9) [3]	4.6 (0.42) [3]
E	86.3 (0.30) [4]	193.3 (2.4) [5]	4.3 (0.27) [5]
F	83.6 (0.81) [5]	200.2 (6.8) [4]	3.7 (0.56) [6]
G	83.4 (0.49) [6]	170 (2.1) [9]	3.5 (0.35) [7=]
H	82.1 (1.05) [8]	184 (5.3) [7]	3.3 (0.32) [9]
I	79.1 (0.82) [9]	173.5 (4.5) [8]	3.5 (0.34) [7=]

whereas because of that stiffening, there is an inherent hold-up of foam collapse per se, which is the parameter that the other two methods especially detect. Beer F is also bittered in this way, and again the ranking by NIBEM (though not by Constant) was higher than when using the Steinfurth procedure. It has been demonstrated that beers with high bitterness display better foam stability and that reduced iso- α -acids afford better foam stability than the equivalent bitterness delivered in the form of unreduced bitter acids^{4,6}.

With these exceptions the other lager style beers performed similarly to one another: that is, substantially poorer than the ales.

CONCLUSIONS

There was a broad correlation between the three different procedures for assessing foam stability: the instrumental technique that assessed foam decay directly, the instrumental technique that assessed drainage, and the simple manual technique that fundamentally measured foam survival. Each of the methods displayed good reproducibility. All of the methods demonstrated the superior foam stability of examined ales over lagers, however there were some differences in ranking of beer foam quality, in particular with the beers bittered with reduced iso- α -acids,

which performed better when assessed by methods that quantified the foam per se, rather than drainage.

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