

Determination of Boiled Wort Colour

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on behalf of the Analysis Committee of the European Brewery Convention.

A method for the determination of boiled wort colour has been collaboratively tested by the Analysis Committee of the European Brewery Convention. In this trial the 14th EBC Standard Malt and two commercial malts were tested by 21 laboratories. Repeatability (r_{95}) and reproducibility (R_{95}) values of 0.33 - 0.42 and 1.12 - 1.44 EBC units were obtained respectively at a mean level of 4.7 - 5.2 EBC units. At a mean level of 8.9 EBC units these respective values were 0.44 and 2.25 EBC units. The data sets could be split into two sub-sets for laboratories using either the included heating plate boiling procedure or the glycerol/oil bath boiling procedure. Statistical analysis of both sub-sets revealed that reproducibility is unambiguously better for the glycerol/oil bath procedure at all levels. For repeatability the situation is less clear. The evaluated method is recommended for inclusion in Analytical-EBC.

INTRODUCTION

The Analysis Committee of the European Brewery Convention decided to evaluate a method for the determination of boiled wort colour. The method was a synthesis of two other methods which were different in the boiling procedure applied, viz, using a heating plate and glycerol/oil bath procedure. Both boiling procedures

were hosted in the method tested here. A collaborative trial was organised in which originally 21 laboratories participated.

EXPERIMENTAL

The organisation of the collaborative trial and the statistical treatment of the data were carried out

TABLE I. Raw data obtained for the boiled wort colour determination (EBC units).

Laboratory	Malt A		Malt B		Malt C	
1	5.30	5.35	9.85	10.15	5.30	–
2	3.70	3.80	7.00	7.20	4.40	4.60
3	4.80	5.00	9.60	9.20	5.10	5.40
4	4.90	5.00	9.80	9.50	5.30	5.60
5	4.74	4.75	9.16	9.17	5.36	5.37
6	4.03	4.23	8.30	8.28	4.55	4.63
7	3.70	3.60	7.92	8.00	3.62	3.75
8	4.80	4.84	9.57	9.66	5.19	5.21
9	5.00	5.10	9.55	8.80	6.00	5.15
10	3.68	3.90	8.18	7.63	4.33	5.13
11	4.48	4.30	7.90	7.78	5.13	5.20
12	5.34	5.35	8.80	9.06	8.16*	7.94*
13	5.80†	5.15†	8.52*	9.54*	5.40	5.29
14	4.83†	4.35†	8.85	8.55	5.48	5.28
15	4.74	4.75	9.22	9.24	5.48	5.50
16	4.62	4.75	9.27	8.90	5.28	5.00
17	4.60	4.78	8.78	8.95	5.30	5.25
18	4.88	4.95	9.12	9.32	5.18	5.25
19	4.68	4.70	9.15	9.33	5.65	5.40
20	5.38	5.48	9.95	10.15	5.93	5.98
21	4.65	4.85	7.90	7.63	4.50	4.68
22	4.23	4.18	8.40	8.43	4.68	4.65

Boiling procedure: laboratories 1 - 8 heating plate, laboratories 9 and 10 heating mantle (data not used); laboratories 11 - 22 glycerol/oil bath.

- † Straggler according to Cochran
- * Outlier according to Grubbs (eliminated)

according to the procedure given in the International Standard ISO 5725¹. The trial employed a balanced uniform-level experiment. Two industrial malts (A and B) and the 14th EBC Standard Malt (C) were distributed to the participating laboratories together with the method description. Soluble nitrogen contents for malts A – C were 0.80, 0.83 and 0.72% d.m. respectively². Corresponding malt colours were 2.6, 4.8 and 2.6 EBC units respectively³. Participants were requested to analyse the samples and to specify the boiling procedure(s) they had used.

RESULTS AND DISCUSSION

Results were received from 21 laboratories. The raw data are presented in Table I. Two laboratories (9 and 10) employed a heating mantle for boiling and, therefore, their data were excluded from statistical processing. Laboratory 1 sent only one result for malt C and equally the result was eliminated. An incorrect sample of malt C was sent to laboratory 7. Therefore, the corresponding results were excluded. One laboratory employed both boiling procedures (lab 5 = lab 15). Stragglers according to the Cochran test were identified for two data sets of malt A and one data set of malt C. One Grubbs outlier was removed for both malt B and C.

The precision data are given in Table II. The mean values for malts A and C are on the same level, whereas malt B yields a substantially higher mean value. The ratios between boiled wort colour data and malt colour data are 1.8, 1.9 and 2.0 for malts A - C respectively. This is in correspondence with usual ratio values based on extensive practical experiences with this method for pale malt worts. Repeatability data for the heating plate boiling procedure in comparison to those for the glycerol/oil bath procedure are better for malt A, but comparable or worse with both other malts.

Reproducibility data for the glycerol/oil bath procedure, however, are better with all malts tested. In general, the repeatability data are substantially better than those obtained for malt colour for both the whole data set and the two sub-sets analysed separately. For reproducibility these values are higher but still in line with the corresponding malt colour data⁴. Again, reproducibility data for malts A - C using the glycerol/oil bath procedure meet those for malt colour the best, giving acceptable reproducibility data ratios of 1.4 -1.7.

CONCLUSION

The result of this collaborative trial showed that repeatability and reproducibility values for the determination of boiled wort colour are at an acceptable level. The precision data for the glycerol/oil bath boiling procedure are better than those obtained for the heating plate procedure, especially with respect to reproducibility. Based on these results the Analysis Committee of the European Brewery Convention has decided to recommend the evaluated method for incorporation in Analytica-EBC.

REFERENCES

1. International Standard, ISO 5725. Precision of test methods, Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests, 1994.
2. European Brewery Convention, Analytica-EBC, 5th edition, Verlag Hans Carl Getränke-Fachverlag, Nürnberg, 1998, method 4.9.
3. European Brewery Convention, Analytica-EBC, 5th edition, Verlag Hans Carl Getränke-Fachverlag, Nürnberg, 1998, method 4.7.1.
4. White, F. H., *Journal of the Institute of Brewing*, 1995, 101, 431.

TABLE II. Summary of precision data (EBC units)

Malt Samples	Boiling procedure	Number of Laboratories	Mean	r ₉₅	R ₉₅
A	both	20	4.7	0.42	1.44
	glycerol/oil bath	12	4.8	0.51	1.18
	heating plate	8	4.5	0.24	1.72
B	both	19	8.9	0.44	2.55
	glycerol/oil bath	11	8.9	0.43	1.87
	heating plate	8	8.9	0.44	2.84
C	both	17	5.2	0.33	1.12
	glycerol/oil bath	11	5.3	0.29	1.09
	heating plate	6	5.1	0.39	1.18