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Analytica-EBC – Precision values of wort analyses

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

In Analytica-EBC (1) method 8.3: Specific Gravity of Wort by Density Meter, method 8.4: Viscosity of Wort: Glass Capillary Viscometer (IM), method 8.5: Colour of Wort: Spectrophotometric Method (IM), method 8.7: Fermentable Carbohydrates in Wort by HPLC (IM), method 8.8: Bitterness of Wort (IM), method 8.9.1: Total Nitrogen in Wort: Kjeldahl Method and method 8.11: Zinc in Wort by Atomic Absorption Spectrophotometry (IM) are described, but repeatability (r_{95}) and reproducibility (R_{95}) values are missing. So these methods have been collaboratively tested by members of the Analysis Committee of the European Brewery Convention in 1999 to obtain the corresponding precision data. In method 8.12: Total Polyphenols in Wort by Spectrophotometry the precision values are missing as well, but because of testing a new ammonium ferric citrate reagent the data have been postponed. The worts analyzed had extract contents of ca 18°P (% m/m), 14°P, 12°P, 10°P and 8°P respectively. The precision values are listed below.

BC 35 Wort

(Descriptors: Analysis methods, collaborative test, accuracy.

Deskriptoren: Analysenmethoden, Ringanalyse, Genauigkeit).

1 Introduction

The Analysis Committee of the European Brewery Convention decided to complete some wort analyses described in Analytica-EBC by precision values concerning repeatability (r_{95}) and reproducibility (R_{95}). An interlaboratory trial was organised in which a varying number of laboratories (n) participated dependent on the method in question.

2 Experimental

The organisation of the collaborative trial and the statistical treatment of the data were performed according to the procedures given in the International Standard ISO 5725 (2). Two trials were undertaken using a uniform design.

An industrial high gravity brewed and pasteurised wort with ca 18°P (% m/m) was circulated among the participating laboratories. Participants were asked to determine the original wort and diluted worts (dilutions with water made by weight per weight to concentrations of ca 14°P, 12°P, 10°P and 8°P respectively)

3 Results and Discussion

The basic data received for the methods in question are presented below.

Whenever the observations of data suggested inhomogeneity of variance the Cochran's test was used, for dealing with stragglers and outliers among the mean values the Dixon's test and the Grubbs' test were used.

Following the results set out in tables below the overall precision values are given.

Precision values (n = number of participating laboratories, m = mean value)

	Range	r_{95}	R_{95}
Specific Gravity (n = 14)	1.03200 to 1.07450	0.00008	0.00035
	1.07450	0.00012	0.00057
In terms of °P (% m/m)	8 to 14	0.02	0.08
	18	0.03	0.13
Viscosity, mPas (n = 11 to 12) (See Note under Results and Discussion)	1.46 to 2.51	0.02	-0.03 + 0.123 m
Colour, EBC Units (n = 13 to 14)	7 to 16	0.1	1.52 + 0.12 m
Bitterness, BU (n = 14 to 15)	18 to 42	-0.36 + 0.05 m	0.72 + 0.14 m
Total Nitrogen, mg/l (n = 11)	700 to 1650	24	34 + 0.06 m
Fermentable Carbohydrates, g/100 ml (n = 6) *	5.57 to 13.13	0.56	0.76 + 0.24 m
Zinc, mg/l (n = 6 to 7) *	0.22 to 0.46	0.024	-0.073 + 0.806 m

* For the analytes Fermentable Carbohydrates and Zinc a little number of results was collected, so the values r_{95} and R_{95} respectively should be considered as a guide only.

3.1 Extract, % m/m

(derived from Analytica-EBC, method 8.3 Specific Gravity by Density Meter)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
1	18.02	18.01	0.01	18.02
2	18.12	18.12	0.00	18.12
3	17.85	17.79	0.06*	17.82**
4	18.08	18.08	0.00	18.08
5	18.03	18.04	0.01	18.04
6	18.10	18.10	0.00	18.10
7	18.10	18.10	0.00	18.10
8	18.15	18.13	0.02	18.14
9	18.12	18.14	0.02	18.13
10	18.07	18.07	0.00	18.07
11	18.08	18.08	0.00	18.08
12	17.99	17.99	0.00	17.99
13	18.10	18.11	0.01	18.11
14	18.08	18.10	0.02	18.09
15	18.12	18.15.	0.03	18.14

* Cochran-Test: Outlier. C = 0.600 > 0.575 (1%)
** Dixon-Test: Straggler. Q = 0.565 (5 %) < 0.629 < 0.647 (1%)
n = 14. Mean = 18.09. r_{95} = 0.03. R_{95} = 0.13

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
1	14.01	13.99	0.02	14.00
2	14.09	14.08	0.01	14.09
3	13.78	13.83	0.05*	13.81**
4	14.05	14.05	0.00	14.05
5	14.03	14.03	0.00	14.03
6	14.06	14.07	0.01	14.07
7	14.06	14.06	0.00	14.06**
8	14.11	14.10	0.01	14.11
9	14.06	14.07	0.01	14.07
10	14.04	14.05	0.01	14.05
11	14.04	14.04	0.00	14.04
12	14.06	14.05	0.01	14.06
13	14.07	14.07	0.00	14.07
14	14.09	14.09	0.00	14.09
15	14.12	14.11	0.01	14.12

* Cochran-Test: Outlier. C = 0.694 > 0.575 (1%)
** Dixon-Test: Outlier. Q = 0.789 > 0.647 (1%)
n = 14. Mean = 14.07. r_{95} = 0.02. R_{95} = 0.09

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
1	12.02	12.00	0.02	12.01
2	12.09	12.08	0.01	12.09
3	11.87	11.96	0.09*	11.92**
4	12.04	12.04	0.00	12.04
5	12.07	12.07	0.00	12.07
6	12.08	12.07	0.01	12.07
7	12.07	12.07	0.00	12.07
8	12.13	12.10	0.03	12.12
9	12.09	12.09	0.00	12.09
10	12.08	12.08	0.00	12.08
11	12.04	12.05	0.01	12.05
12	12.09	12.07	0.02	12.08
13	12.08	12.08	0.00	12.08
14	12.08	12.09	0.01	12.09
15	12.14	12.14	0.00	12.14

* Cochran-Test: Outlier. C = 0.794 > 0.575 (1%)
** Dixon-Test: Outlier. Q = 0.714 > 0.647 (1%)
n = 14. Mean = 12.08. r_{95} = 0.03. R_{95} = 0.09

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
1	10.02	10.01	0.01	10.02
2	10.06	10.06	0.00	10.06
3	9.88	9.90	0.02	9.89**
4	10.05	10.05	0.00	10.05
5	10.03	10.03	0.00	10.03
6	10.06	10.07	0.01	10.07
7	10.06	10.06	0.00	10.06
8	10.09	10.10	0.01	10.10
9	10.09	10.09	0.00	10.09
10	10.06	10.06	0.00	10.06
11	10.12	10.13	0.01	10.13
12	10.08	10.07	0.01	10.08
13	10.07	10.07	0.00	10.07
14	10.05	10.07	0.02	10.06
15	10.10	10.10	0.00	10.00

** Dixon-Test: Outlier. Q = 0.683 > 0.647 (1%)
n = 14. Mean = 10.06. r_{95} = 0.02. R_{95} = 0.08

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
1	8.04	8.04	0.00	8.04
2	8.05	8.05	0.00	8.05
3	8.01	7.95	0.06*	7.98**
4	8.04	8.04	0.00	8.04
5	8.03	8.03	0.00	8.03
6	8.04	8.04	0.00	8.04
7	8.04	8.04	0.00	8.04
8	8.08	8.10	0.02	8.09
9	8.06	8.07	0.01	8.07
10	8.05	8.05	0.00	8.05
11	8.02	8.03	0.01	8.03
12	8.06	8.07	0.01	8.07
13	8.05	8.05	0.00	8.05
14	8.05	8.05	0.00	8.05
15	8.11	8.11	0.00	8.11

* Cochran-Test: Outlier. C = 0.842 > 0.575 (1%)
** Dixon-Test: Straggler. Q = 0.565 (5%) < 0.588 < 0.647 (1%)
n = 14. Mean = 8.05. r_{95} = 0.01. R_{95} = 0.07

Precision

The precision values (% m/m, derived from the specific gravity of the wort determined by density meter) deduced from the results of fourteen laboratories analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
8 to 14	0.02	0.08
18	0.03	0.13

3.2 Viscosity, mPas (Analytica-EBC, method 8.4)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
1	2.676	2.676	0.000	2.670
2	1.989	1.964	0.025	1.977**
4	2.440	2.440	0.000	2.440
6	2.497	2.493	0.004	2.495
7	2.513	2.489	0.024	2.501
8	2.556	2.553	0.003	2.555
9	2.663	2.639	0.024	2.651
10	2.490	2.500	0.010	2.495
11	2.527	2.525	0.002	2.526
12	2.531	2.539	0.008	2.535
13	2.299	2.302	0.006	2.301
15	2.465	2.455	0.010	2.460

** Dixon-Test: Straggler. Q = 0.479 (5%) < 0.480 < 0.579 (1%)
n = 11. Mean = 2.512. r_{95} = 0.023. R_{95} = 0.286

Wort, ca 14°P

Lab	1. det.	2. det.	w	m
1	2.137	2.137	0.000	2.137
2	2.034	2.034	0.000	2.034
4	2.000	2.110	0.020	2.100
6	1.973	1.970	0.003	1.972
7	1.997	2.060	0.063*	2.029
8	2.029	2.022	0.007	2.026
9	2.069	2.058	0.011	2.064
10	1.980	1.980	0.000	1.980
11	2.007	2.016	0.009	2.012
12	1.981	1.980	0.001	1.981
13	1.837	1.837	0.000	1.837
15	1.953	1.955	0.002	1.954

* Cochran-Test: Outlier. C = 0.857 > 0.653 (1%)
n = 11. Mean = 2.009. r_{95} = 0.016. R_{95} = 0.227

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
1	1.932	1.932	0.000	1.932
2	1.797	1.795	0.002	1.796
4	1.900	1.840	0.06	1.870
6	1.762	1.758	0.004	1.760
7	1.789	1.786	0.003	1.788
8	1.813	1.814	0.001	1.814
9	1.858	1.849	0.009	1.854
10	1.770	1.780	0.010	1.775
11	1.806	1.805	0.001	1.806
12	1.784	1.785	0.001	1.785
13	1.657	1.657	0.000	1.657**
15	1.761	1.770	0.009	1.766

** Dixon-Test: Straggler. Q = 0.479 (5%) < 0.484 < 0.579 (1%)
n = 11. Mean = 1.813. r_{95} = 0.038. R_{95} = 0.150

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
1	1.743	1.743	0.000	1.743
2	1.613	1.615	0.002	1.614
4	1.670	1.670	0.000	1.670
6	1.587	1.580	0.007	1.584
7	1.609	1.596	0.013	1.603
8	1.638	1.636	0.002	1.637
9	1.678	1.668	0.010	1.673
10	1.590	1.600	0.010	1.595
11	1.663	1.658	0.005	1.661
12	1.582	1.590	0.008	1.586
13	1.495	1.500	0.005	1.498
15	1.573	1.580	0.007	1.577

n = 12. Mean = 1.620. r_{95} = 0.014. R_{95} = 0.177

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
1	1.592	1.592	0.000	1.592
2	1.456	1.456	0.000	1.456
4	1.490	1.460	0.030	1.475
6	1.425	1.411	0.014	1.418
7	1.434	1.450	0.016	1.442
8	1.459	1.460	0.001	1.456
9	1.497	1.510	0.013	1.504
10	1.440	1.440	0.000	1.440
11	1.471	1.475	0.004	1.473
12	1.471	1.494	0.023	1.483
13	1.358	1.365	0.007	1.362
15	1.390	1.399	0.009	1.395

n = 12. Mean = 1.458. r_{95} = 0.027. R_{95} = 0.165

Precision

The precision values (mPas) deduced from the results of twelve and eleven laboratories respectively analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
1.46 to 2.51	0.02	- 0.03 + 0.123 m

where m is the mean value.

Note

It has to be taken into consideration that also other types of viscometers than capillary viscometers have been used.

3.3 Colour, EBC Units

(Analytica-EBC, method 8.5)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
1	19.12	19.16	0.04	19.14
2	14.80	14.80	0.00	14.80
3	15.80	15.80	0.00	15.80
4	23.60	23.60	0.00	23.60**
5	16.32	16.32	0.00	16.32
6	16.60	16.40	0.40	16.50
7	17.20	17.30	0.20	17.25
8	14.70	14.80	0.10	14.75
9	17.50	17.50	0.00	17.50
10	16.10	16.10	0.00	16.10
11	14.51	14.50	0.01	14.51
12	15.78	15.78	0.00	15.78
13	14.80	15.00	0.20	14.90
14	15.87	15.85	0.02	15.86
15	15.30	15.50	0.20	15.40

** Dixon-Test: Outlier. Q = 0.693 > 0.647 (1%)

' n = 14. Mean = 16.0. r_{95} = 0.20. R_{95} = 3.59

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
1	14.01	13.99	0.02	14.00
2	11.60	11.60	0.00	11.60
3	11.10	11.10	0.00	11.10
4	20.80	20.80	0.00	20.80**
5	12.43	12.37	0.06	12.40
6	14.10	14.10	0.00	14.10
7	13.20	13.30	0.10	13.25
8	11.20	11.20	0.00	11.20
9	14.20	14.20	0.00	14.20
10	12.30	12.20	0.10	12.25
11	11.18	11.18	0.00	11.18
12	11.28	11.28	0.00	11.28
13	11.50	11.60	0.10	11.55
14	11.77	11.75	0.02	11.76
15	11.90	12.40	0.05	12.15

** Dixon-Test: Outlier. Q = 0.708 > 0.647 (1%)

n = 14. Mean = 12.3. r_{95} = 0.10. R_{95} = 3.23

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
1	12.02	12.00	0.02	12.01
2	9.90	9.85	0.05	9.88
3	9.50	9.50	0.00	9.50
4	15.20	15.20	0.00	15.20**
5	10.36	10.45	0.09	10.41
6	11.30	11.30	0.00	11.30
7	11.30	11.40	0.10	11.35
8	9.70	9.73	0.03	9.72
9	11.70	11.70	0.00	11.70
10	10.50	10.40	0.10	10.45
11	9.37	9.41	0.04	9.39
12	9.63	9.68	0.05	9.66
13	9.72	9.70	0.02	9.71
14	10.38	10.37	0.01	10.38
15	9.90	10.0	0.10	9.95

** Dixon-Test: Straggler. Q = 0.565 (5%) < 0.631 < 0.647 (1%)
n = 14. Mean = 10.4. r_{95} = 0.12. R_{95} = 2.46

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
1	10.02	10.01	0.01	10.02
2	8.18	8.18	0.00	8.18
3	7.90	7.90	0.00	7.90
4	14.10	14.10	0.00	14.10**
5	8.45	8.42	0.03	8.44
6	9.08	9.00	0.08	9.04
7	9.40	9.60	0.20	9.50
8	7.80	7.75	0.05	7.78
9	9.80	9.80	0.00	9.80
10	8.60	8.40	0.20	8.50
11	8.02	7.96	0.06	7.99
12	8.00	8.03	0.03	8.02
13	8.10	8.15	0.05	8.13
14	8.68	8.66	0.02	8.67
15	9.50	10.00	0.50*	9.75

* Cochran-Test: Outlier. C = 0.719 > 0.575 (1%)
** Dixon-Test: Outlier. Q = 0.703 > 0.670 (1%)
n = 13. Mean = 8.61. r_{95} = 0.17. R_{95} = 2.13

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
1	8.04	8.04	0.00	8.04
2	6.48	6.48	0.00	6.48
3	6.30	6.30	0.00	6.30
4	9.80	9.80	0.00	9.80
5	6.63	6.62	0.01	6.63
6	7.15	7.18	0.03	7.17
7	7.40	7.50	0.10	7.45
8	6.35	6.33	0.02	6.34
9	8.40	8.40	0.00	8.40
10	6.90	6.90	0.00	6.90
11	6.27	6.29	0.02	6.28
12	6.35	6.35	0.00	6.35
13	6.45	6.47	0.02	6.46
14	6.69	6.67	0.02	6.68
15	6.70	7.30	0.60*	7.00

* Cochran-Test: Outlier. C = 0.966 > 0.575 (1%)
n = 14. Mean = 7.09. r_{95} = 0.06. R_{95} = 2.90

Precision

The precision values (EBC Units) deduced from the results of fourteen and thirteen laboratories respectively analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
7 to 16	0.1	1.52 + 0.12 m

where m is the mean value.

3.4 Fermentable Carbohydrates, g/100 ml

(Analytica-EBC, method 8.7)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
2	13.969	14.081	0.112	14.025
5	10.893	10.601	0.292	10.747
7	13.058	13.131	0.073	13.095
10	14.446	14.430	0.016	14.438
14	14.163	14.260	0.097	14.212
15	12.330	12.170	0.160	12.250

n = 6. Mean = 13.128. r_{95} = 0.304. R_{95} = 4.035

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
2	11.010	10.584	0.426	10.797
5	8.186	8.065	0.121	8.126
7	10.194	9.922	0.272	10.058
10	10.899	10.780	0.119	10.839
14	11.071	11.022	0.049	11.046
15	9.970	9.460	0.490	9.215

n = 6. Mean = 10.014. r_{95} = 0.593. R_{95} = 3.270

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
2	8.702	9.134	0.432	8.918
5	6.860	7.805	0.945	7.333
7	8.119	8.124	0.075	8.122
10	9.190	9.332	0.142	9.261
14	9.361	9.553	0.192	9.457
15	8.080	7.740	0.340	7.910

n = 6. Mean = 8.500. r_{95} = 0.916. R_{95} = 2.462

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
2	7.806	7.464	0.342	7.635
5	5.807	6.377	0.570	6.092
7	6.871	6.703	0.168	6.787
10	7.727	7.771	0.044	7.749
14	7.955	7.948	0.007	7.952
15	6.440	6.580	0.140	6.510

n = 6. Mean = 7.121. r_{95} = 0.573. R_{95} = 2.190

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
2	6.050	6.026	0.024	6.038
5	4.250	3.996	0.254	4.123
7	5.359	5.408	0.049	5.384
10	6.210	6.254	0.044	6.232
14	6.640	6.320	0.320	6.480
15	5.020	5.310	0.290	5.165

n = 6. Mean = 5.570. r_{95} = 0.413. R_{95} = 2.477

Precision

The precision values (g/100 ml) deduced from the results of six laboratories analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
5.57 to 13.13	0.56	0.76 + 0.24 m

where m is the mean value.

3.5 Bitterness, BU (Analytica-EBC, method 8.8)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
1	40.4	40.7	0.3	40.55
2	47.2	47.3	0.1	47.25
3	38.7	41.0	2.3	39.85
4	43.8	42.7	1.1	43.25
5	43.4	43.4	0.0	43.40
6	43.8	42.1	1.7	42.95
7	42.6	44.2	1.6	43.40
8	43.6	43.2	0.4	43.40
9	41.6	41.8	0.2	41.70
10	39.7	39.7	0.0	39.70
11	39.3	39.6	0.3	39.45
12	39.5	42.0	2.5	40.75
13	43.6	43.9	0.3	43.75
14	41.5	41.7	0.2	41.60
15	45.2	44.9	0.3	45.05

n = 15. Mean = 42.4. r_{95} = 2.2. R_{95} = 6.4

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
1	30.7	31.0	0.3	30.85
2	36.2	36.0	0.2	36.10
3	32.1	29.6	2.5*	30.85
4	35.4	34.0	1.4	34.70
5	33.7	33.6	0.1	33.65
6	32.2	31.9	0.3	32.05
7	33.2	32.4	0.8	32.80
8	33.9	33.5	0.4	33.70
9	31.0	31.2	0.1	31.10
10	30.9	30.8	0.1	30.85
11	31.2	30.7	0.5	30.95
12	32.0	32.2	0.2	32.10
13	34.1	33.9	0.2	34.00
14	33.5	33.5	0.0	33.50
15	34.4	34.6	0.2	34.50

* Cochran-Test: Outlier. C = 0.647 > 0.575 (1%).
n = 14. Mean = 32.9. r_{95} = 1.0. R_{95} = 4.7

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
1	26.2	26,4	0.2	26.30
2	31.1	30.8	0.3	30.95
3	27.7	26.4	1.3	27.05
4	28.9	28.1	0.8	28.50
5	29.2	29.2	0.0	29.20
6	25.3	26.6	1.3	25.95
7	28.8	27.5	1.3	28.15
8	28.9	28.4	0.5	28.65
9	27.7	27.6	0.1	27.65
10	26.1	26.3	0.2	26.20
11	27.1	26.7	0.4	26.90
12	27.9	27.4	0.5	27.65
13	28.7	29.0	0.3	28.85
14	23.7	23.9	0.2	23.80
15	28.9	28.9	0.0	28.90

n = 15. Mean = 27.7. r_{95} = 1.3. R_{95} = 4.9

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
1	20.6	20.9	0.3	20.75
2	25.2	25.1	0.1	25.15
3	22.1	22.8	0.7	22.45
4	23.6	24.0	0.4	23.80
5	23.0	23.1	0.1	23.05
6	22.5	22.1	0.4	22.30
7	21.9	22.8	0.9	22.35
8	23.4	23.3	0.1	23.35
9	23.4	23.3	0.1	23.35
10	21.8	22.0	0.2	21.90
11	23.6	23.2	0.4	23.40
12	23.3	22.6	0.7	22.95
13	24.8	25.0	0.2	24.90
14	18.6	18.8	0.2	18.70
15	23.9	23.8	0.1	23.85

n = 15. Mean = 22.8. r_{95} = 0.8. R_{95} = 4.5

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
1	16.8	17.0	0.2	16.00
2	20.2	19.8	0.4	20.00
3	18.9	18.8	0.1	18.85
4	18.5	18.7	0.2	18.60
5	18.4	18.5	0.1	18.45
6	17.0	16.9	0.1	16.95
7	17.5	18.6	1.1	18.05
8	18.6	18.6	0.0	18.60
9	18.6	18.7	0.1	18.65
10	16.9	16.8	0.1	16.85
11	17.2	17.8	0.6	17.50
12	17.2	17.7	0.5	17.45
13	18.9	19.1	0.2	18.00
14	17.8	17.9	0.1	17.85
15	18.8	18.8	0.0	18.80

n = 15. Mean = 18.1. r_{95} = 0.8. R_{95} = 2.5

Precision

The precision values (BU) deduced from the results of fifteen and fourteen laboratories respectively analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
18 to 42	- 0.36 + 0.05 m	0.72 + 0.14 m

where m is the mean value.

3.6 Total Nitrogen, Kjeldahl, mg/l

(Analytica-EBC, method 8.9.1)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
1	1849.9	1849.9	0.0	1849.9**
2	1686.4	1694.8	8.4	1690.6
6	1648.5	1648.5	0.0	1648.5
7	1649.0	1666.0	17.0	1657.5
8	1635.0	1661.6	26.6	1648.3
9	1607.2	1596.0	11.2	1601.6
10	1552,0	1540,0	12,0	1546,0
11	1671.3	1664.3	7.0	1667.8
12	1618.4	1615.6	2.8	1617.0
13	1691.9	1718.7	26.8	1705.3
14	1632.8	1638.0	5.2	1635.4
15	1702.4	1706.6	4.2	1704.5

** Dixon-Test: Outlier Q = 0.582 > 0.579 (1%).
n = 11. Mean = 1647.5. r_{95} = 28.0. R_{95} = 135.5

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
1	1573.7	1573.7	0.0	1573.7**
2	1294.2	1297.0	2.8	1295.6
6	1256.5	1263.5	7.0	1260.0
7	1281.0	1277.0	4.0	1279.0
8	1280.1	1280.1	0.0	1280.1
9	1239.8	1253.9	14.1	1246.9
10	1165,0	1189,0	24,0*	1177,0
11	1265.3	1272.3	7.0	1268.8
12	1185.8	1188.6	2.8	1187.1
13	1308.1	1299.1	9.0	1306.6
14	1288.0	1288.0	0.0	1288.0
15	1271.2	1275.4	4.2	1273.3

* Cochran-Test: C = 0.541 (5%) < 0.574 < 0.653 (1%).
** Dixon-Test: Outlier. Q = 0.885 > 0.605 (1%).
n = 11. Mean = 1259.9. r_{95} = 19.1. R_{95} = 118.6

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
1	1352.3	1359.0	6.7	1355.7**
2	1093.9	1103.9	9.9	1098.9
6	1081.5	1067.5	14.0	1074.5
7	1094.0	1089.0	5.0	1091.5
8	1068.8	1091.7	22.9	1080.3
9	1021.3	1034.3	13.0	1027.8
10	1002,0	1004,0	2,0	1003,0
11	1133.3	1118.3	15.0	1125.8
12	1036.0	1034.6	1.4	1035.3
13	1087.1	1076.6	10.5	1081.9
14	1092.0	1093.7	1.7	1092.9
15	1132.6	1097.6	35.0	1115.1

** Dixon-Test: Outlier. Q = 0.701 > 0.579 (1%).
n = 11. Mean = 1075.2. r_{95} = 30.7. R_{95} = 109.6

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
1	1135.3	1135.3	0.0	1135.3**
2	883.8	910.5	26.7	897.2
6	885.5	892.5	7.0	889.0
7	902.0	900.0	2.0	901.0
8	893.4	894.5	1.1	894.0
9	881.1	895.2	14.1	888.2
10	845,0	845,0	0.0	845,0
11	929.3	942.3	13.0	935.8
12	862.4	849.2	13.2	855.8
13	945.2	930.3	14.9	937.8
14	906.5	906.5	0.0	906.5
15	921.2	889.0	32.2	905.1

n* Dixon-Test: Outlier. Q = 0.707 > 0.579 (1%).
n = 11. Mean = 895.9. r_{95} = 30.6. R_{95} = 82.3

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
1	924.9	921.6	3.3	923.3**
2	720.0	718.6	1.4	719.3
6	710.5	703.5	7.0	707.0
7	714.8	714.8	0.0	714.8
8	716.9	710.4	6.5	713.7
9	664.5	671.5	7.0	668.0
10	660.0	649.0	11.0	654.5
11	735.8	740.3	4.5	738.1
12	655.2	658.0	2.8	656.6
13	700.3	692.9	7.4	696.6
14	712.2	715.7	3.5	714.0
15	723.8	712.6	11.2	718.2

** Dixon-Test: Outlier. Q = 0.725 > 0.579 (1%)
n = 11. Mean = 700.1. r_{95} = 13.3. R_{95} = 79.6

Precision

The precision values (mg/l) deduced from the results of eleven laboratories analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
700 to 1650	24	34 + 0.06 m

where m is the mean value.

3.7 Zinc, mg/l

(Analytica-EBC, method 8.11)

Wort, ca 18°P

Lab	1.det.	2.det.	w	m
4	0.569	0.544	0.025	0.557
5	0.254			
9	0.428	0.424	0.004	0.426
10	0.476	0.474	0.002	0.475
11	0.417	0.415	0.002	0.416
12	0.495	0.480	0.015	0.488
13	0.543	0.528	0.015	0.536
15	0.290	0.290	0.000	0.290

n = 7. Mean = 0.455. r_{95} = 0.025. R_{95} = 0.253

Wort, ca 14°P

Lab	1.det.	2.det.	w	m
4	0.591	0.578	0.013	0.585
5	0.225			
9	0.323	0.321	0.002	0.322
10	0.379	0.378	0.001	0.379
11	0.349	0.347	0.002	0.348
12	0.491	0.446	0.045*	0.469
13	0.432	0.423	0.009	0.428
15	0.270	0.280	0.010	0.275

* Cochran-Test: Outlier. C = 0.849 > 0.838 (1%).
n = 6. Mean = 0.389. r_{95} = 0.015. R_{95} = 0.307

Wort, ca 12°P

Lab	1.det.	2.det.	w	m
4	0.418	0.433	0.015	0.426
5	0.206			
9	0.272	0.276	0.004	0.274
10	0.329	0.325	0.004	0.327
11	0.312	0.308	0.004	0.310
12	0.271	0.309	0.038	0.290
13	0.385	0.407	0.022	0.396
15	0.250	0.250	0.000	0.250

n = 7. Mean = 0.325. r_{95} = 0.035. R_{95} = 0.183

Wort, ca 10°P

Lab	1.det.	2.det.	w	m
4	0.271	0.259	0.012	0.265
5	0.187			
9	0.221	0.225	0.004	0.223
10	0.282	0.275	0.007	0.279
11	0.235	0.237	0.002	0.236
12	0.280	0.270	0.010	0.275
13	0.347	0.321	0.026	0.334
15	0.230	0.230	0.000	0.230

n = 7. Mean = 0.263. r_{95} = 0.024. R_{95} = 0.110

Wort, ca 8°P

Lab	1.det.	2.det.	w	m
4	0.229	0.232	0.003	0.231
5	0.183			
9	0.180	0.182	0.002	0.181
10	0.225	0.219	0.006	0.222
11	0.186	0.187	0.001	0.187
12	0.218	0.207	0.011	0.213
13	0.282	0.308	0.026	0.295
15	0.200	0.200	0.000	0.200

n = 7. Mean = 0.218. r_{95} = 0.022. R_{95} = 0.110

Precision

The precision values (mg/l) deduced from the results of seven and six laboratories respectively analysing wort samples at 5 levels are:

Range	r_{95}	R_{95}
0.22 to 0.46	0.024	- 0.073 + 0.806 m

where m is the mean value.

4 Conclusion

The results of this collaborative trial showed that the repeatability (r_{95}) and re-producibility (R_{95}) values for the wort tested are at an acceptable level, so the Analysis Committee of the European Brewery Convention decided to take these precision values as official, except for the precision of determination of Zinc and Fermentable Carbohydrates which is considered as a guide.

5 Zusammenfassung

Hagen, W., und Schwarz, H.: Analytica-EBC – Präzisionswerte von Würzeanalysen — Monatsschrift für Brauwissenschaft 53, Nr. 9/10, 185 – 191, 2000

BC 35 Würze

In der Analytica-EBC werden folgende Methoden ohne die Werte der Reproduzierbarkeit (r_{95}) und Wiederholbarkeit (R_{95}) beschrieben: 8.3: Spezifisches Gewicht der Würze durch Dichtemessung, 8.4: Viskosität der Würze: Glaskapillar-Viskometer, 8.5: Würzefarbe: Spektrometrische Methode, 8.7: Vergärbare Kohlenhydrate in Würze durch HPLC, 8.8: Bittere der Würze (IM), 8.9.1: Gesamtstickstoff in Würze: Kjeldahl Methode und 8.11: Zink in Würze durch Atomabsorptionsspektroskopie. Diese Methoden wurden 1999 durch eine Ringuntersuchung von den Mitgliedern des Analysenkommittees der EBC getestet, um die entsprechenden Präzisionsdaten zu erhalten. Auch bei der Methode 8.12: „Gesamtpolyphenole in der Würze durch Spektrometrie“ fehlen exakte Daten, aber auf Grund eines neuen Tests mit Ammonium-Eisen-Citrat als Reagens wurde diese Versuchsreihe verschoben. Die analysierten Würzen wiesen Extraktgehalte von ca 18°P (Gew.%), bzw. 14°P, 12°P, 10°P und 8°P auf.

Hagen, W., et Schwarz, H.: Analytica-EBC – Valeurs de précision pour les analyses de moût — Monatsschrift für Brauwissenschaft 53, No. 9/10, 185 – 191, 2000

BC 35 Moût

Dans Analytica EBC, les méthodes suivantes sont décrites sans valeurs de répétabilité (r_{95}) et valeurs de reproductibilité (R_{95}): 8.3: Poids spécifique du moût par mesure de la densité, 8.4:Viscosité du moût: viscosimètre à tube capillaire, 8.5: Couleur du moût: méthode spectrophotométrique, 8.7: Glucides fermentescibles dans le moût par CLHP, 8.8: Amertume dans le moût (MI), 8.9.1. Azote total dans le moût: méthode Kjeldahl et 8.11: Zinc dans le moût par spectroscopie d’absorption atomique. Ces méthodes ont été testées en 1999 au cours de tests inter-laboratoires par les membres du Comité des Analyses de l’EBC dans le but d’obtenir les valeurs de précision. Il manque également les valeurs précises pour la méthode 8.12: Polyphénols totaux dans le moût par spectrophotométrie. Un nouveau test inter-laboratoire est prévu utilisant le citrate ferrique d’ammonium comme réactif ce qui explique le retard des essais. Les moûts analysés présentaient des teneurs en extrait d’environ 18° P (% poids), ainsi que 14° P, 12° P, 10° P et 8° P.

6 References

1. European Brewery Convention, Analytica-EBC, Grundwerk 1998. Fachverlag Hans Carl, Nürnberg 1998.
2. International Standard ISO 5725, 1994.