Malt Analysis

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CONCLUSION

The ASBC procedure for wort color was compared with an alternate "correction factor" procedure. The data indicate that the alternate procedure gives lower color values than the ASBC procedure, but the total error in this study was unacceptably high in all cases.

RECOMMENDATION

Further collaborative study of the correction factor procedure is suggested.

TABLE I
Malt Wort Color Determined by ASBC and Alternate Procedure

	Method				Method			
	Correction Factor		ASBC		Correction Factor		ASBC	
Laboratory	A	B	A	B	C	D	C	D
1	1.28	1.56	1.45	1.71	1.33	1.26	1.45	1.41
2	1.84	2.07	2.24	2.47	1.75	1.23	2.34	2.06
3	0.79	1.14	1.39	1.55	1.75	1.37	1.53	1.34
4	1.52	1.83	1.51	1.87	1.63	1.42	1.54	1.51
5	1.20	1.76	1.50	1.77	0.16[a]	1.35	1.42	1.43
6	1.41	1.66	1.67	1.88	1.27	1.38	1.57	1.54
7	1.17	1.52	1.33	1.70	1.41	1.17	1.48	1.35
8	1.41	1.76	1.37	1.71	1.35	1.42	1.33	1.38
9	1.21	1.64	1.58	1.86	0.89	1.13	1.65	1.41
10	1.43	1.87	1.53	1.88	1.44	1.43	1.40	1.46
11	1.75	2.32	1.91	2.10	0.27	1.36	3.24[a]	1.71
12	1.73	2.00	2.02	2.26	1.87	1.46	2.09	1.78
Mean	1.39	1.76	1.63	1.90	1.47	1.33	1.65	1.52
Grand mean	1.58		1.76		1.40		1.59	

[a]Identified as outliers; neither value of such pairs used in subsequent calculation.

TABLE II
Statistical Summary of Wort Color Data

				Error					
Pair	Method	N	Grand Mean	Within-Laboratory	Between-Laboratory	Total	c.v.[a]	Calculated F	Critical F[b]
A-B	Correction factor	12	1.58	0.0225	0.2847	0.2964	18.8	24.80	2.82
	ASBC	12	1.76	0.0496	0.2689	0.2734	15.5	59.73	2.82
C-D	Correction factor	10	1.40	0.1768	0.1338	0.2217	15.9	2.15	3.18
	ASBC	10	1.59	0.0890	0.2612	0.2760	17.4	18.23	3.18

[a]c.v. = coefficient of variation.
[b]At $P = 0.50$.

TABLE III
Correction Factors Reported by Collaborators

Collaborator	N	Mean	Standard Deviation	Coefficient of Variation (%)
1	18	2.45	0.572	23.3
2	10	6.02×10^{-4}	1.66×10^{-3}	275.0
3	10	2.49	1.65	66.3
4	10	1.95	1.31	67.3
5	12	6.67×10^{-3}	2.88×10^{-3}	43.2
6	15	3.02×10^{-3}	8.83×10^{-4}	29.2
7	10	3.29×10^{-2}	1.01×10^{-2}	30.7
8[a]	...	...	...	...
9	10	2.31×10^{-2}	5.30×10^{-3}	22.9
10	12	4.87×10^{-3}	2.26×10^{-4}	4.6
11	10	5.03	3.45	68.6
12	10	3.73×10^{-1}	8.01×10^{-1}	214.7

[a]Data for individual samples not available.

EXPERIMENTAL

Collaborators were sent two sample pairs of malt. One pair (A-B) yielded clear worts, the other (C-D) turbid worts. The collaborators were asked to determine, for their individual equipment, a turbidity correction factor equal to the change in wort color per unit change in turbidity. For this, at least 10 malt samples from each collaborator's laboratory were used to prepare ASBC worts. Wort color and turbidity were determined for each wort, and each was then filtered through a 0.45-μ membrane. Wort color and turbidity were again measured, and the ratio of change in color to change in turbidity was calculated for each and then averaged over all the samples.

The sample pairs submitted were then extracted and the color and turbidity of the ASBC worts determined. The correction factor as calculated above was applied and colors calculated as follows:

Correction factor × turbidity reading = Color correction

and

Color reading − color correction = Corrected color.

These same worts were then processed according to WORT-9 to yield ASBC color values.

RESULTS AND DISCUSSION

The data from 12 collaborators are presented in Tables I and II. Two outliers were identified in sample pairs C-D, and neither sample of either pair was included in subsequent calculations.

Between-laboratory error is high for both methods using clear worts (sample pair A-B) and for turbid wort using the ASBC method (Table II). Coefficients of variation for both methods and both sample pairs are also high compared to values obtained in Malt Analysis Check Service studies.

The correction factor procedure gave lower average color values for wort color than did the ASBC procedure for both sample pairs. This is in agreement with previous collaborative studies in which the two methods were compared on the same worts (1,2).

A source of error that may greatly affect the data when using the turbidity correction procedure is the wide variability encountered

in determining the conversion factor. Although all conversion factors are unique to the particular instruments used to determine them, the individual data supplied by the collaborators for the calculation of the factor showed coefficients of variation ranging from about 4 to over 200% (Table III).

The data for sample A-B were recalculated using only those five laboratories reporting coefficients of variation below 30.7%. The between-laboratory error, total error, coefficient of variation, and

TABLE IV
Brewer's Malt Analysis (dry basis)

Sample[a]		Moisture (%)	Extract FG (%)	Fine-Coarse Difference (%)	Diastatic Power (°ASBC)	α-Amylase (20°C DU)	Soluble Protein (N × 6.25)	Malt Total Protein (N × 6.25)	ASBC Wort Color	Number Reporting
A	Mean	4.22	82.62	1.54	121.9	44.31	5.856	11.99	1.806	39
	S.D.	0.18	0.41	0.28	4.9	3.19	0.129	0.28	0.124	
	c.v.	4.3	0.5	18.5	4.0	7.2	2.2	2.3	6.9	
B	Mean	4.10	82.68	1.70	122.0	44.28	5.891	12.01	1.788	40
	S.D.	0.14	0.41	0.47	6.1	3.41	0.124	0.29	0.114	
	c.v.	3.4	0.5	27.4	5.0	7.7	2.1	2.4	6.4	
C	Mean	3.87	77.71	1.76	156.5	44.91	5.601	13.59	1.540	42
	S.D.	0.16	0.47	0.44	4.7	2.74	0.162	0.33	0.132	
	c.v.	4.2	0.6	28.3	3.0	6.1	2.9	2.4	8.6	
D	Mean	3.98	82.01	1.20	125.9	45.54	4.705	10.80	1.929	42
	S.D.	0.20	0.49	0.45	5.0	3.32	0.113	0.24	0.312	
	c.v.	5.0	0.6	37.4	4.0	7.3	2.4	2.2	16.2	
E	Mean	4.32	80.66	1.67	102.1	38.39	5.194	12.45	2.135	44
	S.D.	0.14	0.48	0.41	5.1	2.42	0.119	0.31	0.132	
	c.v.	3.3	0.6	24.6	5.0	6.3	2.3	2.5	6.2	
F	Mean	4.42	77.76	1.30	145.1	47.52	5.522	12.81	1.842	44
	S.D.	0.18	0.39	0.41	4.4	3.37	0.149	0.27	0.101	
	c.v.	4.0	0.5	31.2	3.0	7.1	2.7	2.1	5.5	
G	Mean	4.71	77.46	1.20	152.9	41.13	5.392	13.06	1.999	37
	S.D.	0.15	0.46	0.24	7.7	2.22	0.113	0.29	0.147	
	c.v.	3.2	0.6	20.4	5.0	5.4	2.1	2.2	7.4	
H	Mean	4.43	77.65	1.29	151.4	41.18	5.623	13.14	1.926	37
	S.D.	0.12	0.47	0.34	4.5	1.89	0.124	0.26	0.096	
	c.v.	2.7	0.6	26.5	3.0	4.6	2.2	2.0	5.0	

[a]S.D. = standard deviation; c.v. = coefficient of variation.

TABLE V
Cereal Adjunct Analysis (dry basis)

Sample[a]	Moisture (%)	Extract[b] Malt Method 1	Extract[b] Enzyme Method 2	Oil[1b] (%)	Granulation (Ro-Tap) (%) On #14	On #20	On #30	On #40	Thru #40
Corn grits									
Mean	11.17	87.11	91.05	0.95	0.8	70.8	25.1	2.1	1.6
S.D.	0.53	5.82	0.97	0.09	1.0	6.8	6.3	1.0	1.4
c.v.	4.7	6.7	1.0	9.5	125.0	9.6	25.1	47.6	87.5
Number reporting	10	3	8	9	8	8	8	8	8
Corn starch									
Mean	8.43	104.1	102.4	0.05					
S.D.	0.46	1.11	1.94	0.05					
c.v.	5.5	1.1	1.9	100.0					
Number reporting	9	3	6	9					
Corn grits									
Mean	10.66	91.0	92.0	0.75	0.2	55.5	36.9	4.0	3.1
S.D.	0.36	1.09	1.19	0.08	0.14	10.4	9.8	0.96	2.0
c.v.	3.4	1.2	1.3	10.7	70.0	18.7	26.6	24.0	64.5
Number reporting	10	3	7	10	8	8	8	8	8
Corn grits									
Mean	11.80	91.82	93.18	0.87	0.1	24.8	57.3	15.5	2.2
S.D.	0.30	1.39	1.29	0.14	0.11	7.9	3.5	5.7	1.1
c.v.	2.5	1.5	1.4	16.1	110.0	31.9	6.1	36.8	50.0
Number reporting	9	3	7	9	8	8	8	8	8

[a]S.D. = standard deviation; c.v. = coefficient of variation.
[b]In percent, dry basis.

calculated F value were significantly reduced. This indicates the need for great care in determining this factor if reliable results are to be obtained using the correction factor method.

CONTINUING PROGRAMS

The Malt Analysis Check Service and the Cereal Adjunct Check Service have continued their functions. Data obtained from samples distributed in 1981 are given in Tables IV and V.

LITERATURE CITED

1. American Society of Brewing Chemists. Report of Subcommittee on Malt Analysis. *Journal* 37:118, 1979.
2. American Society of Brewing Chemists. Report of Subcommittee on Malt Analysis. *Journal* 38: 90, 1980.