Malt Analysis

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CONCLUSIONS

1. The current ASBC procedure for turbidity compensation in Congress Wort (celite filtration) does not fully or uniformly remove the turbidity.
2. The procedure employing celite filtration and a 700-nm correction for turbidity showed the least variability for hazy wort but a high standard deviation on the clear wort. Lack of familiarity with the other procedures produced variable data.
3. The amount of data collected on this collaborative series is inadequate to permit a final judgment on these procedures.

RECOMMENDATIONS

1. The four procedures should be subjected to further collaborative testing.
2. A separate group within the subcommittee should be set up to continue establishment of standardization procedures for the Buhler-Miag disc mill.

CONGRESS WORT COLOR[1]

Color measurement on Congress Wort has been a problem because some turbidity is always present. Instrumental measurement of color is biased by the light-scattering effect of the turbidity. The effect of turbidity on color is therefore a function of the distance from the sample cell to the measuring photo cell. Various methods have been used to correct for turbidity, some based on removal of turbidity by filtration, others by measurement and mathematical compensation for the turbidity. An early ASBC wort color method was of the latter type, using a 700-nm reading as a measurement of turbidity and subtracting this from the absorbance reading at 430 nm. Although measurement of turbidity at 700 nm will give a linear response to turbidity concentration (5), the amount of correction was found by a previous ASBC subcommittee (3) to be inadequate at high turbidity levels. This subcommittee also found that the 700-nm reading measures a color component in the wort in addition to turbidity. Thus, at very low turbidities, the amount of correction indicated by the 700-nm reading could be excessive. The celite filtration procedure now in use (1) was recommended by this subcommittee in 1968 (3). Frequently expressed concerns about this procedure include the possibility of adsorption of color by the relatively large amount of celite, leading to lower-than-actual color values, and the variable and incomplete removal of turbidity.

[1] Subcommittee members participating in the color collaborative: A. Agis, D. A. Baker, R. A. Carroll, J. Chladek, A. A. Fischer, P. J. Fromader, J. Livingston, and W. L. Swenson.

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PROCEDURES

The survey reported by this subcommittee last year (2) indicated that four general methods for turbidity correction are in current use. Of these, the method in which the reading at 700 nm is subtracted from the reading at 430 nm was dropped because it did not give an adequate correction. At the Annual Meeting, we added for consideration the Selas[2] filtration procedure, which is in use in our industry, and the membrane filtration procedure reported by van Strien and Drost (6).

Two malts having uncorrected color at a similar level were distributed for test use. One malt gave a hazy wort at a moderate color level, the other a clear wort at a high level.

The purpose of the collaborative test was to obtain data on the procedures in use so that within-laboratory and between-laboratory correlation of methods could be determined and a better understanding of existing problems obtained. Because filtration and nonfiltration methods as well as variations in filtration media existed as variables in the procedures, we hoped to identify the extent of bias from factors such as color adsorption by celite and measurement of both color and turbidity by the reading at 700 nm. If the data permitted, we intended to make a judgment on the suitability of the current ASBC procedure and the other four procedures in order to move the next collaborative work to the Malt Analysis Check Service distribution.

The current ASBC procedure, using celite filtration of the wort, is listed as procedure No. 1 (1). A frequently used modification of this procedure recognizes the fact that removal of turbidity by celite is variable and incomplete and applies a "700-nm" correction to the celite-filtered wort. This is procedure No. 2.

Procedure No. 3 does not use filtration but is a modification of the original unsatisfactory 700-nm correction method. A reading is made to determine absorbance at 430 nm and another to determine turbidity. The turbidity reading could be by nephelometer or by a 700-nm reading. A factor applied to the turbidity reading converts it into 430-nm absorbance units, which are then subtracted from the original reading at 430 nm. A procedure of this type was reported by Benard and Scriban (4); their factor was applicable only to their equipment. Procedure No. 3 eliminates possible

[2] Selas Corporation of America, Flowtronics Division, 1957 Pioneer Rd., Huntingdon Valley, PA 19006.

adsorption problems but could be biased if the 700-nm reading is used to measure turbidity and if it does include a color component. This factor was not taken into account in the original planning of the collaborative test.

Procedure No. 4 uses a ceramic Selas filter and also the "700-nm" correction on the filtered wort. The final filtration procedure (No. 5a) uses membrane filtration. Because 700-nm readings indicated additional turbidity, this correction was also made and termed procedure 5b. Although color adsorption might be possible for celite, it is assumed not to be a factor in membrane filtration.

TABLE I
Sample A (Hazy Wort) Color Values by Five Procedures

Procedure		Laboratory										
Number	Name	A	B	C	D	E	F	G	H	Mean	SD	Range
	Uncorrected color	2.58	2.71	1.91	3.47	2.78	2.82	2.56	2.56	2.67	0.43	0.49
1	Celite filtration	1.60	1.53	1.33	1.63	1.59	1.44	2.20[a]	1.48	1.51	0.11	0.30
2	Celite filtration plus 700 correction	1.48	1.46	1.27	1.50	1.50	1.39	1.85[a]	1.29	1.41	0.10	0.23
3	Turbidity conversion factor	1.52	1.01	1.33	···	1.57	2.36[a]	1.48	1.73	1.44	0.25	0.72
4	Selas filtration plus 700 correction	1.48	1.91	1.48	1.66	1.79	···	1.75	···	1.68	0.17	0.43
5a	Membrane filtration	1.53	1.94	1.91	3.17[a]	1.64	1.66	1.86	1.53	1.72	0.18	0.41
5b	Membrane filtration plus 700 correction	1.46	1.77	1.48	2.67[a]	1.58	1.56	1.50	1.35	1.52	0.13	0.42

[a] Outliers by Dixon's test.

TABLE II
Sample B (Clear Wort) Color Values by Five Procedures

Procedure		Laboratory										
Number	Name	A	B	C	D	E	F	G	H	Mean	SD	Range
	Uncorrected color	78	2.93	2.51	2.99	2.78	2.96	2.55	2.50	2.75	0.21	0.49
1	Celite filtration	64	2.93	2.32	2.96	2.68	2.91	2.90	2.50	2.73	0.23	0.64
2	Celite filtration plus 700 correction	50	2.73	2.32	2.75	2.65	2.69	2.60	2.15	2.55	0.21	0.60
3	Turbidity conversion factor	68	2.42	2.43	···	2.66	2.69	2.52	2.19	2.51	0.18	0.50
4	Selas filtration plus 700 correction	55	3.17[a]	2.38	2.77	2.53	···	2.55	···	2.56	0.16	0.39
5a	Membrane filtration	65	3.01	2.48	3.01	2.60	2.91	2.49	2.32	2.68	0.26	0.69
5b	Membrane filtration plus 700 correction	53	2.82	2.40	2.86	2.50	2.68	2.30	2.13	2.52	0.25	0.73

[a] Outlier by Dixon's test.

TABLE III
Brewer's Malt Analyses (dry basis)

Sample		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)	Wort Color, ASBC	Number Reporting
A	Mean	5.69	76.84	1.47	153.5	42.32	5.611	13.43	1.593	43
	SD	0.17	0.45	0.30	7.9	3.24	0.127	0.30	0.122	
	c.v.[a]	3.0	0.6	20.4	5.1	7.7	2.3	2.2	7.7	
B	Mean	4.81	77.16	1.66	148.7	43.32	5.538	13.26	1.615	43
	SD	0.18	0.47	0.34	6.4	3.04	0.123	0.28	0.168	
	c.v.	3.7	0.6	20.5	4.3	7.0	2.2	1.6	10.4	
C	Mean	4.31	81.53	1.37	106.3	41.75	4.653	11.19	1.705	48
	SD	0.20	0.38	0.36	7.4	2.67	0.134	0.27	0.128	
	c.v.	4.6	0.5	26.3	7.0	6.4	2.9	2.4	7.5	
D	Mean	3.99	75.77	1.94	127.3	40.79	4.995	13.19	1.958	48
	SD	0.17	0.40	0.45	5.9	2.55	0.135	0.32	0.157	
	c.v.	4.3	0.5	23.2	4.6	6.3	2.7	2.4	8.0	
E	Mean	4.51	77.90	1.97	160.3	47.84	5.596	13.70	1.737	43
	SD	0.16	0.43	0.48	7.3	3.12	0.117	0.25	0.091	
	c.v.	3.5	0.6	24.4	4.6	6.5	2.1	1.8	5.2	
F	Mean	4.49	78.20	1.40	163.7	46.77	5.549	13.36	1.653	43
	SD	0.15	0.44	0.32	8.3	2.06	0.111	0.25	0.103	
	c.v.	3.3	0.6	22.9	5.1	4.4	2.0	1.9	6.2	

[a] c.v. = Coefficient of variation, %.

RESULTS

Data for the hazy wort are given in Table I and for clear wort in Table II. Means, standard deviations, and ranges are shown for the color values by each method.

The hazy wort shows the expected greater variation between laboratories for uncorrected color.

Procedure No. 1 shows quite good data uniformity for the hazy wort but poor uniformity for the clear wort.

Procedure No. 2 shows excellent between-laboratory uniformity for the low color hazy wort. For the clear wort, the standard deviation of 0.21 is above normal levels, as indicated by the color data in Table III. Because this wort has high color, the variability is possibly due to color adsorption during filtration and to a color component in the 700-nm reading. The data in Table I suggest a true color value of 1.50 for the hazy wort. Four of the eight values obtained by procedure No. 2 are within ± 0.10 of this value, as are some values from each of the other procedures.

Lack of experience with the procedures was apparently a factor in increasing data variability. The 700-nm reading was found to be unsatisfactory for turbidity measurements in procedure No. 3; for this procedure, turbidity must be measured with a nephelometer.

Membrane filter data (No. 5a) indicate a need for an additional turbidity correction.

Data variability makes the use of these results impossible for some of the intended purposes.

TABLE IV
Cereal Adjunct (Corn Grits) Analysis Data (dry basis)

	Sample	Moisture (%)	Extract, % Malt Method	Extract, % Enzyme Method	Oil (%)
1	Mean	10.95	91.62	92.16	0.81
	SD	0.44	2.30	1.48	0.09
	c.v.[a]	4.0	2.5	1.6	11.1
	Number reporting	10	2	9	10
2	Mean	10.13	91.52	91.07	0.75
	SD	0.31	0.88	0.98	0.10
	c.v.	3.1	1.0	1.1	12.8
	Number reporting	10	2	9	10
3	Mean	10.15	91.48	91.33	0.74
	SD	0.48	0.40	1.28	0.08
	c.v.	4.7	0.4	1.4	10.8
	Number reporting	10	2	9	10
4	Mean	10.17	92.92	91.37	0.72
	SD	0.39	1.70	1.73	0.06
	c.v.	3.8	1.8	1.9	8.3
	Number reporting	10	3	9	10

[a] c.v. = Coefficient of variation, %.

CONTINUING PROGRAMS

The Malt Analysis Check Service and the Cereal Adjunct Check Service have continued their functions. Some delay was experienced on the malt analysis distribution; the schedule was accelerated slightly to correct for the delay. Data obtained during 1979 are given in Tables III and IV.

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