

NOTE

Reduction of Solvent Use in the Hop Laboratory¹

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Organic solvents in the workplace are classified as dangerous and/or hazardous. Such classifications make it necessary to take great care in the inventory, use, and disposal of the solvents. Any reductions in the amounts of solvent used in a particular method(s) would result in savings at purchase as well as during disposal or recycling.

Hops-6A (1) requires a specific amount of ground hop pellet powder (5 g) to be extracted with a specific amount of toluene (100 ml). The purpose of this work was to determine whether a 50% reduction in the amounts of the ground hop pellet powder and toluene used would yield the same results as the stipulated amounts.

PROCEDURE

Collaborators were sent three vacuum-packed sample pairs of hop pellets with low, medium, and high levels of α -acid. The

samples were analyzed for α -acid, β -acid, and hop storage index by the spectrophotometric method (1), which extracts 5 g of hop pellet powder with 100 ml of toluene. The samples were also analyzed by extraction of 2.5 g of hop pellet powder with 50 ml of toluene. Dilutions were done in duplicate. Results obtained were analyzed statistically following the AOAC statistical procedure (2).

RESULTS AND DISCUSSION

Results of the collaborators are shown in Tables I–III. There were no outliers according to the Dixon test used in Statistical Analysis-4 (1). The statistical summary of the data in Table IV shows acceptable repeatability and reproducibility for all sample pairs by both extraction regimes (2.5 g in 50 ml of toluene and 5.0 g in 100 ml of toluene).

TABLE I
Hop Pellet Extraction Tests

Collaborator	α -Acids (5 g/100 ml)						α -Acids (2.5 g/50 ml)					
	Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair	
	A	B	C	D	E	F	A	B	C	D	E	F
1	4.20	3.90	7.20	7.25	12.60	12.75	4.25	3.90	7.15	7.30	12.60	13.05
2	4.30	4.00	7.35	7.30	12.70	12.85	4.25	4.00	7.20	7.30	12.75	13.15
3	4.10	3.80	7.05	7.05	12.40	12.60	4.10	3.90	7.05	7.10	12.35	12.55
4	4.00	3.85	6.80	7.05	12.25	12.35	4.05	3.80	6.75	6.70	11.80	12.15
5	4.25	3.80	7.60	7.75	12.35	12.45	4.25	3.85	7.40	7.65	12.40	12.50
6	4.20	4.00	7.50	6.90	12.15	12.55	4.15	4.10	7.15	7.10	12.60	12.55
7	4.65	4.35	7.85	7.15	12.15	12.25	4.50	4.30	7.60	6.95	12.05	12.25
8	4.30	4.05	7.35	7.20	12.50	12.50	4.30	4.05	7.25	7.15	12.40	12.65
Mean	4.250	3.967	7.338	7.206	12.388	12.538	4.231	3.988	7.194	7.156	12.369	12.603
Grand Mean	4.109		7.272		12.463		4.109		7.175		12.486	

TABLE II
Hop Pellet Extraction Tests

Collaborator	β -Acids (5 g/100 ml)						β -Acids (2.5 g/50 ml)					
	Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair	
	A	B	C	D	E	F	A	B	C	D	E	F
1	3.15	2.80	4.80	4.65	7.80	8.05	3.15	2.85	4.70	4.65	7.85	8.25
2	3.25	2.90	4.90	4.90	7.85	8.15	3.20	2.95	4.80	4.90	8.05	8.30
3	3.30	2.95	4.85	4.90	8.10	8.30	3.30	2.95	4.85	4.90	8.00	8.30
4	3.30	2.95	4.95	4.95	8.35	8.50	3.25	2.90	4.90	4.90	8.25	8.40
5	3.55	3.10	5.00	5.05	8.35	8.70	3.40	3.05	5.05	4.95	8.50	8.75
6	3.05	2.75	5.15	4.90	8.40	8.75	3.15	2.85	4.95	4.85	8.50	8.65
7	3.00	2.75	4.45	5.00	8.40	8.50	2.95	2.55	4.45	5.00	8.65	8.40
8	3.45	3.15	5.15	5.00	8.45	8.45	3.45	3.15	5.15	5.10	8.30	8.55
Mean	3.256	2.919	4.906	4.919	8.212	8.425	3.231	2.906	4.856	4.906	8.263	8.450
Grand Mean	3.088		4.913		8.319		3.069		4.881		8.356	

¹Presented as a poster at the 57th Annual Meeting, San Antonio, TX, April 1991.

TABLE III
Hop Pellet Extraction Tests

Collaborator	Hop Storage Index (5 g/100 ml)						Hop Storage Index (2.5 g/50 ml)					
	Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair		Sample Pair	
	A	B	C	D	E	F	A	B	C	D	E	F
1	0.311	0.320	0.304	0.284	0.266	0.266	0.308	0.310	0.303	0.280	0.267	0.268
2	0.345	0.340	0.317	0.306	0.286	0.285	0.343	0.343	0.314	0.311	0.287	0.291
3	0.317	0.319	0.299	0.290	0.267	0.266	0.317	0.320	0.301	0.290	0.266	0.268
4	0.367	0.331	0.334	0.310	0.276	0.288	0.353	0.337	0.330	0.314	0.300	0.285
5	0.352	0.369	0.262	0.258	0.269	0.274	0.347	0.380	0.284	0.254	0.279	0.274
6	0.328	0.340	0.313	0.304	0.279	0.283	0.344	0.373	0.323	0.307	0.293	0.285
7	0.287	0.271	0.277	0.265	0.263	0.254	0.294	0.282	0.272	0.252	0.260	0.257
8	0.307	0.296	0.295	0.276	0.260	0.258	0.307	0.299	0.296	0.280	0.260	0.262
Mean	0.326	0.323	0.300	0.286	0.271	0.272	0.327	0.331	0.303	0.286	0.276	0.274
Grand Mean	0.325		0.293		0.271		0.329		0.294		0.275	

TABLE IV
Statistical Summary of Results^a

Sample Pair	No. of Labs	Grand Mean	Repeatability			Reproducibility		
			s_r	cv_r	r_{95}	s_R	cv_R	R_{95}
α -Acids (5 g/100 ml)								
A/B	8	4.109	0.063	1.5	0.175	0.186	4.5	0.521
C/D	8	7.272	0.243	3.3	0.680	0.293	4.0	0.820
E/F	8	12.463	0.082	0.7	0.231	0.200	1.6	0.561
α -Acids (2.5 g/50 ml)								
A/B	8	4.109	0.074	1.8	0.208	0.151	3.7	0.422
C/D	8	7.175	0.193	2.7	0.542	0.264	3.7	0.739
E/F	8	12.486	0.116	0.9	0.325	0.330	2.6	0.924
β -Acids (5 g/100 ml)								
A/B	8	3.088	0.041	1.3	0.115	0.170	5.5	0.477
C/D	8	4.913	0.172	3.5	0.481	0.181	3.7	0.506
E/F	8	8.319	0.088	1.1	0.247	0.254	3.1	0.712
β -Acids (2.5 g/50 ml)								
A/B	8	3.069	0.033	1.1	0.092	0.167	5.5	0.468
C/D	8	4.881	0.151	3.1	0.423	0.178	3.8	0.499
E/F	8	8.356	0.137	1.6	0.384	0.236	2.8	0.660
Hop storage index (5 g/100 ml)								
A/B	8	0.325	0.012	3.8	0.034	0.280	8.7	0.079
C/D	8	0.293	0.005	1.6	0.013	0.021	7.2	0.059
E/F	8	0.271	0.004	1.6	0.012	0.011	4.1	0.031
Hop storage index (2.5 g/50 ml)								
A/B	8	0.329	0.013	3.9	0.036	0.029	8.9	0.082
C/D	8	0.294	0.006	1.9	0.016	0.022	7.5	0.061
E/F	8	0.275	0.005	1.7	0.013	0.014	5.1	0.039

^a All calculations were based on reference 2.

CONCLUSIONS

1. Extraction of 2.5 g of hop pellet powder with 50 ml of toluene gives the same results as extracting 5.0 g with 100 ml. Alteration in the method would lead to a considerable reduction in use of this organic solvent.
2. Hops-6A should be modified to allow extraction of 2.5 g of hop pellet powder with 50 ml of toluene.

REFERENCES

1. American Society of Brewing Chemists. *Methods of Analysis*, 7th ed. Hops-6A α - and β -Acids in hops and hop pellets by spectrophotometry and by conductivity; Statistical Analysis-4 Youden unit collaborative testing procedure. The Society: St. Paul, MN, 1976.
2. Guidelines for Collaborative Study Procedures. *J. Assoc. Off. Anal. Chem.* 71:161, 1988.

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