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Influence of Gluten Components and Flour Lipids on Soft White Wheat Quality[1]

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ABSTRACT

Soft white wheat flours from varied growing conditions were analyzed for selected variables of gluten and components of flour lipid to identify those that are associated with baking quality as measured by cookie diameter and cake volume. Statistical analysis indicated that among the gluten variables, yield of gluten and pentosan in gluten were the variables most associated with cookie diameter corrected for protein content. However, when the correction for protein content was not taken into account, total protein was shown to be negatively correlated with cookie diameter. Among the components of flour lipid, polar lipid had the highest correlation with cake volume. These variables, therefore, appear to be important in the end-use quality of soft white wheat.

Soft wheat flours with low protein content are used for pastry products rather than for breadmaking, where hard wheat flour with higher protein content is used (Hoseney et al 1988). However, the protein content is not the only factor determining end-use properties. Protein quality can influence the baking properties of both hard wheat flour (Orth and Bushuk 1972) and soft white wheat flour (Kaldy and Rubenthaler 1987).

An important factor in protein quality is the gluten characteristics of a dough. Gluten is formed by the interactions of the proteins, glutenin and gliadin, which also associate with lipid and pentosans during dough formation (D'Appolonia and Kim 1976, Hoseney 1986). A strong dough with an extensive gluten network is suitable for breadmaking (Pomeranz 1988). In contrast, a weak dough, without an extensive gluten network, is best for cookies and cakes (Gaines 1990). Consequently, flour quality is influenced by the nature of the gluten and its various components. However, very little is known about gluten and its components in soft white wheat flour, especially with reference to baking quality.

Pentosans also have an influence on flour quality and dough formation (Yamazaki 1955, Shogren et al 1987). Native flour pentosans were found to have a negative effect on both cookie diameter and cake volume (Kaldy et al 1991). Some pentosans are part of the gluten matrix, but the exact nature of the association with the matrix is unknown. Also, the influence of the gluten-associated pentosans on baking quality of soft white wheat flour has not been established.

Flour lipids also influence the baking quality of soft white wheat flour. Cookies baked from flours with the lipids removed had smaller diameters than those baked from unextracted flours (Cole et al 1960). Studies on cake quality have also indicated that removal of lipids reduces cake volume (Seguchi and Matsuki 1977).

As far as lipid fractions are concerned, nonpolar and polar lipids in spring wheat flour have been shown to have an influence on loaf volume (Bekes et al 1986). Both nonpolar and polar lipids were found to be necessary for the restoration of cookie spread in defatted flour from a cultivar of eastern soft white wheat (Kissell et al 1971).

The purpose of this study was to examine gluten and lipid components in flours from soft white wheat grown under a broad range of conditions and to identify the gluten and lipid variables most associated with baking quality.

MATERIALS AND METHODS

Soft white wheat samples were collected from a broad range of growing environments in Alberta and Ontario, Canada, and in Washington State. Fifteen samples of soft white spring wheat were from a 500-km-wide region of Alberta. Ten samples were cv. Fielder, one was cv. Owens, one was cv. Dirkwin, and the remaining three samples were mixed (commercial) spring wheat cultivars, mainly Fielder and Owens. All were grown in 1984 except one Fielder sample, which was grown in 1983. Of the five samples from Washington State, four were Fielder. One was grown in 1981, another in 1982, and two samples in 1983. The other sample was Owens, grown in 1984. Three of the five winter wheat samples from Ontario were the cultivar Fredrick, grown in 1982, 1983, and 1984. The two other samples were mixed (commercial) cultivars grown in 1984.

All samples were milled on a Buhler pneumatic laboratory mill at the USDA Western Wheat Quality Laboratory, Pullman, WA, as described previously (Kaldy and Rubenthaler 1987). Cookie and cake baking, as well as some of the other tests, were also done at the Western Wheat Quality Laboratory as described previously (Kaldy and Rubenthaler 1987). The samples were stored under refrigeration. Some of the carbohydrates in flour were analyzed as previously described (Kaldy et al 1991).

As reported previously (Kaldy and Rubenthaler 1987, Kaldy

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et al 1991), the mean flour yield and standard deviation for all flour samples was 70.0 ± 2.7% with a range of 61.2–73.6%. The mean flour ash was 0.40 ± 0.03% with a range of 0.35–0.45%. Flour protein was 10.30 ± 1.14% (range 8.4–13.3%), soluble pentosan was 0.47 ± 0.05% (range 0.37–0.58%), and enzyme-extractable pentosan was 1.15 ± 0.07% (range 0.99–1.26%). For the corrected cookie diameter, the variation in diameter due to the variation in protein content was eliminated by correcting the results to a 9% protein content (Rubenthaler et al 1985).

Gluten Extraction and Analysis

Gluten was isolated from the soft white flours by hand washing (method 38-10, AACC 1983). The wet gluten was allowed to dry at 30°C for 24–48 hr and then dried for 1 hr at 100°C. After 15 min in a desiccator, the dry gluten was weighed and expressed as a percentage of flour to provide the yield of gluten. The gluten then was transferred to a mortar and crushed with a pestle. The resulting powder was saved for the determination of protein, phosphorus, and pentosan.

The protein and phosphorus contents of gluten were determined from the same sample digest by an automated colorimetric procedure (Technicon Industrial Systems 1977). Pentosans in gluten were hydrolyzed with 2*N* HCl for 4.5 hr at 100°C and determined using orcinol (Hashimoto et al 1987).

Flour Lipids

The ether-extractable lipids were determined using folded filter papers (methods 30-20 and 30-26, AACC 1983).

The determination of nonpolar and polar lipids was based on the method described by Zadernowski and Sosulski (1978) with modifications. The nonpolar lipids were extracted from the dried chloroform/methanol-extracted residue with cold hexane, and the polar lipids were extracted with methanol rather than with silicic acid. The nitrogen and phosphorus in polar lipids were determined as described under gluten.

Statistical Analysis

Simple and partial correlation coefficients (Steel and Torrie 1980) were obtained to determine the gluten and lipid variables that were most associated with cookie diameter, corrected cookie diameter, and cake volume, which were used as measures of baking quality (Kaldy et al 1991). Although simple correlations give a measure of the association between a given pair of variables, when there are intercorrelations with other variables, the simple coefficient will also reflect this (Steel and Torrie 1980). In addition, other variables associated with baking quality may not be evident from the simple correlations alone. The use of partial correlation coefficients, which eliminate any linear tendency of any combination of other variables to affect jointly the two variables under

TABLE I
Gluten and Lipid Components and Baking Quality in Soft White Wheat Flours[a,b]

Sample	YDGL (%)	PRGL (%)	PHGL (%)	PEGL (%)	PRPE (ratio)	PEGF (%)	TOPR (%)	GPTP (%)	GASP (%)	GAEP (%)	GAES (%)	ELIP (%)	NLIP (%)	PLIP (%)	TLIP (%)	NPLI (%)	PPLI (%)	CODI (cm)	CODIC[c] (cm)	CAVOL (ml)
Location 1, Ontario																				
1	10.6	72.9	0.105	0.68	107	0.072	9.0	85.9	16.7	6.5	10.6	1.13	0.60	0.94	1.55	2.85	0.29	9.15	9.01	1,275
2	10.2	74.8	0.125	0.71	105	0.072	9.3	81.8	16.0	6.5	10.9	1.20	0.76	0.94	1.69	3.42	0.36	9.41	9.30	1,325
3	12.9	73.0	0.098	0.56	130	0.072	10.5	89.7	14.7	6.9	12.9	0.99	0.76	0.93	1.69	3.85	0.29	9.05	9.05	1,245
4	8.7	78.3	0.101	0.58	135	0.051	8.4	81.7	13.8	5.2	8.2	1.05	0.78	0.97	1.75	3.38	0.37	9.25	9.05	1,290
5	11.8	69.4	0.114	0.73	95	0.086	9.8	83.6	18.7	7.9	13.7	1.16	0.73	0.97	1.70	4.55	0.28	9.19	9.12	1,295
Mean	10.8	73.7	0.109	0.65	114	0.071	9.4	84.5	16.0	6.6	11.3	1.11	0.73	0.95	1.68	3.61	0.32	9.21	9.11	1,286
SE	0.7	1.4	0.006	0.05	6	0.007	0.4	1.2	1.6	0.6	1.4	0.04	0.06	0.07	0.06	0.31	0.02	0.08	0.06	21
Location 2, Alberta																				
6	12.1	67.3	0.127	0.94	72	0.114	9.7	84.5	22.4	11.0	21.5	1.07	0.73	1.03	1.76	4.11	0.27	8.92	8.85	1,260
7	13.6	67.6	0.143	0.76	89	0.104	10.7	86.2	22.1	8.7	14.3	1.07	0.60	1.11	1.71	3.70	0.43	9.11	9.13	1,235
8	14.4	67.3	0.129	0.72	93	0.104	11.7	82.7	18.9	8.7	16.0	1.18	0.69	1.13	1.82	3.69	0.30	8.51	8.63	1,175
9	11.5	73.3	0.117	1.12	65	0.129	10.0	84.4	22.2	10.8	20.8	1.06	0.63	1.13	1.76	4.75	0.24	9.25	9.21	1,135
10	13.0	69.9	0.153	0.93	75	0.121	10.6	85.9	27.5	9.9	15.5	1.18	0.48	1.04	1.53	3.54	0.26	8.90	8.91	1,205
11	15.0	64.5	0.119	0.82	79	0.123	10.9	88.2	22.8	10.6	19.8	1.08	0.58	1.03	1.61	3.20	0.27	8.62	8.67	1,250
12	13.3	65.3	0.120	0.85	77	0.113	9.9	88.2	23.5	9.5	15.9	1.12	0.61	1.01	1.62	3.33	0.27	8.89	8.83	1,250
13	11.3	68.1	0.119	0.77	88	0.087	8.7	88.3	18.9	7.3	11.8	1.01	0.59	0.91	1.51	3.02	0.23	9.06	8.90	1,270
14	14.5	66.3	0.109	0.66	100	0.096	10.8	88.7	19.6	8.1	13.7	0.98	0.34	1.00	1.34	2.62	0.28	8.81	8.85	1,180
15	16.5	60.1	0.120	0.73	82	0.120	10.8	91.5	27.9	10.0	15.6	1.12	0.36	1.02	1.38	2.34	0.27	8.79	8.82	1,165
16	14.9	60.5	0.138	0.92	66	0.137	10.3	87.2	29.8	11.2	18.0	1.17	0.52	0.99	1.51	2.23	0.28	8.97	8.96	1,250
17	11.4	66.8	0.152	0.97	69	0.111	9.0	85.2	24.1	9.4	15.4	1.09	0.60	1.10	1.70	3.30	0.25	9.06	8.92	1,225
18	11.4	65.6	0.139	0.95	69	0.108	8.7	85.5	26.3	9.6	15.2	1.00	0.65	0.97	1.62	3.41	0.28	9.04	8.87	1,260
19	12.7	66.2	0.112	0.85	78	0.108	9.7	87.3	18.6	8.9	16.9	1.30	0.29	1.42	1.70	3.48	0.29	8.89	8.81	1,205
20	15.6	64.5	0.126	0.91	71	0.142	10.9	91.8	29.6	11.3	18.2	1.16	0.31	1.40	1.70	3.80	0.35	8.76	8.81	1,160
Mean	13.4	66.2	0.128	0.86	78	0.114	10.2	87.0	23.6	9.7	16.6	1.11	0.53	1.09	1.62	3.37	0.28	8.91	8.88	1,215
SE	0.4	0.8	0.003	0.03	4	0.004	0.2	0.7	0.9	0.4	0.8	0.02	0.03	0.04	0.04	0.18	0.01	0.05	0.04	12
Location 3, Washington																				
811532	15.8	64.7	0.096	0.68	95	0.108	11.6	88.1	27.0	10.1	16.1	1.08	0.55	0.91	1.46	2.63	0.23	9.01	9.01	1,344
821302	19.1	61.6	0.097	0.58	106	0.111	13.3	88.8	24.1	9.2	14.8	0.96	0.35	0.76	1.11	1.99	0.27	8.70	8.74	1,370
831812	16.5	62.9	0.102	0.71	89	0.117	11.0	93.7	25.4	10.6	18.3	1.01	0.66	0.81	1.47	1.78	0.26	8.89	8.94	1,295
831843	16.8	59.7	0.095	0.83	72	0.139	11.7	85.4	30.9	13.6	24.4	1.00	0.40	1.11	1.51	3.48	0.31	8.91	9.03	1,205
841742	14.8	62.8	0.121	0.59	106	0.087	10.6	87.9	20.7	7.6	11.9	0.95	0.34	1.30	1.64	3.61	0.27	9.16	9.06	1,235
Mean	16.6	62.3	0.102	0.68	94	0.112	11.6	88.8	25.6	10.2	17.1	1.00	0.46	0.98	1.44	2.70	0.27	8.93	8.96	1,290
SE	0.7	1.4	0.006	0.05	6	0.007	0.4	1.2	1.6	0.6	1.4	0.04	0.06	0.07	0.06	0.31	0.02	0.08	0.06	21
Grand mean	13.5	66.9	0.12	0.78	97	0.11	10.3	86.9	22.5	9.2	15.6	1.08	0.56	1.04	1.59	3.28	0.29	8.97	8.94	1,244

[a] YDGL = yield of gluten; PRGL = protein in gluten; PHGL = phosphorus in gluten; PEGL = pentosan in gluten; PRPE = ratio of protein to pentosan in gluten; PEGF = pentosan in gluten on a flour basis; TOPR = total flour protein; GPTP = protein in gluten as percentage of total flour protein; GASP = pentosan in gluten as a percentage of soluble pentosan in flour; GAEP = pentosan in gluten as a percentage of enzyme-extractable pentosan in flour; GAES = pentosan in gluten as a percentage of enzyme-extractable minus soluble pentosan in flour; ELIP = ether extractable lipids in flour; NLIP = nonpolar lipids in flour; PLIP = polar lipids in flour; TLIP = sum of nonpolar and polar lipids in flour; NPLI = nitrogen in polar lipids; PPLI = phosphorus in polar lipids; CODI = cookie diameter; CODIC = corrected cookie diameter; CAVOL = cake volume, SE = standard of error of a mean.

[b] Results, except for CODI, CODIC, and CAVOL, are corrected to be 0% moisture.

[c] Corrected to 9% protein at 14% moisture.

TABLE II
Correlation Coefficients of Gluten and Lipid Components in Soft White Wheat Flours[a]

Variables[b]	YDGL	PRGL	PHGL	PEGL	PRPE	PEGF	TOPR	GPTP	GASP	GAEP	GAES	ELIP	NLIP	PLIP	TLIP	NPLI	PPLI	CODI	CODIC	CAVOL
YDGL	...																			
PRGL	−0.66**[c]	...																		
PHGL	−0.27	0.03	...																	
PEGL	−0.38	0.17	0.26	...																
PRPE	0.10	0.26	−0.27	−0.87**	...															
PEGF	0.46*	−0.41	0.01	0.62**	−0.74**	...														
TOPR	0.85**	−0.27	−0.21	−0.34	0.21	0.36	...													
GPTP	0.54**	−0.40	−0.33	−0.33	0.14	0.14	0.18	...												
GASP	0.34	−0.50*	0.26	0.49*	−0.65**	0.80**	0.12	0.16	...											
GAEP	0.31	−0.36	−0.05	0.67**	−0.75**	0.93**	0.22	0.01	0.76**	...										
GAES	0.21	−0.19	−0.21	0.63**	−0.65**	0.80**	0.23	−0.09	0.45*	0.92**	...									
ELIP	0.12	−0.16	0.15	0.23	−0.41*	0.36	0.15	−0.13	0.23	0.25	0.20	...								
NLIP	−0.41	0.37	0.20	0.25	−0.10	−0.11	−0.24	−0.34	−0.12	0.07	0.18	−0.22	...							
PLIP	−0.10	0.02	0.06	0.13	−0.07	0.11	−0.06	−0.10	−0.06	0.06	0.11	0.38	−0.48*	...						
TLIP	−0.48	0.36	0.25	0.36	−0.16	0.00	−0.29	−0.42*	−0.18	0.12	0.28	0.19	0.43*	0.59**	...					
NPLI	−0.34	0.37	0.13	0.44*	−0.22	0.12	−0.05	−0.46*	−0.11	0.22	0.37	−0.01	0.17	0.55**	0.73**	...				
PPLI	0.14	0.00	0.18	−0.19	0.19	0.02	0.20	−0.13	0.05	0.00	−0.05	0.08	−0.12	0.34	0.23	0.08	...			
CODI	−0.72**	0.40	0.38	0.47*	−0.27	−0.17	−0.69**	−0.31	−0.02	−0.13	−0.16	−0.12	0.18	0.11	0.27	0.30	0.02	...		
CODIC	−0.45*	0.34	0.35	0.49*	−0.31	0.08	−0.36	−0.26	0.12	0.10	0.07	−0.05	0.15	0.14	0.29	0.38	0.18	0.89**	...	
CAVOL	−0.14	−0.02	0.16	−0.11	−0.01	−0.26	−0.17	−0.08	−0.08	−0.24	−0.28	0.01	0.36	−0.60**	−0.29	−0.39	−0.10	0.04	−0.18	...

[a] Correlation coefficients (21 df) for all variables after variation due to location was removed.
[b] YDGL = yield of gluten; PRGL = protein in gluten; PHGL = phosphorus in gluten; PEGL = pentosan in gluten; PRPE = ratio of protein to pentosan in gluten; PEGF = pentosan in gluten on a flour basis; TOPR = total flour protein; GPTP = protein in gluten as percentage of total flour protein; GASP = pentosan in gluten as a percentage of soluble pentosan in flour; GAEP = pentosan in gluten as a percentage of enzyme-extractable pentosan in flour; GAES = pentosan in gluten as a percentage of enzyme-extractable minus soluble pentosan in flour; ELIP = ether extractable lipids in flour; NLIP = nonpolar lipids in flour; PLIP = polar lipids in flour; TLIP = sum of nonpolar and polar lipids in flour; NPLI = nitrogen in polar lipids; PPLI = phosphorus in polar lipids; CODI = cookie diameter; CODIC = corrected cookie diameter; CAVOL = cake volume.
[c] $P < 0.05$ and 0.01 for * and **, respectively.

consideration, provides additional insight into relationships between the baking quality and gluten and lipid variables. In this study, the effects of two other variables were accounted for in determining the partial correlations.

Variation due to growing environment of the wheat samples was removed before determining the correlations by including dummy variables corresponding to the Alberta, Ontario, and Washington locations (Draper and Smith 1981). The CORR procedure of SAS (SAS Institute 1989) software was used to perform the statistical analyses.

RESULTS AND DISCUSSION

The data for the gluten, lipid, and baking quality variables are presented in Table I. Simple correlation coefficients among the baking quality and the gluten and lipid variables are given in Table II. A summary of the simple and partial correlations that were statistically significant are presented in Table III.

For cookie diameter, the simple correlations indicated that there were significant negative associations with yield of gluten ($r = -0.72$, $P < 0.01$) and total protein ($r = -0.69$, $P < 0.01$) and a positive association with pentosan in gluten ($r = 0.47$, $P < 0.05$) (Table II). The partial correlations involving yield of gluten and total protein were not significant ($P > 0.05$) (Table III). However, the partial correlation involving pentosan in gluten increased and was significant ($r_p = 0.55$, $P < 0.05$) (Table III). The small partial correlation coefficients between cookie diameter and either yield of gluten or total protein reflected their intercorrelations with other variables. For example, the simple correlation between yield of gluten and total protein was 0.85 ($P < 0.01$) (Table II). Significant negative partial correlations were also evident between cookie diameter and gluten pentosan as a percentage of enzyme-extractable minus soluble pentosan and between cookie diameter and gluten pentosan as a percentage of enzyme-extractable pentosan ($r_p = -0.45$ and -0.44, respectively; $P < 0.05$) (Table III), which were also highly intercorrelated ($r = 0.92$, $P < 0.01$) (Table II). Consequently, yield of gluten, total protein, and pentosan in gluten seem to be most associated with cookie diameter. To a lesser degree, gluten pentosan as a percentage of enzyme-extractable pentosan and as a percentage of enzyme-extractable pentosan minus soluble pentosan is also involved.

For the corrected cookie diameter, which included a correction to 9% protein content, there were significant simple correlations between corrected cookie diameter and yield of gluten ($r = -0.45$, $P < 0.05$) and between cookie diameter and pentosan in gluten ($r = 0.49$, $P < 0.05$) (Table II). Partial correlations involving corrected cookie diameter and yield of gluten were not significant ($P > 0.05$). However, partial correlations involving corrected cookie diameter and pentosan in gluten became as large as 0.64 ($P < 0.01$) when their association with two other variables was considered (Table III). No other gluten or lipid variables had significant partial correlation with corrected cookie diameter. Consequently, yield of gluten and pentosan in gluten are the variables most associated with corrected cookie diameter. Although other variables are associated with corrected cookie diameter through their relation with yield of gluten and pentosan in gluten, correlations involving these are not significant.

TABLE III
Summary of Simple and Partial Correlations for the Variables Associated with Baking Quality[a]

Baking Quality	Variable	Correlation[b] Simple	Partial
CODI	YDGL	−0.72**[c]	NS[d]
	TOPR	−0.69**	NS
	PEGL	0.47*	0.55*
	GAES	NS	−0.45*
	GAEP	NS	−0.44*
CODIC	YDGL	−0.45*	NS
	PEGL	0.49*	0.64**
CAVOL	PLIP	−0.60**	−0.69**
	GAEP	NS	−0.46*

[a] YDGL = yield of gluten; PEGL = pentosan in gluten; TOPR = total flour protein; GAEP = pentosan in gluten as a percentage of enzyme-extractable pentosan in flour; GAES = pentosan in gluten as a percentage of enzyme-extractable minus soluble pentosan in flour; PLIP = polar lipids in flour; CODI, cookie diameter; CODIC = corrected cookie diameter; CAVOL = cake volume.
[b] Degrees of freedom (df) for simple and partial correlations are 21 and 19, respectively.
[c] $P < 0.05$ and 0.01 for * and **, respectively.
[d] Not significant.

Only polar lipid had a significant simple correlation with cake volume ($r = -0.60$, $P < 0.01$) (Table II). Partial correlation between cake volume and polar lipid was of similar magnitude. A significant negative association between cake volume and gluten pentosan as a percentage of enzyme-extractable pentosan was also evident ($r_p = -0.46$, $P < 0.05$) (Table III). Thus, polar lipid is the variable most associated with cake volume. However, gluten pentosan as a percentage of enzyme-extractable pentosan may also have some influence on cake volume, as shown for cookie diameter.

Development of a strong gluten matrix is undesirable in cookie baking since this prevents cookie spread (Gaines 1990). This study shows that increasing the amount of gluten reduces cookie spread. Since yield of gluten and total protein in flour are strongly correlated ($r = 0.85$, $P < 0.01$) (Table II), higher protein levels also reduce cookie spread.

When cookie diameter corrected for protein content is considered, the effect of total flour protein is not significant. This is expected, because the variation in cookie diameter due to the variation in total flour protein is taken into account. However, yield of gluten still shows a negative association with cookie diameter, despite the correction for protein content, although its influence is considerably reduced.

Previous studies have shown that flour pentosans have a negative effect on cookie diameter (Yamazaki 1955, Kaldy et al 1991). In this study, pentosan in gluten had a positive effect on cookie diameter. The relationship of gluten pentosan to soluble, enzyme-extractable, or total pentosan is unclear. Gluten pentosan is, on average, 22.5 and 9.2% of soluble and enzyme-extractable pentosans, respectively, and it is 15.6% of the difference between enzyme-extractable and soluble pentosans in flour (Table I). However, gluten pentosan does show significant positive correlations ($P < 0.01$) with the latter two pentosan parameters (Table II). When the partial correlation is determined, the association of pentosan in gluten with cookie diameter increases slightly. When correlations were determined between the cookie diameter corrected for protein content and pentosan in gluten, a highly significant partial correlation also was found. Apparently, the effect of pentosan in gluten is not influenced by protein. Pentosan in gluten may function by allowing the gluten to spread more.

Gluten pentosan expressed as a percentage of the difference between enzyme-extractable and soluble pentosan in flour showed a negative partial correlation with cookie diameter. Gluten pentosan expressed as a percentage of enzyme-extractable pentosan in flour had a negative partial correlation with both cookie diameter and cake volume. These correlations may reflect the negative associations of cookie diameter and cake volume with flour pentosans reported previously (Kaldy et al 1991).

Clements and Donelson (1982) found that lipids are responsible for the achievement of cake volume. Overheating extracted flour lipids caused the lipids to become gummy. When reconstituted with flour and used in cake baking, the overheated lipids reduced cake height. In this study, a negative association was found between polar lipids and cake volume. This suggests that the polar lipids may make the batter more viscous so that maximum volume is not achieved.

CONCLUSIONS

Soft white wheat flour from a broad range of growing conditions was examined. Gluten and its constituents and flour lipid components associated with end-use qualities were identified. The important variables were yield of gluten, total protein, pentosan in gluten, and polar lipids in flour. Yield of gluten had a negative influence on cookie diameter with and without a correction for protein content, whereas pentosan in gluten had a positive influence. Total protein had a negative association with cookie diameter. Polar lipid was negatively associated with cake volume.

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